MINISTRY OF EDUCATION

CURRICULUM GUIDELINES

PHYSICS

GRADES – 10, 11, 12

DEPARTMENT OF EDUCATION
2010

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MINISTRY OF EDUCATION

MISSION STATEMENT

The mission of the Department of Education is to provide all persons in The Bahamas an opportunity to receive an education that will equip them with the necessary beliefs, attitudes, knowledge and skills required for work and life in a democratic, Christian society.

THE PHILOSOPHY

The Department of Education embraces a philosophy that all human beings have an undeniable right to an education, one that will enable them to understand their privileges and responsibilities in the community. The following principles are grounded in the Philosophy:

(i) A belief in the ability of the teaching/learning process to unlock and draw out the fullest potential of the individual;
(ii) An uncompromising commitment to the pursuit of excellence by teachers, learners and all who are associated with educational enterprises;
(iii) A belief in the value of the differing gifts and aptitudes of individuals, and in the importance of these differences in an inter-dependent society;
(iv) An appreciation of the natural and cultural heritage of The Bahamas;
(v) A recognition of The Bahamas as a part of a wider world community with which it must interact productively.

THE CURRICULUM

The curriculum developers have adopted, in part, the philosophies of John Dewey that "Knowledge is based on experience caused by the learner being in an active relationship with the environment" and Constructivism by Jean Piaget who proposes that "the learner should be in an environment where they are engaged in questioning, hypothesizing, investigating, debating, analyzing and evaluating."

ASSUMPTIONS

The Curriculum Guidelines are based on the assumptions that follow:

(i) Students want to learn.
(ii) The physical classroom environment as well as the experiences both inside and outside the classroom affect learning.
(iii) Students have the capacity to construct mental interpretations and concepts of the instructional experiences.
(iv) Students have the prerequisite knowledge and skills as outlined in the Appendix IV.

DESIGN

The design used for the curriculum guidelines include components of several designs, namely:

(i) **Backward** – initially, the knowledge, skills and attitudes required of students exiting secondary school after completing a three-year Biology Course of study were identified. These served as the basis for the selection of learner outcomes/specific objectives, content, instructional strategies and methods of assessment in the document.
(ii) **Skills-based** – the content is used to develop skills. Consequently, learner outcomes give focus to skills.
(iii) **Spiral** – skills and concepts are developed at each grade level (and as far as possible in successive units).
(iv) **Multidisciplinary** – most skills are applicable in other disciplines in particular, Language Arts, Social Sciences, Mathematics and career and vocational studies. Cross references are made to highlight complementary and supplementary information in other subjects (as well as units).
(v) **Flexible** – it allows teachers the latitude to modify the guidelines to accommodate students of high and average ability levels as well as students of different multiple intelligences and learning styles.
(vi) **Authentic** – the examples, problems and formative assessment used are relevant to the students' daily experiences.

OVERVIEW

INTENT

It is intended that this curriculum would be used by teachers throughout The Commonwealth of The Bahamas to provide a measure of standardized instruction.
It is intended further that students having completed the three-year course of study as outlined, will have common knowledge, skills and attitudes relative to a variety of Physical Science topics. Students completing this course of study should exhibit a level of scientific literacy that would enable them to function in tertiary level Physics courses as well as entry level in a Physics-related career. Further, it is intended that student-focused instructional activities facilitate students assuming responsibility for their learning. Finally, the use of these guidelines will provide students with many opportunities and experiences to develop identified skills that are assessed formatively. This would serve as a means of preparing them for summative assessment of skills in the Bahamas General Certificate of Secondary Education Examinations thereby increasing their level of success.

PLANNING

Teachers are encouraged to use the curriculum as a guideline for planning lessons. The sequence of learner outcomes in the scope of work allows a number of closely related learner outcomes to be included in one lesson. An example would be an investigation in which several skills (formulating hypothesis, designing and conducting an investigation, using scientific equipment and materials, recognizing and controlling variables, making observations, predicting, collecting and processing data, drawing relevant conclusions) are included. It is important that the learner outcomes included in one lesson facilitate students in developing concepts.

In an effort to place more emphasis on students' active involvement in the teaching-learning process, there are a number of activities that require students to do research or set up prior to a lesson. It is therefore suggested that when Schemes of Work are developed, such activities requiring prior planning are indicated in the time sequence required. Similarly, many opportunities are provided for group work and cooperative learning. It is important that planning includes ample lead time prior to presentations being made.

It is recognized that no curriculum guidelines would perfectly suit the pace at which all students master the information and skills. Consequently, there are several activities and/or similar skills outlined for a topic/sub-topic. It is suggested that teachers may omit some of the activities for classes that readily acquire the information and skills while more activities might be used with classes that need more reinforcement. Alternatively, if scheduling makes time a constraint, the number of activities and/or the number of learner outcomes addressing the same skill for a topic may be reduced. While this flexibility allows modifications to meet students' needs, teachers are advised to ensure that this does not lead to insufficient time to complete the course of study or a speedy completion with excessive "revision" time.

It is essential that lesson planning should be based on students' need to develop defined skills and/or attitudes as well as knowledge.

The time allocation in the curriculum is based on two 70 minutes lessons per week or three lessons of 50 minutes each per week for thirty (30) weeks per year.

INSTRUCTIONS

Throughout the curriculum guidelines there is a dual focus to the suggested instructional strategies: that they engage students actively in the learning process and that they are varied to allow students of different learning styles to benefit. Teachers are therefore encouraged to use the strategies indicated, or similar ones.

A concerted effort has been made by science curriculum committees to avoid duplication of information being taught at more than one school level and in more than one subject. While teachers are encouraged to ensure that students derive the maximum benefits from each lesson, care should be taken to avoid automatically re-teaching information and concepts that have been designated to junior high school curricula.

In the same manner that there are many common features of the Bahama Islands there are significant differences geographically and in terms of availability of resources. Teachers are therefore encouraged to include local examples in their planning and instructions.

Formative assessment is an integral part of effective planning for instruction and as such should be ongoing. Hence, a variety of means of assessing activities, skill development and learner outcomes are included in the curriculum. It is suggested that these, or similar methods, are used to assess students' progress in the identified skills, knowledge and attitudes.

The traditional methods of assessment utilizing tests containing structured questions and objective/multiple choice questions similar to those used on the Bahamas General Certificate of Secondary Education Examinations should be used more as summative assessments for the end of unit, mid-term and end of term assessment.

EVALUATION

As this is a draft document to be used and then evaluated, an evaluation form is included. Since the curriculum is being phased in, it is important that teachers complete and submit the Evaluation Form for tenth grade at the end of the first year. Similarly, forms for eleventh and twelfth grades should be remitted at the end of the second and third years respectively. This would enable revisions to be made to each section after the year has passed; thereby avoiding a lengthy and tedious major revision of the whole curriculum at the end of three years.

INTRODUCTION

RATIONALE FOR SCIENCE EDUCATION IN THE BAHAMAS

To provide opportunities that engage and expose all students in The Bahamas in acquiring scientific knowledge, attitudes and skills which will enhance critical thinking, problem-solving and organizational skills. In so doing, students will be prepared to participate in varied scientific and technological careers in the global environment, as well as realize the impact that they make on the natural world and appreciate the need for conservation.

OVERARCHING GOAL

To become critical thinkers, problem-solvers, innovators, visionaries, scientifically and technologically literate citizens who will appreciate, interpret and conserve the natural environment.

SUB-GOALS

- To develop analytical and evaluative skills thus becoming critical thinkers.
- To utilize the scientific method as a means of becoming problem solvers.
- To utilize creativity expressions to demonstrate the application of scientific knowledge and principles.
- To utilize scientific knowledge and the awareness of technological advances as a means of functioning effectively in the world.
- To formulate, present and defend arguments based on facts.
- To develop an appreciation for the safe and sustainable use of resources.
- To obtain the basic knowledge, skills and attitudes that are necessary for success in Physics Courses of study at the tertiary level.
- To develop skills that are necessary for success in entry level Physics-related jobs/careers.

FOCUS

It is increasingly obvious that in this age of information, no course of study can apprise students with all of the basic information of that discipline. It is therefore increasingly necessary, that students are equipped with the skills for acquiring information and processing the information as well as making decisions based on the processed information. The scientific method applied to problem solving highlights the skills that prepare students for life in the community. It is therefore important that all students are provided with extensive opportunities to develop these skills.

The combination of topics ensures that students who complete the three year course of study, have a good background in mechanics, structure and behaviour of matter, energy (waves, heat, light, electricity), atomic and nuclear physics.

GENERAL OBJECTIVES

1. Use materials and scientific equipment correctly and safely.
2. Make observations.
3. Utilize classification process.
4. Make inferences and draw conclusions.
5. Communicate information.
6. Recognize relationships.
7. Measure accurately.
8. Make predictions.
9. Collect, process and interpret data/information.
10. Formulate hypotheses.
11. Recognize and control variables.
12. Design, conduct and evaluate scientific investigations.
13. Formulate models.
14. Apply principles and concepts (scientific & technological) to make products.
15. Make informed, responsible and wise decisions.
16. Pursue new knowledge.
17. Demonstrate critical thinking.

RATIONALE FOR INCLUSIONS

Members of the Curriculum Development Committee reviewed Physics curricula from Australia (Victoria), United States of America (Connecticut), South Africa and the Caribbean Examinations Council. A comparative analysis was done for these areas of: focus, format, goals, methodologies and content. The results of this analysis were used, in part, to inform this document.

Questionnaires designed to seek the input of the public were prepared and distributed. The analysis of data from the questionnaires that were completed by educators, students and members of the community in Abaco, North Andros, Eleuthera, Exuma, Grand Bahama, Long Island and New Providence was used in preparing this document.

While there is no current Physics Curriculum, The Physics Curriculum 2010 is compared with the BGCSE Syllabus 1996 in three areas:

(i) Additions

Based on the relevance and application of physical concepts to today's world, several units have been added to the curriculum, which are currently absent from the Physics Syllabus. These include the following:

- Introduction of the basic concepts of Astrophysics
- Integration of aspects of Geophysics at relevant sections of the curriculum
- Recognition of other states of matter - plasma and Bose-Einstein Condensate
- Recognition of re-sublimation- deposition as the phase change from vapour to solid state when heat is removed

(ii) Modifications

Additionally, a more hands-on approach to learning physical concepts, more significant focus on the application of physical concepts and the inter-relations with other disciplines have been stressed. To this end, greater emphasis has been placed on the following physical science concepts when compared to the syllabus and will therefore require more detailed study:

- Physical measurements, quantities and units to lay the foundation needed for this course
- Contributions made by physicists and careers associated with physical science
- Resolution of vectors
- Projectile and Circular motion
- Bernouille's Principle and its applications
- Electronics

- Moment of couples
- Alternative Sources of Energy as the way forward
- Electrostatics – particularly in the introduction of Coulomb's Law and greater focus on capacitance
- Application of the motor effect in electric meters

The order of teaching some units have been rearranged to enable the foundational prerequisite knowledge to be established as a springboard upon which students can assimilate new knowledge. Rearrangement of these units is also justified in that closely related units follow concurrently so that students can better glean concepts. To this end, the following units have been moved to grade levels as indicated:

Grade 10

- Circular and Projectile motion
- Newton Laws of Motion
- Moments and machines
- Momentum
- Moment of couples

Grade 11

- Kinetic theory and gas laws
- Heat
- Optics

Grade 12

- Electrostatics
- Current Electricity
- Magnetism and electromagnetism

(iv) **Format**

- The format of the Scope and Sequence allows referencing to the extent to which skills are targeted at each grade level. It also indicates the depth of content to be covered and the order of sub-topics.
- The Scope of Work includes learner outcomes, content, student activities, resources and assessment strategies. The learner outcomes have been placed in the first column as a means of emphasizing their importance. A final column has been included with suggested methods of assessment for the learner outcomes and instructional activities. This serves to reinforce focus on the identified skills. In addition, the varied methods of assessment included, satisfy the overwhelming input from the Public Perception Questionnaire that assessment should not be based exclusively on tests.

(v.) Special Notes – Physical Measurements and Units

It is probably best to begin the grade 10 to grade 12 leg of this physics course almost entirely hands-on.

Students will enjoy doing things as they form physics concepts and develop mathematical skills. This will be a great confidence-booster for a starter – much needed, since many students are suspicious of the difficulties believed to be present in physics.

Students will also be developing teamwork skills as they explore techniques of measurement and share their results among colleagues.

This kind of introduction, properly executed in a hands-on manner almost exclusively, can make a big difference in students' overcoming their fear of physics and enjoy learning about science from this foundation science subject.

It is estimated that these introductory activities can be completed in one month.

Background considerations for teachers

In physics, measurement plays an important role.
Measurement

- helps students verify physics principles, and thus gives them that "aha" feeling of rightness (or possible wrongness) concerning established physics principles;
- helps students confirm or negate their predictions or hypotheses;
- properly taught, inculcates a discipline of doing things with precision (the measurements have to be "right" – little room for error); this attitude helps students to think and speak with precision as compared with vague ways of expressing notions;
- helps students to grasp concepts; by performing hands-on activities, they are able to move from the concrete to the abstract and conceptualize sometimes confusing concepts such as mass and weight, distance and displacement, heat and temperature;
- lays foundation skills in measuring and recording techniques that would be used later in real-world occupations such as in industry, laboratory technology and medicine, to name a few.

In the spirit of these introductory remarks, we begin with something with which students are very familiar – the ruler. We will introduce ideas of precision, significant figures, tabulation of results and finding an average.

SCOPE AND SEQUENCE – TOPICS & CONTENT

GRADE 10	GRADE 11	GRADE 12
Introduction, History and Careers Meaning of Physics Physicists and their contributions Careers	**Structure and Behaviour of Matter:** Kinetic Theory of Matter Adhesion, cohesion, elasticity Brownian Motion Anomalous expansion of water Heating and cooling curves Factors affecting melting and boiling points	**Electricity:** Current – difference between direct and alternating current (advantages and disadvantages) Circuit components and symbols, parallel and series circuits Ohm's Law
Physical Measurements Physical quantities, S. I. units	**Gas Laws:** Boyles' Law Charles' Law Pressure Law The Combined Gas Equation	**Electricity in the home:** Local methods of electricity production Ring circuits Wiring homes Cost of electricity Electrical safety
Mechanics: Forces (contact and non-contact) Vectors (addition and resolution of forces) Work, Energy, Power – kinetic and potential energy (problem solving)	**Heat Energy:** Heat and Internal energy Specific Heat Capacity Specific Latent Heat Methods of heat transfer Expansion Applications	**Magnetism & electromagnetism:** Magnetic theory Magnetic force fields Methods of magnetization and demagnetization
Machines: Principle of moments Couples Simple machines – mechanical advantage, velocity ratios, efficiency	**Waves:** Mechanical waves – transverse and longitudinal waves (properties, displacement-time graphs) Sound waves – production, reflection, refraction, diffraction, vibrating strings, audio range (humans), speed of sound, echoes (applications), wavelength, velocity, frequency, pitch, amplitude, acoustics Cathode Ray Oscilloscope	**Current and Magnetism:** Fleming's Left-hand rule D. C. electric motor Moving coil galvanometer Induction of an e.m.f. Principle, use and application of transformers Generators

SCOPE AND SEQUENCE – TOPICS & CONTENT

GRADE 10	GRADE 11	GRADE 12
Motion: *Linear* - scalar and vector quantities, speed, velocity, acceleration, equations of motion (problem solving) *Circular*- centripetal *Newton's Laws of Motion* – examples, problem solving, applications, collisions (elastic and inelastic), momentum, the law of conservation of linear momentum	**Electromagnetic Spectrum:** Electromagnetic spectrum – properties of component waves Universal wave equation	**Atomic and Nuclear Physics:** The Atom – sub-atomic particles, values of A and Z The nucleus – isotopes, chain reactions, nuclear fusion, nuclear fission, comparison of alpha, beta and gamma radiation, Geiger Muller Tube Half-life – radioactive sources, decay curves, radioactive waste, rate meter, design of a nuclear power plant, critical mass, uses of radioactive isotopes, negative effects of radioactive waste
Hydrostatics: Pressure Fluid Pressure Archimedes' Principle Manometer Barometer Pascal's Principle Bernouille's Principle	**Optics:** Pinhole camera Laws of reflection, spherical mirrors, ray diagrams Refraction, refractive index, critical angle Dispersion of light through a prism Experiments and calculations for convex lenses Comparison of the camera and the eye Telescope	**Electronics:** Thermionic emissions Cathode ray oscilloscope Semi-conductor diode Half wave rectification of alternating current Light emitting diode Light dependent resistor Use of relays in power amplification Simple electronic circuits
	Static Electricity: Electrostatics – atomic model, charging by friction, Van de Graaf generator, use of electroscopes, capacitors, applications of electrostatics	**Astrophysics**

SCOPE OF SKILLS GRADES 1 – 12

Objectives	Grades 1 – 6	Grades 7 – 9	Grades 10 - 12
Use materials and scientific equipment correctly and safely.	√	√	√
Make observations.	√	√	√
Utilize classification process	√	√	√
Make inferences and draw conclusions	√	√	√
Communicate information.	√	√	√
Recognize relationships (including spatial).	√ (Mainly spatial)	√	√
Measure accurately.	√	√	√
Make predictions.	√	√	√
Collect, process and interpret data/information.	√	√	√
Formulate hypotheses.	√	√	√
Recognize and control variables.			√
Design, conduct and evaluate scientific investigations.	√	√	√
Formulate models.	√	√	√
Apply principles and concepts (scientific & technological) to create products.		√	√
Make informed, responsible and wise decisions.	√	√	√
Pursue new knowledge.	√	√	√
Demonstrate critical thinking.	√	√	√

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Use materials and scientific equipment correctly and safely

GRADE 10	GRADE 11	GRADE 12
• Use appropriate instruments to measure quantities to degree of accuracy allowed by the instrument: ruler, measuring cylinder, stop watch, clock, thermometer, triple beam balance, digital balance, spring balance, Vernier caliper, micrometer screw gauge, ammeter, voltmeter. • Use the spring balance to measure force. • Use moving objects (trolleys, marbles, billiard balls) safely to differentiate between elastic and inelastic collisions. • Use common materials (plastic bottles, used cans, masking tape) to demonstrate that pressure in a fluid is dependent on depth and density of fluid and independent of shape, width or area of container base.(pressure increases with depth and density of fluid) • Use common materials safely to demonstrate atmospheric pressure. (rubber suckers, sucking egg into bottle, inverting a glass of water covered with a sheet of paper,) • Use barometer to describe how atmospheric pressure varies with height and from day to day e.g. weather systems. • Use spring balance, beam balance and displacement can (or concept of displacement) to demonstrate/verify Archimedes' principle. • Use common materials to investigate the ease of floatation in fluids of different densities.	• Use common materials (e.g. Ball& ring, gauge & bar) to demonstrate that different materials expand by different amounts for the same change in temperatures (linear expansivity). • Use common materials to construct models to demonstrate the greenhouse effect. • Use rope, slinky etc. to demonstrate that mechanical waves transfer energy along matter. • Use vibrating tuning forks, speakers, strings etc. to explain that sound waves are produced when objects vibrate. • Use stop watch, measuring tape, etc to determine the speed of sound from echo experiments. • Use convex lens, meter stick, card board screen etc. to experimentally determine the relationship between thickness and focal length of a convex lens. • Use the rough method (screen, meter stick etc.) to experimentally locate the principal focus of a concave mirror. • Use transparent blocks, pins, protractor, etc. to verify Snell's law of refraction experimentally. • Use transparent blocks, water, coin, pins etc. to experimentally determine the refractive index of a material by real & apparent depth method. • Handle electrical and electronic circuits safely. • Use common materials (e.g. Balloons, ebonite, polyethene rods) to demonstrate charging by friction.	• Use the cathode ray oscilloscope to distinguish between alternating (a.c.) and direct current (d. c.). • Use circuit components (including switches, fuses, resistors, variable resistors, filament lamps and diodes) safely in circuits. • Use instruments to accurately measure current and voltage. • Use circuit components and appropriate measuring instruments to investigate factors which affect resistance of a conductor (cross-sectional area, length, type of material, temperature). • Use common circuit components to construct series and parallel circuits. • Use appropriate measuring instruments to distinguish between series and parallel circuits. (with reference to current, voltage and resistance) • Use common circuit components to construct test circuits to determine the resistance of a given circuit component, through the application of Ohm's Law. (use voltmeter and ammeter) • Use plotting compass and/or iron filings and bar magnets to illustrate magnetic lines of force for a bar magnet and between poles of two bar magnets. • Use wires and appropriate core to construct an electromagnet and investigate the factors affecting the strength of an electromagnet.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Use materials and scientific equipment correctly and safely

GRADE 10	GRADE 11	GRADE 12
• Safely set up and use a water bath to perform experiment and plot heating/cooling curve and identify phase change (for wax, naphthalene-only in fume chamber!) from constant temperature.	• Charge objects and electroscopes by electrostatic induction and by contact.	• Safely use test circuits to demonstrate how fuses and circuit breakers protect from circuit over load and short circuits. • Use the semiconductor diode in circuits to show that current passes basically in one direction through a semi conductor diode. • Use appropriate measuring instruments and circuits to describe the variation of resistance of the thermistor with temperature and represent on graphs. • Use appropriate measuring instruments and circuits to describe the variation of resistance of the light-dependent resistor with light intensity and represent on graphs. • Use circuit components to construct simple electronic circuits such as motor control, light-operated switches, fire alarms and burglar alarms. • Use simple control and monitoring systems with electronic AND, NOT and OR, NOR and NAND gates. • Use telescope or naked eye to observe celestial objects (constellations, moon, some planets. E.g. motion of stars in relation to the North Star & the earth). (Caution: NEVER look at the Sun directly or through a telescope or even through coloured glass! Permanent eye-damage can result!).

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Make observations

GRADE 10	GRADE 11	GRADE 12
• Observe the direction of various forces (upthrust, weight, tension, etc) • Observe and describe energy transformations in common devices and processes e.g. batteries, electric iron, motors, generators etc. • Observe that moving bodies have kinetic energy which is converted into other forms when stopped. • Observe the effect of changing the distance from the fulcrum and the size of force on the turning effect of the force. • Observe terminal velocity of an object falling through a fluid. • Observe elastic and inelastic collisions. • Observe drag as an object moves through a fluid. • Recognize that a centripetal force is needed for circular motion. • Identify examples of centripetal force. (gravity in planetary and satellite motion, friction in moving around curves- roundabouts, tension in string whirling objects around). • Differentiate between elastic and inelastic collisions. • Observe the increase in pressure in a fluid as depth and density of the fluid increases. • Observe that pressure acts equally in all directions at the same depth in a fluid.	• Define internal energy of a substance and describe the factors that affect it - mass, temperature, nature and state of substance. • Define and demonstrate an understanding specific heat capacity. • Define and demonstrate an understanding of specific latent heat. • Determine the specific heat capacity of a solid or liquid using direct heating method and method of mixtures. • Relate temperature changes to thermal expansion/contraction of various materials. • Describe the anomalous expansion of water between 0^{o}C and 4^{o}C. • Recognize and demonstrate that different materials expand by different amounts for the same change in temperatures (linear expansivity). • Demonstrate that mechanical waves transfer energy along matter. • Recognize that a medium is needed for mechanical wave propagation. • List behaviours shown by waves: rectilinear propagation, reflection, refraction, diffraction. • Recognize that longitudinal and transverse waves show similar behaviours and obey the same laws. • Recognize that sound waves require a medium for propagation.	• Observe cathode ray oscilloscope traces to distinguish between alternating (a.c.) and direct current (d.c.). • Observe circuit components (including switches, fuses, resistors, variable resistors, filament lamps and diodes). • Observe the effects of cross-sectional area, length, type of material, temperature on the voltage and current through a conductor. • Observe differences between parallel and series circuits (with reference to current, voltage and resistance), after construction of such circuits. • Observe and compare current versus voltage graphs for filament bulb, thermistors, LDRs and explain their applications. • Observe and locate the poles of a magnetic dipole by suspending it freely in the earth's magnetic field • Observe attraction between magnets and various materials and so classify the materials as magnetic and non- magnetic. • Observe iron filings (or plotting compasses) traces of magnetic lines of force for a bar magnet and between poles of two bar magnets. • Observe the effects of stroking a magnetic material with the pole of permanent magnet. • Observe the magnetic flux patterns for a straight wire, a circular coil and a solenoid each carrying a direct current.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Make observations

GRADE 10	GRADE 11	GRADE 12
• Observe that liquid pressure is independent of shape, width or area of container base (liquid finds its own level). • Observe simple demonstrations/applications of Bernouille's principle eg. Jumping egg demonstration, sailing, flight, soccer, roof tops lifting off in hurricanes etc. • Observe the ease of floatation in fluids of different densities. • Observe the effects of temperature on the volume of a fixed mass of gas at constant pressure. • Observe how the volume of a fixed mass of gas relates to its pressure at constant temperature. (Boyle's law apparatus). • Observe models to predict changes in gas pressure due to changes in temperature, volume and number of particles. • Observe how the boiling point of liquids is affected by dissolved solids (impurities) and pressure changes (eg. altitude, pressure cookers) • Observe temperature changes as molten wax is cooled. • Observe the cooling effect of evaporation. (alcohol on arm etc) • Observe phase changes (sublimation, melting, freezing condensation). • Observe diffusion and Brownian motion.	• Describe the qualitative effects and relationship of thickness, tension and length on the frequency/pitch of a vibrating string or skin. • Describe acoustic resonance and its application in musical instruments. • State the conditions for total internal reflection. • Define critical angle (semi circular blocks, optical cables) • Observe critical angle for a material using a semi-circular block and ray box. • Observe real depth and apparent depth for a material(water, glass, Perspex) and hence determine the refractive index. • Observe, predict and account for the effect of light rays passing from one optical medium to another (refraction). • Observe images formed at the principal focus of a concave mirror. • Observe incident, reflected and normal rays. • Observe the relationship between angle of incidence and angle of reflection for light reflected by a plane surface. • Observe images formed by a pin-hole camera and images formed by a plane mirror. • Observe and describe the image formed by optical devices (nature- real, virtual, orientation- upright, inverted, vertically or laterally inverted, size- magnified or diminished, position- in relation to device).	• Observe the effect of placing a current-carrying conductor perpendicularly to a magnetic field (kicking wire experiment) and draw the resultant lines of force for the current carrying conductor in a uniform magnetic field. • Observe what happens when a current-carrying conductor is placed parallel to a magnetic field. • Observe a current carrying coil experiencing a couple in a uniform magnetic field. (d.c. motor or model of d.c. motor) • Observe the effect of current, number of turns and magnetic field strength on the force and hence speed of electrical motors.(models) • Observe the induction of an e.m.f. (and hence current in a complete circuit) based on the relative motion of a conductor perpendicular to a magnetic field (& motion of magnet in solenoid). • Observe the effects of strength of magnetic field, # of turns on solenoid, speed of motion, cross sectional area of the conductor on the magnitude of induced e.m.f. and current in a complete circuit. • Observe internal parts of a transformer (mutual induction). • Observe cathode ray oscilloscope traces for sound waves. • Observe the effects of changing around a semiconductor diode in a bulb circuit. • Observe light-emitting diodes (LED) working in circuits. (calculators, etc)

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Make observations

GRADE 10	GRADE 11	GRADE 12
	• Observe the relationship between thickness and focal length of a convex lens. • Observe internal structure of cow's/goat's eye and compare structure to human eye. • Perform experiments to observe blind spot, binocular vision, inversion of image on retina. • Observe the operation of the simple lens camera and the pin-hole camera and compare to the operation of the human eye. • Observe the effects of charged objects on each other e.g. balloons, ebonite rod, polythene. • Observe a charged object attracting objects having net zero charge. • Observe electroscopes charged by electrostatic induction and by contact. • Observe the effects of charged objects on charged electroscopes.	• Observe the variation of resistance of a thermistor with temperature (using thermistor in a bulb circuit). • Observe the variation of resistance of the light-dependent resistor with light intensity.(using LDR in a bulb circuit. • Observe celestial objects (constellations, moon, some planets. E.g. motion of stars in relation to the North Star & the earth) (Caution: NEVER look at the Sun directly or through a telescope or even through coloured glass! Permanent eye-damage can result!). • Observe the various phases of the Moon and eclipses (or models of same). • Observe and classify stars based on colour.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Utilize classification process

GRADE 10	GRADE 11	GRADE 12
• Classify forces as contact or non-contact. • Classify force as a vector quantity as opposed to a scalar quantity. • Classify simple machines as force or distance multipliers. • Classify common levers as first, second or third class. • Classify physical quantities as vector and scalar quantities e.g. distance and displacement, speed and velocity. • Classify collisions as elastic or inelastic. • Classify matter into the states based on motion, kinetic energy & arrangement of particles, and forces between particles. • Classify phase changes as endothermic or exothermic.	• Classify the members of the electromagnetic spectrum according to frequency or wavelength. • Classify rays on ray diagrams as incident, reflected or refracted. • Classify materials as becoming electrostatically charged negatively or positively. • Classify waves as longitudinal or transverse. • Classify images as real or virtual. • Classify lenses as convex or concave.	• Classify materials as magnetic and non- magnetic. • Classify magnetic materials as magnetically hard and soft materials. • Classify stars based on colour. • Classify nuclear emissions as alpha, beta or gamma.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Make inferences and draw conclusions

GRADE 10	GRADE 11	GRADE 12
• Infer that the direction of motion is based on area of low pressure created by high velocity air particles. (Bernouille's principle) • Infer the presence of atmospheric pressure based on simple experiments.	• Recognize that longitudinal and transverse waves show similar behaviours and obey the same laws. • Conclude that sound waves require a medium for propagation after experimenting. (bell jar experiment) • Infer the values for angles of reflection and angles of incidence (given either) for light reflected by a plane surface. • Conclude that refraction occurs as light passes from one optically dense medium to another of different density. • Conclude that the degree of bending (change of speed) of light rays is related to the refractive index of the materials it passes through. • Infer that the thicker a convex lens, the shorter will be its focal length. • Infer that at certain distances from the eye, the image is formed at the blind spot. • Infer after experimenting that the image is inverted on the retina. • Infer after experimenting that human vision is binocular. • Infer the charge of an object based on repulsion with another object of known charge.	• Infer how resistance varies from current versus voltage graphs (filament bulb, thermistor, LDR) and explain their applications. • Infer that current is induced in a conductor if the conductor cuts magnetic field lines. • Infer the age of dead organic materials by using carbon dating. • Infer the half-life of a radioactive isotope from a decay graph. • Make inference about the structure of atoms based on alpha scattering data. • Make an inference about stars based on their colour.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Communicate information

GRADE 10	GRADE 11	GRADE 12
• Tabulate measurements with appropriate column/ row headings (physical quantity, units) to present information in a concise manner. • Illustrate on diagrams, all forces acting on an object. • Construct a chart to summarize the law of conservation of energy. • Make a flipchart/poster to display energy transformations in common devices and processes e.g. batteries and hydroelectricity, motors, generators. • Make a slide show presentation to show objects with gravitational potential energy and kinetic energy. • Draw diagrams to illustrate that moving bodies have kinetic energy which is converted into other forms when stopped. • Make a comic strip to communicate the definition for power as the rate of doing work or transferring energy and the units for power as Joules per second or Watts. • Collect and display pictures of single fixed, single moving and block & tackle pulley systems in action • Make a poster or flip chart to distinguish between instantaneous speed, average speed and constant speed. • Make a video presentation to show examples of projectile motion in every day life. (sports- shot put, soccer, discus, missiles).	• Communicate to the class through simulation/ demonstration that heat as the transfer of thermal energy from one object to another due to a temperature difference between them. • Define internal energy of a substance and describe the factors (mass, temperature, nature and state of substance) that affect the total internal energy of an object. • Define and demonstrate an understanding of specific heat capacity. • Define and demonstrate an understanding of specific latent heat. • Distinguish between latent heat of fusion and latent heat of vaporization. • Communicate to the class by using simulations/diagrams etc a description of common effects of the anomalous expansion of water between 0^oC and 4^oC. eg. Freezing of tops of lakes, bursting of bottles in freezer etc) • Orally present to the class using models/diagrams/simulations the greenhouse effect in terms of changes in wavelength of UV radiation. • Recognize that longitudinal and transverse waves show similar behaviours and obey the same laws. • State the audio frequency range in humans and compare to that of other animals. • Describe characteristics of sound (pitch, loudness, quality) and their relation to frequency and amplitude.	• Define current as the rate of electron flow (charge) measured in Coulombs per second and use $I = \frac{Q}{t}$ to solve problems • Make a chart to display the differences between alternating (a.c.) and direct current (d. c.) • Use circuit symbols and describe circuit components, symbols, and functions (including switches, fuses, resistors, variable resistors, filament lamps and diodes). • Define potential difference as the work done or energy transferred per unit charge passed between any two points ($V= \frac{W}{Q}$). • Define resistance as the opposition to the flow of electrons through a conductor. • Describe why (a) an ammeter should have a very low resistance and positioned in series (b) a voltmeter should have a very high resistance and positioned in parallel circuitry. • State Ohm's law ($R = \frac{V}{I}$) and apply it to solve problems (including graphical problems). • Communicate to the class, using test circuits, how to determine resistance of given components by applying Ohm's Law.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Communicate information

GRADE 10	GRADE 11	GRADE 12
• Make a slide show, poster board or video production to describe and summarise Newton's 3 laws of motion, clearly stating applications of each law. • Discuss in groups and design experiments to demonstrate the law of conservation of linear momentum. • Make a game to differentiate between elastic and inelastic collisions. • Explain to peers using demonstrations, the relationship between pressure exerted and the area and force applied. • Describe Pascal's principle and its application to hydraulic systems (e.g. braking systems, hydraulic press) to peers using diagrams or models. • Produce an annotated slide show/pictures/diagrams to show the application of Bernouille's principle to sailing, flight, soccer, roof tops lifting off in hurricanes etc. • Discuss (communicate) in groups how Archimedes' principle can be easily verified in the lab (and post this on a blog site). • Make a chart to communicate the differences between boiling and evaporation. • Draw an annotated diagram for display of a generalized cooling curve indicating phase changes.	• Describe the qualitative effects of, and relationship between thickness, tension and length and the frequency/pitch of a vibrating string or skin. • Describe acoustic resonance and its application in musical instruments. • Communicate to the class, using diagrams the classification of the members of the electromagnetic spectrum in terms of wavelength or frequency. • Summarize on a chart for display, the general properties of electromagnetic waves: possess electric and magnetic properties, transfer energy, travel at the speed of light, do not need material medium for propagation. • Describe the image formed by optical devices (nature- real, virtual, orientation upright, inverted, vertically or laterally inverted, size)- magnified or diminished, position- in relation to device. • Draw annotated diagrams for display in the classroom a description of optical terms associated with spherical mirrors- (principal focus, principal axis, center of curvature, pole, focal length, radius of curvature). • Summarise the definitions for refractive index in terms real-apparent depth, wave speeds, angle of incidence & refraction on a poster for display. • Draw diagrams for display in the classroom to show critical angle and total internal reflection.	• Deduce how resistance varies from current versus voltage graphs (bulb, thermistors, LDR's) and explain their applications. • Identify the poles of a magnetic dipole by suspending it freely in the earth's magnetic field. • Communicate through the use of simulations/models, the domain theory. • Communicate through simulations/demonstrations the factors determining field strength (closeness of poles, alignment of domains). • Illustrate magnetic lines of force for a bar magnet and between poles of two bar magnets. • Communicate to the class by appropriate means, the different methods of magnetization and demagnetization. • Draw generalized diagrams for display to show the magnetic flux pattern for a straight wire, a circular coil and a solenoid each carrying a direct current. • Orally communicate to the class while demonstrating, the operation of electromagnetic devices e.g. relays, electric bells, circuit breakers, scrap iron lifts. • Distinguish between magnetically hard and soft materials. • Orally communicate to the class while demonstrating, the effect of placing a current-carrying conductor perpendicularly to a magnetic field (Fleming's left hand rule) and display the resultant lines of force for the current carrying conductor in a uniform magnetic field.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Communicate information

GRADE 10	GRADE 11	GRADE 12
• Discuss in groups, the postulates of the kinetic theory of matter and communicate this to peers in the form of a song. • Discuss in groups and explain while demonstrating phenomena which provide evidence for the kinetic theory of matter (diffusion, Brownian motion).	• Draw diagram for display in the classroom to show arrangement and path of light through 45^0 prisms as used in periscopes. • Draw annotated diagrams for display in the classroom a description of optical terms associated with lens- principal focus, principal axis, optical center, focal length for display in the classroom. • Communicate to peers the functioning of the human eye (including accommodation) and correction of eye defects, using models of the human eye. • Draw annotated diagrams for display in the classroom to show eye defects associated with the lens and the use of additional lenses to correct these defects (long & short sightedness). • Use models of atoms to describe the structure of atoms to peers. • Summarise using annotated diagrams to accompany oral explanation to peers the charging of objects and electroscopes by electrostatic induction and by contact. • Make a chart for display in the classroom which summarises the results of using the electroscope to detect the presence of a charge and the sign of charge on objects.	• Orally explain to the class using diagrams/simulations why a rectangular, current carrying coil experiences a couple in a uniform magnetic field. • Orally describe the operation of a d.c. electric motor using models/diagrams/simulations etc. • Communicate to the class through demonstrations (using models constructed) factors affecting the force and hence speed of electrical motors (current, number of turns, magnetic field strength). • Communicate through simulation the application of the motor effect to the operation of the moving coil loudspeaker. • Communicate to the class using diagrams, the operation of the moving coil galvanometer. • Communicate to the class using diagrams how a moving coil galvanometer can be modified for use as an ammeter (with the use of shunts) and a voltmeter (with the use of multipliers). • Communicate to the class using simulation, that electromagnetic induction is an energy transfer process. • Communicate to the class through demonstration, the induction of an e.m.f. (and hence current in a complete circuit) based on the relative motion of a conductor perpendicular to a magnetic field (& motion of magnet in solenoid). • Communicate to the class through demonstration, Faraday's Law.

Communicate information

GRADE 10	GRADE 11	GRADE 12
		• Communicate to the class through demonstration, Lenz's Law (predicting direction of induced current). • Communicate to the class through demonstration, factors that affect the magnitude of induced e.m.f. and current in a complete circuit (strength of magnetic field, # of turns on solenoid, speed of motion, cross sectional area of the conductor). • Communicate to the class through demonstration at least 1 application of electromagnetic induction in alternators (a.c. generators) and (d.c generators/dynamos, Eddy- heating stoves, furnaces). • State the advantages and disadvantages of alternating and direct current. • Represent both d.c. and a.c. on current-time & voltage - time graphs and deduce peak values and frequencies from a.c. • Debate the advantages/disadvantages of local methods of power production (wind, fossil fuels) (propose alternatives) • Research and compare mains voltage & frequencies used in homes (mainly 110 V and 60 Hz in The Bahamas). • Communicate through oral presentation using diagrams/simulations the principle of operation of transformers (mutual induction). • Describe the sources of power losses in real transformers and ways of minimizing these losses. • Distinguish between real and ideal transformers.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Communicate information

GRADE 10	GRADE 11	GRADE 12
		• Distinguish between step up and step down transformers. • Express electrical power as a product of voltage and current (P = VI and apply relationship in solving numeric problems.) • Describe common uses of transformers. (in the home, long distance transmission of power-national grid). • Explain the importance of electrical safety in buildings and describe how fuses and circuit breakers are used to protect from circuit overloads and short circuits. • Orally communicate using simple circuits, a justification of why fuses, circuit breakers, cables must have a suitable current rating for a given use. • Explain the use of earthing (grounding), insulation, double insulation and correct wires as safety measures. • Explain the importance of the use of standard colour codes in electrical wiring. • Display chart showing the colour codes used for electrical wiring in The Bahamas and research colour codes used in other parts of the world. • Communicate to the class with the aid of diagrams/simulations or suitable models a description of a domestic wiring system, justifying the use of ring circuits, two way switches for lighting, the relative positioning of switches, fuses, circuit breakers and earth. • Investigate and communicate by tabulating results a comparison of energy consumption of various appliances in the home, e.g. light bulbs, cooker, air conditioner, toaster oven, water heaters etc.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Communicate information

GRADE 10	GRADE 11	GRADE 12
		• Recognise that the current drawn by an appliance at a given instant is dependent on its power rating and supply voltage, provided other factors remain constant and apply concept in solving numeric problems (I = P/V) • Debate the implications of conserving/not conserving electrical energy in homes. • Communicate the postulates of the Atomic Theory using pictures/models/simulations etc. • Orally communicate using simulations etc. to the class a description of the importance of alpha particle scattering experiments with regard to the structure of the atom. • Communicate using models/pictures/diagrams/simulations the basic structure of an atom (review: nucleus, proton, neutron, electron, orbits). • Make a chart for display to summarize the properties of sub-atomic particles. • Communicate through any appropriate means definitions for atomic number, mass number (nucleon number) and neutron number (X). • Communicate through any appropriate means to peers a definition for isotopes and examples of isotopes.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Communicate information

GRADE 10	GRADE 11	GRADE 12
		• Tabulate for display a comparison of the properties of alpha, beta, gamma radiation (nature, penetration ability, ionization effects, deflection by electric & magnetic fields, speeds). • Account for the changes if any in atomic number or mass number for alpha and beta and gamma decay. • Using diagrams/simulations, communicate to peers the operation of the GM tube, ratemeter/counter and cloud chamber in the detection of radioactive emissions. • Account for the presence of background radiation (cosmic rays, earth-minerals, foods, etc). • Distinguish between observed and corrected count rate (subtracting background radiation). • Define half-life. • Make posters to sensitize the public to safety precautions to protect from harmful radiation. • Make a comic strip/song to distinguish between nuclear fission and nuclear fusion (with the use of equations). • Recognize that energy released from fission or fusion is obtained from mass being converted to energy according to $E = mc^2$.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Communicate information

GRADE 10	GRADE 11	GRADE 12
		• Use simulations/models to describe to peers how nuclear chain reactions occur (including criteria for sustained chain reactions-purity of radioactive fuel, critical mass- the minimum amount of substance required for a sustained chain reaction). • Use diagrams/model/slide show to communicate to the class the main design features of a fission nuclear power plant. • Orally communicate to class the process of thermionic emission. • Orally present to peers using diagrams (/cathode ray oscilloscope) the operation of a cathode ray tube. • Describe the structure of a semiconductor diode (p-type, n-type semiconductors). • Draw graphs to communicate to peers the variation of current with voltage for a semiconductor diode. • State and explain the limitations of the semiconductor diode. • Draw graphs to communicate to peers the use of a single diode in half wave rectification of a.c. • Draw generalized graphs to communicate the variation of resistance of the light-dependent resistor with light intensity and the variation of resistance of the thermistor with temperature.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Communicate information

GRADE 10	GRADE 11	GRADE 12
		• Draw circuit symbols for LDR, LED, thermistors, diodes, reed switches, AND and OR gates. • Make comic strips to communicate the definition of terms: planet, moon, star, galaxy, constellation, solar system, comet, asteroid, meteoroid, meteor, meteorite elliptical orbit, horizon, zodiac, astronomical unit, parallax, light year, frequently designated boundary between outer space & earth's atmosphere. • Orally communicate Newton's law of universal gravitation (inverse square law) and the qualitative relationship between force, mass, distance. • Use pictures/slide presentations to depict/communicate Kepler's First law of planetary motion

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Communicate information

GRADE 10	GRADE 11	GRADE 12
		• Communicate to peers through pictures/slide show different types of optical telescopes (reflecting, refracting, compound-catadioptric). • Communicate to the class through pictures/slide show the types of vehicles and equipment used in space exploration (satellite, shuttle, space station, Hubble telescope, rovers, space exploration vehicles). • Make a comic strip to familiarize peers with great astronomers and their contribution to astronomy. (Bruno, Copernicus, Galileo, Kepler, Hubble, Friedman, Hoyle, etc.) • Orally describe to peers the importance of one aspect of the work of each of the following scientists: Isaac Newton, Michael Faraday, Albert Einstein, Bruno, Copernicus, Galileo, Kepler, Hubble, Friedman, Hoyle, Boyle, Charles • Make a scrap book to communicate the contribution(s) of scientists of interest including at least one Bahamian/ Caribbean scientist to the field of Physics.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Recognize relationships

GRADE 10	GRADE 11	GRADE 12
• Relate units of measurement to each other and so convert between them. • Relate scales on measuring instruments to scales on graphs. • Relate the size of forces and the distance away form the fulcrum to the moment (turning effect) of forces. • Recognize inclined planes, screws & gears as machines. • Determine and use the relationship between mechanical advantage, efficiency and velocity ratio for pulley systems and inclined plane. • Recognize that a centripetal force is needed for circular motion. • Investigate the relationship between mass, applied force and acceleration. • Recognise the relationships existing between pressure, force and area. • Recognize the relationship between phase change and constant temperature by plotting a heating/cooling curve (for wax, naphthalene-only in fume chamber!) from constant temperature. • Relate temperature to molecular speeds. • Relate volume of a fixed mass of gas to its pressure at constant temperature (Boyle's law).	• Express relationship between volume/temperature and density/temperature as graphs for cooling/heating of water. • Relate temperature changes to thermal expansion/contraction of various materials. • Relate latent heat of fusion and latent heat of vaporization for a substance. • Describe the qualitative effects of, and relationship between thickness, tension and length and the frequency/pitch of a vibrating string or skin. • State the audio frequency range in humans and compare to that of other animals. • Describe cathode ray oscilloscope traces and their relationships to frequency (pitch), amplitude (loudness) and wave shape (quality) of sound waves. • Investigate relationship between angles of reflection and angles of incidence for light reflected by a plane surface. • Relate images formed by concave & convex mirrors to their common uses. (e.g. use of concave mirrors in car headlights, reflecting telescopes & convex mirrors in aisles of stores, rear view mirror, etc. • Relate the degree of bending (change of speed) of light rays to the refractive index of the material it passes through.	• Distinguish between alternating (a.c.) and direct current (d. c.). • Recognize the relationship between current and voltage of a conductor at constant temperature as a direct one and express this relationship in the equation ($R = \frac{V}{I}$) and apply it to solve problems (including graphical problems). • Distinguish between magnetically hard and soft materials. • Explain why a rectangular, current carrying coil experiences a couple in a uniform magnetic field. • Recognize the relationship between current, number of turns, magnetic field strength and the force and hence speed of electrical motors. • Recognize the relationship between strength of magnetic field, # of turns on solenoid, speed of motion, cross sectional area of the conductor and the magnitude of induced e.m.f. and current in a complete circuit. • State the advantages and disadvantages of alternating and direct current. • Relate the ratio of the number of turns in the primary coil to the number of turns in the secondary coil to a transformer being either step up and step down. • Apply the relationship $\frac{Vp}{np} = \frac{Vs}{ns}$ to solve turns ratio & voltage problems.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Recognize relationships (including spatial)

GRADE 10	GRADE 11	GRADE 12
• Express relationship between volume and pressure of a fixed mass of gas at constant temperature as an equation and use equation to solve problems ($P_1 V_1 = P_2 V_2$). • Relate volume of a fixed mass of gas to its absolute temperature at constant pressure (Charles' Law). • Relate temperature in degree Celsius to Kelvin temperature. • Express relationship between volume and absolute temperature of a fixed mass of gas at constant pressure, as an equation and use equation to solve problems ($V_1 / T_1 = V_2 / T_2$). • Relate pressure of a fixed mass of gas to its absolute temperature when volume is constant. (Pressure Law). • Express relationship between pressure and absolute temperature of a fixed mass of gas when volume is constant, as an equation and use equation to solve problems ($P_1 / T_1 = P_2 / T_2$). • Recognize the relationships between volume, temperature and pressure for each gas law and make graphical representations of the relationships. • Express the relationship between volume, pressure and temperature of a gas when number of particles is constant, as the general gas law equation and use this equation to solve problems ($P_1V_1 / T_1 = P_2V_2 / T_2$).	• Relate structures of a cow's/goat's eye to structures of the human eye. • Relate the focusing of the lens in the eye to seeing near & distant objects (accommodation). • Compare & contrast the operation of the human eye, simple lens camera and the pin-hole camera. • Describe the force between charged bodies and the qualitative relationship of size of charge and distance between charged bodies (inverse square law: product of mass of bodies /distance squared).	• State Newton's law of universal gravitation (inverse square law) and describe the qualitative relationship between force, mass, distance. • Apply the relationship $V_p I_p = V_s I_s$ to perform current/ voltage calculations for an ideal transformer. • Describe and compare alpha, beta, gamma radiation in terms of their nature, penetration ability, ionization effects, deflection by electric & magnetic fields, speeds. • Recognize the relationship between the atomic number (Z) (number of protons), number of neutrons(X) and mass number (A) of an element. (A=Z+X) • Relate isotopes of an element to the number of protons and neutrons present in the atoms, noting that the isotopes of an element have identical chemical properties and give examples of isotopes including radioisotopes.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Measure accurately

GRADE 10	GRADE 11	GRADE 12
• Use appropriate instruments to measure fundamental quantities to degree of accuracy allowed by the instrument. Rulers, measuring cylinder, stop watches, clock, thermometer, triple beam balance, digital balance, spring balance, Vernier caliper, micrometer screw gauge, ammeter, voltmeter. • Measure force using spring balance. • Investigate factors which affect the moment (turning effect) of forces. • Perform accurate measurements in an investigation of the factors that affect pressure in fluids - depth, density.	• Perform accurate measurements and so determine the specific heat capacity of a solid or liquid using direct heating method and method of mixtures. • Describe the image formed by optical devices (nature- real, virtual, orientation- upright, inverted, vertically or laterally inverted, size- magnified or diminished, position- in relation to device). • Measure accurately angles of reflection and angles of incidence for light reflected by a plane surface. • Measure accurately and so construct ray diagrams (and scale drawings) to describe images formed by concave and convex mirrors and lens. • Measure angles of incidence and angles of refraction to verify Snell's law of refraction experimentally. • Conduct accurate measurement in an experiment to determine the refractive index of a material (glass, water) by real & apparent depth method. • Measure critical angle for a material using a semi-circular block. • Measure accurately focal length and thickness of convex lens to experimentally determine the relationship between them.	• Define current as the rate of electron flow (charge) measured in coulombs per second and use $I = \frac{Q}{t}$ to solve problems. • Accurately measure current and voltage using appropriate measuring instruments. • Accurately measure current, voltage and resistance to distinguish between parallel and series circuits. • Measure voltage and current in test circuits to determine the resistance of a given circuit component, through the application of Ohm's Law. • Deduce how resistance varies from current versus voltage graphs (bulb, thermistors, LDR's) and explain their applications. • Measure naturally occurring radioactivity in the environment using GM tube/ratemeter. • Measure voltage and frequency using a cathode ray oscilloscope and describe how it works. • Design and construct test circuits to determine the resistance of a given circuit component, through the application of Ohm's Law. • Predict the polarity of electromagnets. • Predict the magnetic flux pattern depending on the shape of the conductor (a straight wire, a circular coil or a solenoid) each carrying a direct current.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Make predictions

GRADE 10	GRADE 11	GRADE 12
• Predict the impact/implications of using alternative sources of energy (hydro, geothermal, solar, wind, nuclear, bio-fuels) as against fossil fuels. • Predict direction of motion of particles during diffusion • Describe and demonstrate phenomena which provide evidence for the kinetic theory of matter (diffusion, Brownian motion). • Predict changes in gas pressure due to changes in temperature, volume and number of particles • Predict the effects of changing volume of a fixed mass of gas to its pressure at constant temperature. (Boyle's law). • Predict the effects of changing the temperature of a fixed mass of gas on its volume at constant pressure (Charles' Law). • Predict the effects of changing the pressure of a fixed mass of gas on its absolute temperature when volume is constant. (Pressure Law).	• Predict changes associated with global warming and propose viable solutions with special reference to small island countries like The Bahamas. • Observe, predict and account for the effect of light rays passing from one optical medium to another. (refraction) • Predict the force between charged bodies based on the qualitative relationship of size of charge and distance between charged bodies (inverse square law: product of mass of bodies /distance squared). • Predict the sign of a charged object using an electroscope of known charge. • Predict the behaviour of charged objects in relation to each other e.g. balloons, ebonite rod, polythene. • Predict the angles of incidence and reflection for a particular material. • Predict the relative specific heat of fusion for three materials.	• Predict direction of motion (resultant force) of a current-carrying conductor placed perpendicularly to a magnetic field (Fleming's left hand rule) and draw the resultant lines of force for the current carrying conductor in a uniform magnetic field. • State and observe what happens when a current-carrying conductor is placed parallel to a magnetic field. • Apply Fleming's left hand rule to predict the behaviour of a current carrying conductor, which is perpendicular to a uniform magnetic field. • Describe the operation of the moving coil galvanometer. • Use Fleming's right hand rule to predict direction of induced voltage (current) in a conductor moving in a magnetic field. • Predict direction of induced current by applying Lenz's Law. • Apply the relationship $V_p I_p = V_s I_s$ to perform current/ voltage calculations for an ideal transformer. • Predict the behaviour of alpha, beta, gamma radiation based on their nature and properties (penetration ability, ionization effects, deflection by electric & magnetic fields, speeds.) • Predict the products of alpha, beta and gamma decay.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Collect, process and interpret data/information

GRADE 10	GRADE 11	GRADE 12
• Interpret scales on measuring instruments and scales on graphs. • Process by substituting units for basic quantities to derive the units for derived quantities. • Process numbers to express them in the scientific notation and to given significant figures. • Process information to convert between units. • Process information by adding parallel forces along a line. • Process information to determine the resultant of perpendicular forces (parallelogram law, Pythagoras Theorem scale drawings, trigonometry). • Process information to resolve force into its perpendicular components and determine the components. • Identify force couples. • Collect and process data on the use of inclined planes, screws & gears as machines. • Collect and process information to determine mechanical advantage, efficiency and velocity ratio for pulley systems and inclined plane.	• Collect and process information by using the equations $Q = mc\Delta T$ and $Q = ml$) to solve problems involving heat energy, specific heat capacity, specific latent heat. • Collect and process information to determine the specific heat capacity of a solid or liquid using direct heating method and method of mixtures • Collect and process information to determine the specific latent heat of fusion or vaporization of a substance. • Interpret volume/temperature, density/temperature graphs for water. • Collect information to demonstrate that different materials expand by different amounts for the same change in temperatures (linear expansivity) • Process information by manipulating the wave equations $v = f\lambda$. • Interpret simple displacement-time and displacement-position graphs to find amplitude, frequency and wavelength of waves. • Interpret cathode ray oscilloscope traces and their relationships to frequency (pitch), amplitude (loudness) and wave shape (quality) of sound waves.	• Process information by applying the equation $I = \frac{Q}{t}$ to solve problems. • Use circuit symbols and describe circuit components, symbols, and functions (including switches, fuses, resistors, variable resistors, filament lamps and diodes) • Process information by applying the Ohm's law equation ($R = \frac{V}{I}$) to solve problems (including graphical problems). • Collect and process information to distinguish between parallel and series circuits (with reference to current, voltage and resistance). • Collect and process information by applying the formulae to solve problems involving series, parallel and combination resistors $V_T = V_1 + V_2$ (series), $I_T = I_1 + I_2$ (parallel), $R_T = R_1 + R_2$ (series), $R_T = 1/R_1 + 1/R_2 + 1/R_3$ • Collect and process information using test circuits to determine the resistance of a given circuit component, through the application of Ohm's Law. • Interpret current/voltage graphs for filament bulb, thermistors, LDR's.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Collect, process and interpret data/information

GRADE 10	GRADE 11	GRADE 12
• Process information by manipulating and using the equation speed=$\frac{total\ dist.}{total\ time}$. • Interpret ticker tape charts to describe motion and determine instantaneous speed, constant speed, average speed and uniform acceleration. • Process information by manipulating equations of motion: $a = \frac{v - v_o}{t}$ $v = v_o + at$ $s = v_o t + \frac{1}{2}at^2$ $v^2 = v_o^2 + 2as$ to solve motion problems • Draw, interpret & use motion graphs (displacement-time and velocity-time) qualitatively and quantitatively to determine displacement, time, speed, acceleration. • Identify examples of centripetal force. (gravity in planetary and satellite motion, friction in moving around curves- roundabouts, tension in string whirling objects around). • Process information to determine force and pressure in hydraulic systems. • Collect and process information relating to forces acting on masses	• Describe the image formed by optical devices (nature-real, virtual, orientation- upright, inverted, vertically or laterally inverted, size- magnified or diminished, position-in relation to device). • Experimentally locate the principal focus of a concave mirror (rough method using screen). • Process information by applying the mirror formula using the real is positive sign convention, and the magnification formula to solve problems. • Experimentally determine the refractive index of a material (glass, water) by real & apparent depth method. • Use the following relationships in calculations $n = \frac{real\ depth}{apparent\ depth}$ n = speed of light in first medium/ speed of light in second medium, n = sin i /sin r. • Use the relationship sin c= 1/n to solve problems. • Process information by applying the lens formula using the real is positive sign convention, the magnification formula and the power of a lens formula to solve problems.	• Process information to determine the resistance of shunt or multiplier required, given current and voltage of galvanometer and the total current or voltage of the ammeter or voltmeter, respectively. • Interpret current-time & voltage -time graphs for both a.c and d.c and deduce peak values and frequencies for a.c. • Explain the principle of operation of transformers.(mutual induction). • Process information by applying the relationship $\frac{Vp}{np} = \frac{Vs}{ns}$ to solve turns ratio & voltage problems. • Process information by applying the equation P = VI to solve numeric problems. • Process information by applying the equation $V_p I_p = V_s\ I_s$ to solve problems for an ideal transformer. • Describe with the aid of diagrams or suitable models a domestic wiring system, justifying the use of ring circuits, two way switches for lighting, the relative positioning of switches, fuses, circuit breakers and earth. • Process information by applying the equation I = P/V to solve numeric problems. • Interpret electricity bills and perform calculations of the cost of electrical energy in joules and kilowatt-hours [Energy consumption = Power (kilowatt) x time (h) Cost = kWh x cost per unit (i.e. cost per kWh)].

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Collect, process and interpret data/information

GRADE 10	GRADE 11	GRADE 12
• Collect and process information to determine the relationship between mass, applied force and acceleration. • Process information by manipulating and applying the relationship Force =mass x acceleration to solve problems. • Process information to determine momentum of objects (product of mass and velocity) and use this formula to solve problems. • Process information by applying the law of conservation of linear momentum to solve problems involving elastic and inelastic collisions. • Process information by manipulating the equation Pressure = $\frac{force}{area}$ to solve problems. • Process information by applying and manipulating the equation p = hρg. • Collect and process information to describe how atmospheric pressure varies with height and from day to day e.g. weather systems. • Collect and process information by using the relationship between pressure and absolute temperature of a fixed mass of gas when volume is constant to solve problems. ($P_1 / T_1 = P_2 / T_2$).		• Define the terms: atomic number (Z), mass number (A), neutron number (X). • Write and balance equations for alpha, beta and gamma decay. • Interpret information obtained from investigations on naturally occurring radioactivity in the environment. • Process and interpret information from a decay graph to determine half-life of a radioactive isotope. • Process information to solve radioactive decay problems based on numerical data of half-life. • Process and interpret information to estimate the age of dead organic materials by carbon dating methods. • Distinguish between nuclear fission and nuclear fusion (with the use of equations). • Interpret graphs showing the variation of resistance of the light-dependent resistor with light intensity. • Interpret graphs showing the variation of resistance of the thermistor with temperature. • Describe the use of a single diode in half wave rectification of a.c and draw graphs to illustrate. • Interpret current vs. voltage graphs for a semiconductor diode. • State and explain the limitations of the semiconductor diode with respect to reverse p.d. and forward current.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Collect, process and interpret data/information

GRADE 10	GRADE 11	GRADE 12
• Process information by making graphical representations of the relationships between volume, temperature and pressure for each gas law. • Collect and process information by using the general gas law equation, $P_1V_1 / T_1 = P_2V_2 / T_2$) and apply this equation to solve problems. • Collect and process information by using the equation $V_1 / T_1 = V_2 / T_2$ to solve problems • Collect and process information by using the equation $P_1 V_1 = P_2 V_2$ to solve problems. • Collect and process information by plotting heating/cooling curve and identify phase change (for wax, naphthalene-only in fume chamber!) from constant temperature.		• Describe and explain how the cathode ray oscilloscope works and state common uses. • Observe celestial objects (constellations, moon, some planets. E.g. motion of stars in relation to the North Star & the earth) (Caution: NEVER look at the Sun directly or through a telescope or even through coloured glass! Permanent eye-damage can result!).

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Formulate hypotheses

GRADE 10	GRADE 11	GRADE 12
• Formulate a hypothesis about the effects of using fossil fuels on the environment. • Formulate a hypothesis where Newton's third law is demonstrated (launching rockets etc.). • Formulate a hypothesis where Newton's first law is demonstrated (use of seat belts, and head rests in vehicles). • Formulate a hypothesis to demonstrate that pressure acts equally in all directions at the same depth. • Formulate a hypothesis to demonstrate that liquid pressure is independent of shape, width or area of container base (liquid finds its own level).	• Formulate a hypothesis on the relative wavelengths of visible light, infrared and ultraviolet radiation. • Formulate a hypothesis as to the relative expansivity of three metals. • Formulate a hypothesis as to the type of image formed by a concave lens. • Formulate a hypothesis on the focal length of a convex lens.	• Formulate a hypothesis to investigate Ohm's law ($R = \frac{V}{I}$). • Formulate a hypothesis to distinguish between parallel and series circuits (with reference to current, voltage and resistance), through construction of circuits. • Formulate a hypothesis to determine the resistance of a given circuit component, through the application of Ohm's Law. • Formulate a hypothesis to investigate the factors that determine magnetic field strength. • Formulate a hypothesis to investigate the effect of placing a current-carrying conductor perpendicularly to a magnetic field (Fleming's left hand rule).

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Recognize and control variables

GRADE 10	GRADE 11	GRADE 12
• Recognize the variables to be controlled when investigating how the range of a projectile varies with angle of projection (Catapult expt.). • Recognize the variables to be controlled when investigating the relationship between mass, applied force and acceleration. • Recognize the variables to be controlled when investigating the factors that affect pressure in fluids. • Recognize the variables to be controlled when investigating the ease of floatation in fluids of different densities. • Recognize the variables to be controlled when investigating the relationship between pressure and absolute temperature of a gas. • Recognize the variables to be controlled when investigating the relationship between volume and absolute temperature of a gas. • Recognize the variables to be controlled when investigating the relationship between volume and pressure of a gas. • Recognize the variables to be controlled when determining the effect of dissolved solids (impurities) and pressure changes (e.g. altitude, pressure cookers) on the boiling point of liquids.	• Recognize and control variables in determining specific heat capacities. • Recognize and control variables in an experiment to determine the latent of fusion for a material. • Recognize and control variables in an experiment to determine the latent of vaporization for a material.	• Recognize and control the variables when investigating the resistance of a conductor. • Distinguish between parallel and series circuits (with reference to current, voltage and resistance), through construction of circuits. • Recognize the variables to be controlled when determining the resistance of a given circuit component, through the application of Ohm’s Law. • Recognize the variables to be controlled when investigating naturally occurring radioactivity in the environment.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Design, conduct and evaluate scientific investigations

GRADE 10	GRADE 11	GRADE 12
• Design a simple experiment to investigate factors which affect the moment (turning effect) of forces. • Plan and conduct an experiment to measure the acceleration due to gravity using the free fall method. • Plan an experiment to show how the range of a projectile varies with angle of projection (Catapult expt.). • Design and conduct an experiment to demonstrate that the horizontal and vertical motion are independent (drop an object vertically while projecting another horizontally, note time taken by each to drop.) • Plan an investigation to show the relationship between mass, applied force and acceleration. • Plan an investigation to show that an object moving through a fluid experiences drag. • Plan an investigation to show the factors that affect pressure in fluids - depth, density. • Design and conduct experiments to investigate that pressure acts equally in all directions at the same depth.	• Design and conduct a simple investigation to demonstrate the effects of using fossil fuels on the environment. • Plan and conduct an experiment to determine the specific latent heat of fusion or vaporization of a substance. • Plan and conduct an experiment to determine the specific heat capacity of a solid or liquid using direct heating method and method of mixtures. • Plan and conduct an experiment to determine the speed of sound from echo experiments. • Plan an investigation to show the relationship between angles of reflection and angles of incidence for light reflected by a plane surface. • Plan and conduct an experiment to verify Snell's law of refraction. • Conduct an investigation to demonstrate charging by friction e.g. balloons, ebonite rod, polythene. • Conduct an investigation to demonstrate the charging of objects and electroscopes by electrostatic induction and by contact.	• Conduct an investigation of the factors which affect the resistance of a conductor (cross-sectional area, length, type of material, temperature). • Plan an experiment to distinguish between parallel and series circuits (with reference to current, voltage and resistance), through construction of circuits. • Design test circuits to determine the resistance of a given circuit component, through the application of Ohm's Law. • Plan and conduct an experiment to investigate the factors affecting the strength of an electromagnet. • Plan and conduct an experiment to investigate the effect of placing a current-carrying conductor perpendicular to a magnetic field (Fleming's left hand rule) and draw the resultant lines of force for the current carrying conductor in a uniform magnetic field. • Plan investigations on naturally occurring radioactivity in the environment. • Design simple control and monitoring systems with electronic AND, NOT and OR, NOR and NAND gates. • Design simple electronic circuits such as motor control, light-operated switches, fire alarms and burglar alarms.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Design, conduct and evaluate scientific investigations

GRADE 10	GRADE 11	GRADE 12
• Design and conduct experiments to investigate that liquid pressure is independent of shape, width or area of container base (liquid finds its own level). • Design a simple a simple experiment to demonstrate atmospheric pressure. • Design and conduct an experiment to demonstrate/verify Archimedes principle. • Design and conduct an experiment to investigate the ease of floatation in fluids of different densities. • Plan and conduct an investigation to show the relationship between volume and absolute temperature of a gas (pressure an number of particles constant) (V_1 / T_1 = V_2 / T_2). • Plan and conduct an investigation to show the relationship between the pressure and absolute temperature of a gas (volume and number of particles are constant) (P_1/T_1 = P_2/T_2)) • Plan and conduct an investigation to show the relationship between volume and pressure of a gas (constant temperature and number of particles) (P_1 V_1 = P_2 V_2). • Plan and conduct an investigation to show the effect of dissolved solids (impurities) and pressure changes (e.g. altitude, pressure cookers) on the boiling point of liquids.		

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Design, conduct and evaluate scientific investigations

GRADE 10	GRADE 11	GRADE 12
• Design and conduct simple experiment to demonstrate phase changes (sublimation, resublimation-deposition, melting, freezing condensation and vaporization.) • Design and conduct an investigation to demonstrate phenomena which provide evidence for the kinetic theory of matter (diffusion, Brownian motion).		

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Formulate models

GRADE 10	GRADE 11	GRADE 12
• Make models/simulations to demonstrate the effects of using fossil fuels on the environment. • Make models to demonstrate the use of alternative sources of energy. • Construct models where Newton's first law is demonstrated (use of seat belts & head rests in vehicles). • Construct models where Newton's third law is demonstrated (launching rockets etc.). • Make a model to demonstrate how phase changes are useful in the operation of refrigerators and air conditioners	• Make a model to demonstrate the applications of linear expansion (building of bridges, concrete pavements, steel bridges, aluminium power lines, removing tight-fitting caps from bottles). • Construct a model of a thermostat using bi-metallic strip and thermometers. • Construct models of a water heating system, solar water heating system, solar ovens/ cookers, solar cars etc. • Construct models to demonstrate the greenhouse effect. • Make simple models of transverse and longitudinal waves. • Construct a simple model to show the transmission of sound. • Make simple musical instruments. • Construct a pin-hole camera (model –viewing images, real- pictures taking). • Construct simple periscope, kaleidoscope using plane mirrors. • Construct models of the human eye and relate structures to the function. • Make models of the eye to show defects and their corrections by use of additional lenses. • Make a model of simple optical devices (single lens camera, projector, a compound microscope, a simple refracting telescope. • Make a model to show the construction of a simple capacitor. • Construct models of simple atoms.	• Make a model of parallel and series circuits (with reference to current, voltage and resistance). • Construct models of electromagnetic devices e.g. relays, electric bells, circuit breakers, scrap iron lifts. • Make a model of a d.c. electric motor to show how it operates. • Make a model a domestic wiring system, justifying the use of ring circuits, two way switches for lightning, the relative positioning of switches, fuses, circuit breakers and earth. • Construct simple electronic circuits such as motor control, light-operated switches, fire alarms and burglar alarms. • Construct a mechanical switching model of AND and OR gates and corresponding truth tables (using 2 inputs only). • Construct a model to show the formation of eclipses. • Construct models of various types of vehicles and equipment used in space exploration (satellite, shuttle, space station, Hubble telescope, rovers, space exploration vehicles).

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Apply principles and concepts (scientific & technological) to make products, solve problems & account for observed phenomena

GRADE 10	GRADE 11	GRADE 12
• Construct simple measuring instruments using chosen standards for comparison-balance, roller wheel. • Use their knowledge to determine the resultant of perpendicular forces (parallelogram law, Pythagoras Theorem scale drawings, trigonometry). • Solve problems using the relationships: $P.E_g = mgh$ and $K.E. = ½ mv^2$ • Use their knowledge of energy transfer to explain that moving bodies have kinetic energy which is converted into other forms when stopped. • Apply the relationship work = force x displacement to calculate energy transferred. • Use the equation Power = $\frac{energy}{time}$ to solve problems • Apply the principle of moments to solve problems. • Apply knowledge of machines to explain the use of inclined planes, screws & gears.	• Use the equations $Q = mc\Delta T$ and $Q = ml$) to perform calculations involving heat energy, specific heat capacity, specific latent heat. • Use your knowledge to give applications of specific heat capacity and specific latent heat (e.g. use of water as a coolant). • Use the anomalous expansion of water to account for phenomena such as the freezing over of lakes, bursting of containers as their contents freeze e.g. water pipes. • Use your knowledge to give applications of linear expansion (building of bridges, concrete pavements, steel bridges, aluminium power lines, removing tight-fitting caps from bottles). • Apply your knowledge of methods of heat transfer, to design and construction, a model water heating systems, solar water heating systems, solar ovens/ cookers, complete solar homes, solar cars etc. • Construct models to demonstrate the greenhouse effect. • Use and apply the wave equations: $v = f\lambda$. • Construct musical instruments. • Construct a pin-hole camera (model –viewing images, real picture - taking). • Construct simple periscope, kaleidoscope using plane mirrors.	• Design and construct test circuits to determine the resistance of a given circuit component, through the application of Ohm's Law • Apply formulae to solve problems involving series, parallel and combination resistors $V_T = V_1 + V_2$ (series) $I_T = I_1 + I_2$ (parallel) $R_T = R_1 + R_2$ (series) $1/R_T = 1/R_1 + 1/R_2 + 1/R_3$ (parallel) • Design parallel circuitry for wiring buildings. • Use Ohm's law ($R = \frac{V}{I}$) to solve problems (including graphical problems). • Use the fact that current is the rate of electron flow (charge), measured in coulombs per second and use $I = \frac{Q}{t}$ to solve problems. • Design the different methods of magnetization and demagnetization. • Construct an electromagnet and investigate the factors affecting its strength. • Construct electromagnetic devices e.g. relays, electric bells, circuit breakers, scrap iron lifts. • Explain the importance of the Earth's magnetic field to life on Earth (bird navigation, deflection of charged particles from the sun).

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Apply principles and concepts (scientific & technological) to make products, solve problems & account for observed phenomena

GRADE 10	GRADE 11	GRADE 12
• Calculate mechanical advantage, velocity ratio and efficiency of given simple machine. • Make a relationship between mechanical advantage, efficiency and velocity ratio for pulley systems and inclined plane. • Interpret ticker tape charts to describe motion and determine instantaneous speed, constant speed, average speed and uniform acceleration. • Use the equations of motion: $a = \frac{v - v_o}{t}$ $v = v_o + at$ $s = v_o t + \frac{1}{2} at^2$ $v^2 = v_o^2 + 2as$ to solve motion problems. • Interpret motion graphs (displacement-time and velocity-time) qualitatively and quantitatively to determine displacement, time, speed, acceleration etc.	• Construct ray diagrams (and scale drawings) to describe images formed by concave and convex mirrors. • Apply your knowledge of images formed by concave & convex mirrors, to their common uses (e.g. use of concave mirrors in car headlights, reflecting telescopes & convex mirrors in aisles of stores, rear view mirror, etc.). • Interpret the use of concave mirrors in solar cookers (e.g. rotary cooking). • Apply the mirror formula using the real is positive sign convention, and the magnification formula to solve problems. • Use the following relationships in calculations $n = \frac{real\ depth}{apparent\ depth}$ n = speed of light in first medium/ speed of light in second medium, n = sin i /sin r. • Use the relationship sin c = 1/n to solve problems. • Apply principles to show how total internal reflection is employed in fiber optical cables (and endoscopes).	• Apply Fleming's left hand rule to predict the behaviour of a current carrying conductor, which is perpendicular to a uniform magnetic field. • Construct a simple d.c. electric motor. • Use the factors affecting the force and relate them to the speed of electrical motors.(current, number of turns, magnetic field strength). • Apply the motor effect to the operation of the moving coil loudspeaker. • Construct a simple moving coil galvanometer. • Calculate the resistance of shunt or multiplier, given current and voltage of galvanometer. • Use your knowledge to show that electromagnetic induction is an energy transfer process. • Use your knowledge to demonstrate the induction of an e.m.f. (and hence current in a complete circuit) based on the relative motion of a conductor in a magnetic field. • Use Fleming's right hand rule to determine direction of induced voltage (current) in a conductor moving in a magnetic field. • Use Lenz's Law to predict the direction of induced current. • Apply your knowledge to demonstrate applications of electromagnetic induction. • Interpret both d.c. and a.c. on current-time & voltage -time graphs and deduce peak values and frequencies from a.c.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Apply principles and concepts (scientific & technological) to make products, solve problems & account for observed phenomena

GRADE 10	GRADE 11	GRADE 12
• Apply their knowledge to give examples of projectile motion in everyday life (sports- shot put, soccer, discus, missiles). • Apply your knowledge to show the relationships between centripetal force, mass, distance and speed ($F = (mv^2)/r$). • Apply Newton's second Law of motion to the transfer of momentum e.g. popping a string, catching a ball, hammering a nail and packaging of eggs. • Use the fact that momentum is a product of mass and velocity to solve problems. • Use the law of conservation of linear momentum to solve problems involving elastic and inelastic collisions. • Apply your knowledge to indicate where Newton's third law is demonstrated (launching rockets etc.). • Use the equation, Pressure = $\frac{force}{area}$ to solve problems. • Solve problems using $p = h\rho g$. • Use your knowledge of Pascal's principle and describe its application to hydraulic systems e.g. braking systems, hydraulic press. • Solve problems involving force and pressure in hydraulic systems.	• Construct ray diagrams (& scale drawings) to describe images formed by convex and concave lenses. • Apply the lens formula using the real is positive sign convention, the magnification formula and the power of a lens formula to solve problems. • Design diagrams to show eye defects associated with the lens and the use of additional lenses to correct these defects (long & short sightedness). • Design & construct optical devices (single lens camera, projector, a compound microscope, a simple refracting telescope. • Apply your knowledge of electrostatics to describe applications; hazards, and their associated safety procedures of electrostatics, e.g. capacitors, spark plugs, lightning and lightning conductors, gas lighters, photocopying devices, painting of automobiles, electrostatic precipitation.	• Suggest alternative methods of power production (wind, fossil fuels). • List the sources of power losses in real transformers and ways of minimizing these losses. • Apply the relationship $\frac{Vp}{np} = \frac{Vs}{ns}$ to solve turns ratio & voltage problems. • Use the fact that electrical power is the product of voltage and current ($P = VI$) to solve numeric problems. • Apply the relationship $V_p I_p = V_s \ I_s$ to perform current/ voltage calculations for an ideal transformer. • Demonstrate the importance of electrical safety in buildings and to describe how fuses and circuit breakers are used to protect from circuit overloads and short circuits. • Use your knowledge to explain the use of earthing (grounding), insulation, double insulation and correct wires as safety measures. • Construct diagrams or suitable models of a domestic wiring system, justifying the use of ring circuits, two way switches for lightning, the relative positioning of switches, fuses, circuit breakers and earth.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Apply principles and concepts (scientific & technological) to make products, solve problems & account for observed phenomena

GRADE 10	GRADE 11	GRADE 12
• Apply Bernouille's principle to applications such as sailing, flight, soccer, roof tops lifting off in hurricanes etc. • Use Archimedes' Principle to explain floating and sinking. • Apply your knowledge to everyday applications of Archimedes' Principle - such as Andros water barge, cruise ships, shipping between waters of different densities. • Use the relationship between volume, pressure and temperature of a gas (number of particles is constant), as the general gas law equation, to solve problems ($P_1V_1 / T_1 = P_2V_2 / T_2$). • Use the relationship between pressure and absolute temperature (number of particles & volume are constant), as an equation to solve problems ($P_1 / T_1 = P_2 / T_2$). • Use the relationship between volume and absolute temperature (number of particles and pressure are constant), as an equation to solve problems ($V_1 / T_1 = V_2 / T_2$). • Use the relationship between volume and pressure (number of particles and temperature constant) as an equation to solve problems. ($P_1 V_1 = P_2 V_2$).		• Make an energy consumption comparison of various appliances in the home, e.g. light bulbs, cooker, air conditioner, toaster oven, water heaters etc. • Show that the current drawn by an appliance at a given instance is dependent on its power rating and supply voltage, provided other factors remain constant and apply concept in solving numeric problems (I = P/V). • Interpret electricity bills and perform calculations of the cost of electrical energy in joules and kilowatt-hours [Energy consumption = Power (kilowatt) x time (h) Cost = kWh x cost per unit (i.e. cost per kWh)] • Suggest ways of conserving electrical energy in homes (reducing wastage). • Explain isotopes of the same element have identical chemical properties and give examples of isotopes including radioisotopes. • Account for the changes, if any, in atomic number or mass number for alpha and beta and gamma decay. • Write and balance equations for alpha, beta and gamma decay. • Solve radioactive decay problems based on numerical data of half-life.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Apply principles and concepts (scientific & technological) to make products, solve problems & account for observed phenomena

GRADE 10	GRADE 11	GRADE 12
• Use their knowledge of heating and cooling curves to identify phase changes (for wax, naphthalene-only in fume chamber!). • Apply their knowledge of phase changes to account for the cooling effect of evaporation. • Apply their knowledge to explain how phase changes are useful in the operation of refrigerators and air conditioners. • Use their knowledge to account for the properties of solids, liquids & gases in terms of motion, energy & arrangement of particles, and forces between particles.		• Outline useful and harmful effects of radioactive isotopes in terms of their half-lives and radiation emitted. • List safety precautions used to protect from harmful radiation. • List the uses of radioactive isotopes in medicine, archaeology, industry and food processing etc. • Explain that energy released from fission or fusion is obtained from mass being converted to energy according to $E = mc^2$. • Apply principles to show how nuclear chain reactions occur (including criteria for sustained chain reactions-purity of radioactive fuel, critical mass- the minimum amount of substance required for a sustained chain reaction). • Design the main features of a fission nuclear power plant. • Explain thermionic emission. • Design the main features of a cathode ray tube and explain how it works. • Explain how the cathode ray oscilloscope works and state common uses. • Explain the use of a single diode in half wave rectification of a.c and draw graphs to illustrate.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Apply principles and concepts (scientific & technological) to make products, solve problems & account for observed phenomena

GRADE 10	GRADE 11	GRADE 12
		• Explain how the light-emitting diode (LED) works. • Explain the operation of the reed switch and simple applications. • Design and construct simple electronic circuits such as motor control, light-operated switches, fire alarms and burglar alarms. • Design and use simple control and monitoring systems with electronic AND, NOT and OR, NOR and NAND gates. • Intrepret and apply Kepler's First Law of planetary motion qualitatively

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Make informed, responsible and wise decisions

GRADE 10	GRADE 11	GRADE 12
• Recognize the impact/implications of using alternative sources of energy (hydro, geothermal, solar, wind, nuclear, bio fuels). • Recognize the impact/implications of using fossil fuels as an energy source. • Identify current events reports involving use of energy-renewable & non- renewable. • Identify the importance of energy conservation. • Identify energy conservation tips/strategies. • Identify and model examples where Newton's first law is demonstrated (use of seat belts, &head rests in vehicles). • Advocate the use of environmentally safe refrigerants, proposing of legislation, strategies for preventing/dealing with pollution by refrigerants.	• Identify choices which contribute to global warming, • Advocate the use of sonar in aquatic environments. • Recognize the importance of safety practices and procedures when handling electrical and electronic circuits (wiring in wet surroundings, etc.) • Identify applications; hazards, and their associated safety procedures of electrostatics, e.g. capacitors, spark plugs, lightning and lightning conductors, gas lighters, photocopying devices, painting of automobiles, electrostatic precipitation.	• Recognize the use of parallel circuitry for wiring buildings. • Identify the sources of power losses in real transformers and ways of minimizing these losses. • Identify common uses of transformers (in the home, long distance transmission of power-national grid). • Recognize the importance of electrical safety in buildings and describe how fuses and circuit breakers are used to protect from circuit overloads and short circuits. • Advocate why fuses, circuit breakers, cables must have a suitable current rating for a given use. • Advocate the use of earthing (grounding), insulation, double insulation and correct wires as safety measures. • Advocate the importance of the use of standard colour codes in electrical wiring. • Identify the colour codes used for electrical wiring in the Bahamas and research colour codes used in other parts of the world. • Recognize the energy consumption of various appliances in the home, e.g. light bulbs, cooker, air conditioner, toaster oven, water heaters etc. • Identify ways of conserving electrical energy in homes (reducing wastage). • Advocate the use of nuclear energy as an alternative source of energy. • Explain how the cathode ray oscilloscope works and state common uses. • Recognize the advantages and disadvantages of space exploration.

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Pursue New Knowledge

GRADE 10	GRADE 11	GRADE 12
• Research how precision timing is done e.g. swimming, track races, use of multiflash photography. • Research the impact/implications of using fossil fuels as an energy source. • Investigate the effects of using fossil fuels on global warming and on the ability of presently harmless microorganisms to become pathogenic. • Research current events reports involving use of energy-renewable & non- renewable. • Research the use of environmentally safe refrigerants, proposing of legislation, strategies for preventing/dealing with pollution by refrigerants. • Research states of matter (e.g. plasma and Bose-Einstein Condensate) other than solids, liquids and gases. • Research the importance of one aspect of the work of each of the following scientists: Isaac Newton, Michael Faraday, Albert Einstein, Bruno, Copernicus, Galileo, Kepler, Hubble, Friedman, Hoyle, Boyle, Charles. • Research scientists of interest including at least one Bahamian/ Caribbean scientist and describe their contribution(s) to the field of Physics. • Research careers which rely on the study of Physics. • Research the use of physics in various careers (including emerging careers).	• Research the greenhouse effect and its implications for global warming. • Research choices which contribute to global warming, • Research the applications of echoes (e.g. in depth sounding using sonar and in ultrasound scans). • Research properties and applications/ uses of X-rays, gamma rays, UV rays, infrared, microwaves and radio waves. • Research applications; hazards, and their associated safety procedures of electrostatics, e.g. capacitors, spark plugs, lightning and lightning conductors, gas lighters, photocopying devices, painting of automobiles, electrostatic precipitation. • Research the importance of one aspect of the work of each of the following scientists: Isaac Newton, Michael Faraday, Albert Einstein, Bruno, Copernicus, Galileo, Kepler, Hubble, Friedman, Hoyle, Boyle, Charles. • Research scientists of interest including at least one Bahamian/ Caribbean scientist and describe their contribution(s) to the field of Physics. • Research careers which rely on the study of Physics. • Research the use of Physics in various careers (including emerging careers).	• Research local methods of power production (wind, fossil fuels). • Research common uses of transformers (in the home, long distance transmission of power-national grid). • Identify the use of earthing (grounding), insulation, double insulation and correct wires as safety measures. • Identify the colour codes used for electrical wiring in the Bahamas and research colour codes used in other parts of the world. • Research the use of nuclear energy as an alternative source of energy. • Research the use of radioactive isotopes in medicine, archaeology, industry and food processing etc. • Research useful and harmful effects of radioactive isotopes in terms of their half-lives and radiation emitted. • Research great astronomers and describe their contribution to astronomy (Bruno, Copernicus, Galileo, Kepler, Hubble, Friedman, Hoyle, etc.).

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Pursue New Knowledge

GRADE 10	GRADE 11	GRADE 12
		• Research theories concerning the formation of the earth's magnetic field (e.g. dynamo effect in the core). • Research the importance of one aspect of the work of each of the following scientists: Isaac Newton, Michael Faraday, Albert Einstein, Bruno, Copernicus, Galileo, Kepler, Hubble, Friedman, Hoyle, Boyle, Charles. • Research scientists of interest including at least one Bahamian/ Caribbean scientist and describe their contribution(s) to the field of Physics. • Research careers which rely on the study of Physics. • Research the use of physics in various careers (including emerging careers).

PHYSICS CURRICULUM
SCOPE AND SEQUENCE (SKILLS)

Demonstrate critical thinking

GRADE 10	GRADE 11	GRADE 12
• Describe the impact/implications of using alternative sources of energy (hydro, geothermal, solar, wind, nuclear, biofuels). • Evaluate current events reports involving use of energy-renewable & non- renewable. • Describe the impact/implications of using fossil fuels as an energy source. • Describe the importance of energy conservation. • Describe energy conservation tips/strategies. • Examine the use of environmentally safe refrigerants, proposing of legislation, strategies for preventing/dealing with pollution by refrigerants.	• Describe the greenhouse effect and its implications for global warming. • Evaluate choices which contribute to global warming. • Suggest changes associated with global warming and propose viable solutions with special reference to small island countries like The Bahamas. • Evaluate the use of sonar in aquatic environments. • Evaluate the applications of electromagnetic waves. • Describe applications; hazards, and their associated safety procedures of electrostatics, e.g. capacitors, spark plugs, lightning and lightning conductors, gas lighters, photocopying devices, painting of automobiles, electrostatic precipitation.	• Describe the sources of power losses in real transformers and ways of minimizing these losses. • Explain the importance of electrical safety in buildings and describe how fuses and circuit breakers are used to protect from circuit overloads and short circuits. • Describe why fuses, circuit breakers, cables must have a suitable current rating for a given use. • Explain the use of earthing (grounding), insulation, double insulation and correct wires as safety measures. • Describe with the aid of diagrams or suitable models a domestic wiring system, justifying the use of ring circuits, two way switches for lightning, the relative positioning of switches, fuses, circuit breakers and earth. • Evaluate the use of nuclear energy as an alternative source of energy. • Identify the use of radioactive isotopes in medicine, archaeology, industry and food processing etc. • Suggest useful and harmful effects of radioactive isotopes in terms of their half-lives and radiation emitted discuss/debate the advantages and disadvantages of space exploration. • Critically analyse the effects of technology on the quality of life and the environment locally.

STANDARDS AND BENCHMARKS
GRADE: 10

Use materials and scientific equipment correctly and safely.

- Use the spring balance to measure force.
- Use moving objects (trolleys, marbles, billiard balls) safely to differentiate between elastic and inelastic collisions.
- Use spring balance, beam balance and displacement can (or concept of displacement) to demonstrate/verify Archimedes'Principle.

Make observations.

- Observe the direction of various forces (upthrust, weight, tension).
- Observe the effect of changing the distance from the fulcrum and the size of force on the turning effect of the force.
- Observe the cooling effect of evaporation.
- Observe diffusion and Brownian motion.

Utilize classification process.

- Classify forces as contact or non-contact.
- Classify force as a vector or scalar quantity.
- Classify physical quantities as vector and scalar quantities e.g. distance and displacement, speed and velocity.
- Classify collisions as elastic or inelastic.

Make inferences and draw conclusions.

- Infer that the direction of motion is based on area of low pressure created by high velocity air particles (Bernouille's Principle).
- Infer the presence of atmospheric pressure based on simple experiments.

Communicate information.

- Make a visual presentation to show examples of projectile motion in everyday life.
- Illustrate on diagrams, all forces acting on an object.
- Draw an annotated diagram for display of a generalized cooling curve indicating phase changes.
- Describe the states of matter including plasma and Bose-Einstein Condensate.

Recognize relationships.

- Determine and use the relationship between mechanical advantage, efficiency and velocity ratio for pulley systems and inclined plane.
- Relate temperature to molecular speeds.
- Express the relationship between volume, pressure and temperature of a gas when number of particles is constant.

Measures accurately.

- Use a triple beam balance to measure to 1g.
- Use a Vernier caliper to measure to 0.1cm.
- Use a micrometer screw gauge to measure to 0.01cm.
- Use an ammeter to measure to 0.1A.
- Use a voltmeter to measure to 0.1V.

Make predictions.

- Predict the environmental impact/implications of using a specific alternative source of energy.
- Predict the direction of motion of particles in an experiment to show Brownian motion.
- Predict the effects of changing volume of a fixed mass of gas to its pressure at constant temperature.

Collect, process and interpret data/information.

- Interpret ticker tape charts to describe motion and determine instantaneous speed, constant speed, average speed and uniform acceleration.
- Collect and process information to determine the relationship between mass, applied force and acceleration.
- Collect and process information by plotting heating/cooling curve and identify phase change (for wax, naphthalene-only in fume chamber!) from constant temperature.
- Draw, interpret & use motion graphs (displacement-time and velocity-time) qualitatively and quantitatively to determine displacement, time, speed, acceleration.
- Manipulate the equations of motion to solve problems.

Formulate hypotheses.

- Formulate a hypothesis on applications of Newton's third law.
- Formulate a hypothesis on the direction of pressure exerted in a liquid at a given depth.
- Formulate a hypothesis on liquid pressure being dependent on the shape, width or area of container base.

Recognize and control variables.

- Recognize the variables to be controlled when investigating how the range of a projectile varies with angle of projection.
- Recognize the variables to be controlled when investigating the factors that affect pressure in fluids.
- Recognize the variables to be controlled when investigating the relationship between volume and pressure of a gas.

Design, conduct and evaluate scientific investigations.

- Plan, conduct and evaluate an experiment to measure the acceleration due to gravity using the free fall method.
- Design, conduct and evaluate an experiment to demonstrate/verify Archimedes principle.
- Plan an investigation to show the effect of dissolved solids (impurities) and pressure changes (e.g. altitude, pressure cookers) on the boiling point of liquids.
- Design, conduct and evaluate an experiment to investigate the ease of floatation in fluids of different densities.

Formulate models.

- Make a model to demonstrate the use of an alternative (to fossil fuels) source of energy.
- Construct models where Newton's first law is demonstrated.
- Make a model to demonstrate how phase changes are useful in the operation of refrigerators and air conditioners.

Apply principles and concepts (scientific & technological) to make products.

- Apply Bernouille's Principle to design devices.
- Apply Archimedes' Principle to make a toy or model.
- Apply knowledge of phase changes to design a product.

Make informed, responsible and wise decisions.

- Resolve to use solar energy.
- Practice energy conservation tips/strategies.
- Advocate the use of environmentally safe refrigerants, propose legislation, strategies for preventing/dealing with pollution by refrigerants.

Pursues new knowledge.

- Research how precision timing is done e.g. swimming using multi-flash photography.
- Research current events reports involving use of energy- renewable & non- renewable.
- Research states of matter (e.g. plasma and Bose-Einstein Condensate) other than solids, liquids and gases.

Demonstrate critical thinking.

- Evaluate current events reports involving use of energy- renewable & non- renewable.
- Outline a plan of action that civic groups, churches and businesses might take to ensure that energy wastage is reduced.
- Examine the use of environmentally safe refrigerants, proposing of legislation, strategies for preventing/dealing with pollution by refrigerants.

GRADE: 11

Use materials and scientific equipment correctly and safely.

- Use vibrating tuning forks, speakers, strings correctly to explain that sound waves are produced when objects vibrate.
- Use stop watch, measuring tape correctly to determine the speed of sound from echo experiments.
- Use convex lens, meter stick, card board screen correctly and safely to experimentally determine the relationship between thickness and focal length of a convex lens.
- Use transparent blocks, pins, protractor correctly and safely to verify Snell's law of refraction experimentally.
- Handle electrical and electronic circuits correctly and safely.

Make observations.

- Observe the amount of expansion of different materials for the same change in temperature.
- Observe the transfer of energy along matter by mechanical waves.
- Observe images formed at the principal focus of a concave mirror.
- Observe real depth and apparent depth for a material.
- Observe the effects of charged objects on charged electroscopes.

Utilize classification process.

- Classify portions of the electromagnetic spectrum according to frequency or wavelength.
- Classify materials as becoming electrostatically charged negatively or positively.
- Classify waves as longitudinal or transverse.
- Classify images as real or virtual.

Make inferences and draw conclusions.

- Conclude that the degree of bending (change of speed) of light rays is related to the refractive index of the material it passes through.
- Infer that the thicker a convex lens, the shorter will be its focal length.
- Infer the charge of an object based on repulsion with another object of known charge.

Communicate information.

- Make a visual display to summarize the general properties of electromagnetic waves.
- Draw annotated diagrams describing optical terms associated with spherical mirrors.
- Make an oral presentation on the charging of objects and electroscopes by electrostatic induction and by contact.
- Dramatize or make a cartoon to explain the use of the electroscope to detect the presence of a charge and the nature of charge on objects.

Recognize relationships.

- Express the relationships between volume/temperature and density/temperature as graphs for cooling/heating of water.
- Relate temperature changes to thermal expansion/contraction of various materials.
- Describe the relationship between thickness, tension and length and the frequency/pitch of a vibrating string or skin.
- Demonstrate the relationship between angles of reflection and angles of incidence for light reflected by a plane surface.
- Relate the degree of bending (change of speed) of light rays to the refractive index of the material it passes through.

Measures accurately.

- Measure accurately angles (to 1°) of reflection and angles of incidence for light reflected by a plane surface.
- Measure angles (to 1°) of incidence and angles of refraction to verify Snell's law.
- Measure critical angle (to 1°) for a material using a semi-circular block.
- Measure accurately (1 mm) the focal length and thickness of a convex lens to determine the relationship between them.

Make predictions.

- Predict the behaviour of charged objects in relation to each other e.g. balloons, ebonite rod, polythene.
- Predict the angles of incidence and reflection for a particular material.
- Predict the relative specific heat of fusion for three materials.

Collect, process and interpret data/information.

- Collect and process information by using the equations ($Q = mc\Delta T$ and $Q = ml$) to solve problems.
- Interpret volume/temperature, density/temperature graphs for water.
- Interpret simple displacement-time and displacement-position graphs to find amplitude, frequency and wavelength of waves.

Formulate hypotheses.

- Formulate a hypothesis on the relative wavelengths of visible light, infrared and ultraviolet radiation.
- Formulate a hypothesis as to the relative expansivity of three metals.
- Formulate a hypothesis as to the type of image formed by a concave lens.
- Formulate a hypothesis on the focal length of a convex lens.

Recognize and control variables.

- Recognize and control variables in determining specific heat capacities.
- Recognize and control variables in an experiment to determine the specific latent of fusion for a material.
- Recognize and control variables in an experiment to determine the specific latent of vaporization for a material.

Design, conduct and evaluate scientific investigations.

- Plan, conduct and evaluate an experiment to determine the specific heat capacity of a solid or liquid using direct heating method and method of mixtures.
- Plan, conduct and evaluate an experiment to determine the speed of sound from echo experiments.
- Plan and conduct and evaluate an experiment to verify Snell's law of refraction.
- Conduct and evaluate an investigation to demonstrate the charging of objects and electroscopes by electrostatic induction and by contact.

Formulate models.

- Construct a model of a thermostat using bi-metallic strip and thermometers.
- Construct a model of a water heating system, solar water heating system, solar ovens/ cookers, or solar car.
- Make a simple musical instrument.
- Construct a pin-hole camera (model –viewing images, real- pictures taking).
- Construct a simple periscope or kaleidoscope using plane mirrors.

Apply principles and concepts (scientific & technological) to make products.

- Use knowledge of specific latent heat of fusion and anomalous expansion of water to design a useful gadget.
- Use the principle of refraction of light and the properties of spherical lenses to design and make a useful device.
- Use the law of static electricity to design and make a useful device.

Make informed, responsible and wise decisions.

- Practice safe procedures when handling electrical and electronic circuits.
- Practice safety procedures in using electrostatics.

Pursue new knowledge.

- Research the applications of echoes.
- Research properties and applications/ uses of X-rays, gamma rays, UV rays, infrared, microwaves and radio waves.
- Research the importance of one aspect of the work of each of the following scientists: Isaac Newton, Michael Faraday, Albert Einstein, Bruno, Copernicus, Galileo, Kepler, Hubble, Friedman, Hoyle, Boyle, Charles.

Demonstrate critical thinking.

- Evaluate the use of sonar in aquatic environments.
- Evaluate the applications of electromagnetic waves.
- Suggest changes associated with global warming and propose viable solutions with special reference to small island countries like The Bahamas.

GRADE: 12

Use materials and scientific equipment correctly and safely.

- Safely and correctly use the cathode ray oscilloscope to distinguish between alternating (a. c.) and direct current (d. c.).
- Use circuit components (including switches, fuses, resistors, variable resistors, filament lamps and diodes) safely in circuits.
- Use circuit components to construct simple electronic circuits such as motor control, light-operated switches, fire alarms and burglar alarms.
- Correctly and safely use the semiconductor diode in circuits.

Make observations.

- Observe cathode ray oscilloscope traces to distinguish between alternating (a.c.) and direct current (d.c.).
- Observe differences between parallel and series circuits (with reference to current, voltage and resistance).
- Observe the magnetic flux patterns for a straight wire, a circular coil and a solenoid each carrying a direct current.
- Observe what happens when a current-carrying conductor is placed parallel to a magnetic field.

Utilize classification process.

- Classify planets into rocky (Venus , Mercury, Earth, Mars) and gas giants (Jupiter, Saturn, Uranus, Neptune).
- Classify stars based on colour.
- Classify nuclear emissions as alpha, beta or gamma.

Make inferences and draw conclusions.

- Make inferences on how resistance varies based on current versus voltage graphs.
- Infer the half-life of a radioactive isotope from a decay graph.
- Make inference about the structure of atoms based on alpha scattering data.

Communicate information.

- Make a chart to display the differences between alternating (a.c.) and direct current (d. c.).
- Orally explain to the class using diagrams/simulations why a rectangular, current carrying coil experiences a couple in a uniform magnetic field.
- Describe the operation of a d.c. electric motor using models/diagrams/simulations.
- Make an oral presentation using diagrams/simulations the principle of operation of transformers.
- Make posters to sensitize the public to safety precautions to protect from harmful radiation.
- Make a comic strip/song to distinguish between nuclear fission and nuclear fusion.

Recognize relationships.

- Recognize the relationship between current, number of turns, magnetic field strength and the force and hence speed of electrical motors.
- Describe the qualitative relationship between force, mass, distance.
- Recognize the relationship between the atomic number (Z) (number of protons), number of neutrons (X) and mass number (A) of an element. (A=Z+X).

Measures accurately.

- Accurately measure current, voltage and resistance to distinguish between parallel and series circuits.
- Measure naturally occurring radioactivity in the environment using GM tube/ratemeter.
- Measure voltage and frequency using a cathode ray oscilloscope and describe how it works.

Make predictions.

- Predict direction of motion (resultant force) of a current-carrying conductor placed perpendicularly to a magnetic field (Fleming's left hand rule.
- Predict direction of induced current by applying Lenz's Law.
- Predict the behaviour of alpha, beta, gamma radiation based on their nature and properties (penetration ability, ionization effects, deflection by electric & magnetic fields, speeds).
- Predict the products of alpha, beta and gamma decay.

Collect, process and interpret data/information.

- Collect and process information using test circuits to determine the resistance of a given circuit component, through the application of Ohm’s Law.
- Process information to determine the resistance of shunt or multiplier required, given current and voltage of galvanometer and the total current or voltage of the ammeter or voltmeter, respectively.
- Process information by applying the equation P = VI to solve numeric problems.

Formulate hypotheses.

- Formulate a hypothesis to determine the resistance of a given circuit component, through the application of Ohm’s Law.
- Formulate a hypothesis to investigate the factors that determine magnetic field strength.
- Formulate a hypothesis to investigate the effect of placing a current-carrying conductor perpendicularly to a magnetic field (Fleming’s left hand rule).

Recognizes and controls variables.

- Recognize and control the variables when investigating the resistance of a conductor.
- Recognize the variables to be controlled when determining the resistance of a given circuit component, through the application of Ohm’s Law.
- Recognize the variables to be controlled when investigating naturally occurring radioactivity in the environment.

Design, conduct and evaluate scientific investigations.

- Conduct and evaluate an investigation of the factors which affect the resistance of a conductor (cross-sectional area, length, type of material, temperature).
- Plan, conduct and evaluate an experiment to investigate the factors affecting the strength of an electromagnet.
- Plan, conduct and evaluate an experiment to investigate the effect of placing a current-carrying conductor perpendicular to a magnetic field (Fleming’s left hand rule) and draw the resultant lines of force for the current carrying conductor in a uniform magnetic field.

Formulate models.

- Construct models of electromagnetic devices e.g. relays, electric bells, circuit breakers, scrap iron lifts.
- Make a model of a d.c. electric motor to show how it operates.

Apply principles and concepts (scientific & technological) to make products.

- Construct electromagnetic devices e.g. relays, electric bells, circuit breakers, scrap iron lifts.
- Construct a simple d.c. electric motor.
- Construct diagrams or suitable models of a domestic wiring system, justifying the use of ring circuits, two way switches for lightning, the relative positioning of switches, fuses, circuit breakers and earth.
- Design an appliance or gadget based on the principle of thermionic emission, cathode ray tube or the light-emitting diode (LED).
- Design and construct simple electronic circuits such as motor control, light-operated switches, fire alarms and burglar alarms.

Make informed, responsible and wise decisions.

- Make decisions based on the importance of electrical safety in buildings and describe how fuses and circuit breakers are used to protect from circuit overloads and short circuits.
- Make decisions for purchasing based on the energy consumption of various appliances in the home, e.g. light bulbs, cooker, air conditioner, toaster oven, water heaters.

Pursues new knowledge.

- Research the use of radioactive isotopes in medicine, archaeology, industry and food processing etc.
- Research scientists of interest including at least one Bahamian/ Caribbean scientist and describe their contribution(s) to the field of Physics.
- Research careers which rely on the study of Physics.
- Research the use of physics in various careers (including emerging careers).

Demonstrate critical thinking.

- Evaluate the use of nuclear energy as an alternative source of energy.
- Suggest useful and harmful effects of radioactive isotopes in terms of their half-lives and radiation emitted OR discuss/debate the advantages and disadvantages of space exploration.
- Critically analyse the effects of technology on the quality of life and the environment locally.

COMPARISON OF BENCHMARKS FOR GRADE LEVELS

Grade	Use materials and scientific equipment correctly and safely.	Make observations.	Utilize classification process.	Make inferences and draw conclusions.	Communicate information.	Recognize relationships.	Measures accurately.	Make predictions.
10	Use spring balance, beam balance and displacement can (or concept of displacement) to demonstrate/verify Archimedes principle.	Observe the direction of various forces (upthrust, weight, tension)	Classify force as a vector or scalar quantity.	Infer the presence of atmospheric pressure based on simple experiments.	Illustrate on diagrams, all forces acting on an object.	Express the relationship between volume, pressure and temperature of a gas when number of particles is constant.	Use a Vernier caliper to measure to 0.01 cm.	Predict the effects of changing volume of a fixed mass of gas to its pressure at constant temperature.
11	Use convex lens, meter stick, card board screen correctly and safely to experimentally determine the relationship between thickness and focal length of a convex lens.	Observe real depth and apparent depth for a material.	Classify waves as longitudinal or transverse.	Conclude that the degree of bending (change of speed) of light rays is related to the refractive index of the material it passes through.	Dramatize or make a cartoon to explain the use of the electroscope to detect the presence of a charge and the nature of charge on objects.	Demonstrate the relationship between angles of reflection and angles of incidence for light reflected by a plane surface.	Measure accurately angles (to 1°) of reflection and angles of incidence for light reflected by a plane surface.	Predict the behaviour of charged objects in relation to each other e.g. balloons, ebonite rod, polythene.
12	Use circuit components (including switches, fuses, resistors, variable resistors, filament lamps and diodes) safely in circuits.	Observe the magnetic flux patterns for a straight wire, a circular coil and a solenoid each carrying a direct current.	Classify nuclear emissions as alpha, beta or gamma.	Make inferences on how resistance varies based on current versus voltage graphs.	Make an oral presentation using diagrams/simulations the principle of operation of transformers.	Recognize the relationship between current, number of turns, magnetic field strength and the force and hence speed of electrical motors.	Measure voltage and frequency using a cathode ray oscilloscope	Predict direction of motion (resultant force) of a current-carrying conductor placed perpendicularly to a magnetic field (Fleming’s left hand rule.

COMPARISON OF BENCHMARKS FOR GRADE LEVELS

Grade	Collect, process and interpret data/information.	Formulate hypotheses.	Recognizes and controls variables.	Design, conduct and evaluate scientific investigations.	Formulate models.	Apply principles and concepts (scientific & technological) to make products.	Make informed, responsible and wise decisions.	Pursues new knowledge.
10	Collect and process information to determine the relationship between mass, applied force and acceleration.	Formulate a hypothesis on liquid pressure being dependent on the shape, width or area of container base.	Recognize the variables to be controlled when investigating the relationship between volume and pressure of a gas.	Plan, conduct and evaluate an experiment to measure the acceleration due to gravity using the free fall method.	Make a model to demonstrate the use of an alternative (to fossil fuels) source of energy.	Apply Archimedes Principle to make a toy or model.	Resolve to use solar energy.	Research how precision timing is done e.g. swimming using multi-flash photography.
11	Collect data and process it by using the equations $Q = mc\Delta T$ and $Q = ml$) to solve problems.	Formulate a hypothesis as to the relative expansivity of three metals.	Recognize and control variables in determining specific heat capacities.	Plan, conduct and evaluate an experiment to determine the speed of sound from echo experiments.	Make a simple musical instrument.	Use the principle of refraction of light and the properties of spherical lenses to design and make a useful device.	Practice safe procedures when handling electrical and electronic circuits.	Research properties and applications/ uses of X-rays, gamma rays, UV rays, infrared, microwaves and radio waves.
12	Process information to determine the resistance of shunt or multiplier required, given current and voltage of galvanometer and the total current or voltage of the ammeter or voltmeter, respectively.	Formulate a hypothesis to investigate the effect of placing a current-carrying conductor perpendicularly to a magnetic field (Fleming's left hand rule).	Recognize the variables to be controlled when determining the resistance of a given circuit component, through the application of Ohm's Law.	Conduct and evaluate an investigation of the factors which affect the resistance of a conductor. (cross-sectional area, length, type of material, temperature).	Make a model of a d.c. electric motor to show how it operates	Design and construct simple electronic circuits such as motor control, light-operated switches, fire alarms and burglar alarms.	Make decisions for purchasing based on the energy consumption of various appliances in the home, e.g. light bulbs, cooker, air conditioner, toaster oven, water heaters	Research the use of radioactive isotopes in medicine, archaeology, industry and food processing etc.

COMPARISON OF BENCHMARKS FOR GRADE LEVELS

Grade	Demonstrate critical thinking.
10	Outline a plan of action that civic groups, churches and businesses might take to ensure that energy wastage is reduced.
11	Evaluate the use of sonar in aquatic environments.
12	Evaluate the use of nuclear energy as an alternative source of energy.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: INTRODUCTION, HISTORY & CAREERS

TOPIC: **HISTORY (SCIENTISTS/PERSONALITIES) & CAREERS** DURATION: **1 week**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
Describe the importance of one aspect of the work of a named Physicist.	See columns to the right.	Research contributions of scientists to the field of Physics Create timelines	Internet Library	Rubric for assessing oral presentations.
Describe the meaning and importance of Physics and careers including emerging careers which rely on the study of physics.	Physics is the study of matter and energy and their inter-relations with each other. Careers in which an understanding of forces are needed include engineering, architecture, medicine, dentistry, physiotherapy, athletic coaching and gym management.	• Use a graphic organizer or another visual aid to describe careers which rely on the study of Physics. • Conduct research of various careers that use Physics.		Rubric for assessing visual (aids) presentations.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: PHYSICAL MEASUREMENTS AND UNITS

TOPIC: **LINEAR SCALES** DURATION: **½ week**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr>
<td>• Interpret scales on measuring instruments.
• Use appropriate instruments to measure quantities to degree of accuracy and precision allowed by the instrument. Rulers, measuring cylinder, stop watches, clock, thermometer, triple beam balance, digital balance, spring balance, Vernier caliper, micrometer screw gauge, ammeter, voltmeter.
• Tabulate measurements with appropriate column/ row headings (physical quantity, units).</td>
<td>A scale consists of a zero and marked divisions that enable us to measure a physical quantity. A <u>linear</u> scale is one in which the divisions are equal. An example of a linear scale is the scale on a ruler. The scale divisions are equally spaced. Not all scales are linear, however. In this course, we shall be using mainly instruments with linear scales.
The cm rule (or metre rule)
The scale on this rule starts from a zero. (Make sure students identify the zero mark.) Each cm is divided into 10 equal divisions. Thus, each of these small divisions is 0.1 cm.
<u>Precision of a measurement</u>
The precision of an instrument is the smallest sub-division on the instrument. Thus, the precision of the cm rule is 0.1 cm.
Table headings should contain the physical quantity being measured (e.g length), the quantity symbol (L) and the unit in which the quantity is being measured (cm). Notice the slash (called a <i>solidus</i>) between the quantity symbol and the unit symbol.
Note: Either the bracket or the <i>solidus</i> could be used, but there is a need to be consistent.</td>
<td>1 Displaying linear and non-linear scales
By using actual instruments in the lab. Or diagrams and pictures from textbooks (e.g. <i>Physics for CSEC</i>, by Farley and Trotz).
2 Determining the area of a Bahamian dollar using a cm ruler
<u>Name</u>
<u>Date</u>
<u>Area of a Bahamian Dollar</u>
<u>Purpose</u>: To find the area of a Bahamian dollar
<u>Results</u>
<table>
<tr><th>No.</th><th>Length L/cm</th><th>Width W/cm</th></tr>
<tr><td>1</td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td></tr>
<tr><td>Av.</td><td></td><td></td></tr>
</table></td>
<td>Linear and non-linear scales
(Instruments and/or pictures that have these)
Ruler calibrated in cm to 0.1 cm
(e.g. metre rule or geometry set rule)
Bahamian dollar</td>
<td>Rubric for assessing use of materials and equipment correctly and safely.
Results recorded to 0.1 cm precision.</td>
</tr>
</table>

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: PHYSICAL MEASUREMENTS AND UNITS

TOPIC: **LINEAR SCALES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Express numbers in a measurement to given significant figures.	<u>Significant figures and precision</u> When recording a measurement, careful attention should be paid to instrument precision. Measurements on the cm rule are made to the <u>nearest</u> 0.1 cm. Thus, readings in cm should be recorded to one decimal place such as 4.6 cm or 9.0 cm, but not 9 cm or 9.00 cm. The number of figures in a reading, starting from the first <u>non-zero</u> digit to the last digit (zero or non-zero) are called **significant figures** in a measurement. **Rules for using significant figures with measured values** 1. <u>Addition and subtraction rule</u> The answer takes the least number of <u>decimal places</u>. Thus, 4.6 + 2.02 = 6.6, and not 6.62. Also, 4.6 + 2.87 = 7.5, and not 7.47. 2. <u>Multiplication and division rule</u> The answer takes the least number of <u>significant figures</u>. Thus, 2.87 x 4.3 = 12, and not 12.341.	<u>Calculations</u> <u>Using the cm ruler (or metre rule)</u> 1. The object being measured (the dollar in this case) is as close as possible to the scale on the rule; 2. One end of the object is against the zero mark on the scale; 3. Their eyes are directly above the point on the object and the scale mark when taking a reading (this reduces the error of *parallax* in the reading – see, for example, *Physics for CSEC*, by Farley and Trotz); and 4. Take several readings each of the length and width, at various positions just in case the dollar is not uniform.		The correct number of significant figures.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: PHYSICAL MEASUREMENTS AND UNITS

TOPIC: **LINEAR SCALES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
		2 Challenge: (In-class) Show students a quarto sheet of paper (or any other object) and let them estimate its length in cm. **3 Challenge: (Home activity)** Students measure the thickness of a Bahamian one-cent coin.		Closeness of prediction to actual length. **Accuracy of measurement** Credit for methodology measuring the height of 10 coins stacked together and dividing by 10.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: PHYSICAL MEASUREMENTS AND UNITS

TOPIC: **S.I. SYSTEM OF UNITS** DURATION: **1 week**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr>
<td>3 Use equipment correctly and safely.

Match base quantities and units.</td>
<td>Physical quantities and units
Aspects we measure, like mass, length, time, speed and temperature, are called physical quantities.

The International System (S.I.)

Fundamental quantities and units
In the International System, all physical quantities are based on a small set of physical quantities called fundamental or base quantities. Seven of these base quantities are listed below, together with their unit names and unit symbols.

(Note the rule for writing unit names and unit symbols: All unit names are written with common letters, whether named after a person or not. Unit symbols begin with a capital letter only if the unit is named after a person.)

<table>
<tr><th>Fundamental (base) quantity</th><th>Fundamental (base) unit</th><th>Unit symbol</th></tr>
<tr><td>Mass</td><td>Kilogram</td><td>Kg</td></tr>
<tr><td>Length</td><td>Metre</td><td>M</td></tr>
<tr><td>Time</td><td>Second</td><td>S</td></tr>
<tr><td>Temperature</td><td>Kelvin</td><td>K</td></tr>
<tr><td>Current</td><td>Ampere</td><td>A</td></tr>
<tr><td>Amount of Substance</td><td>Mole</td><td>mol</td></tr>
<tr><td>Luminous Intensity</td><td>Candela</td><td>Cd</td></tr>
</table>
</td>
<td>1. Familiarization with fundamental units

Students handle:
A 1-kg mass
A metre stick
A thermometer to measure room temperature (mention that the thermometer measures temperature in degrees Celsius; to get the temperature in kelvins we add 273 to the Celsius reading)
A clock with seconds-hand or a stopwatch (digital or analogue) to get an idea of one second.

2. Measuring in fundamental units
(Lab records need not be done for these)</td>
<td>The following equipment

Various masses – up to 1 kg
Metre rule
Thermometer (degrees Celsius)
Clock or watch capable of reading in seconds</td>
<td>Rubric for assessing correct use of equipment.

Base quantities and units correctly matched.</td>
</tr>
</table>

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: PHYSICAL MEASUREMENTS AND UNITS

TOPIC: **S.I. SYSTEM OF UNITS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Derive the units for derived quantities.	Derived quantities and units Speed is distance (length) divided by time. Speed is called a derived quantity, since it is a combination of two base quantities (length and time). The S.I. unit for speed is metres per second (m/s). Most of the quantities to be used in this course will be derived quantities. Some of them are named after scientists. For example, force is a combination of mass, length and time. The S.I. unit symbol for force is kg.m/s^2. This unit for force is called a newton (N).	Suggested activities include measuring the following: - the length of the room - the mass of a student (using a bathroom scale; if the scale is in lb, note that 1 kg = 2.2 lb) - the time taken for the teacher to do a certain walk (e.g. the teacher actually walks from one corner to another in the room) - the temperature of this room in degrees Celsius and in kelvins	Bathroom scale	Rubric for assessing processing data.
• Convert between units.	**Conversions** Frequently we need to convert a multiple or a sub-multiple unit to a S.I. unit. This is usually because the S.I. is a coherent system – if we work problems in S.I., the answer automatically turns out in S.I. Furthermore, physical constants that we need in our calculations are usually given in S.I. units. Here two typical examples of conversions. These conversions involves the following prefixes:	3. **Practice in converting units:** cm to m m to cm kg to g g to kg mm to m m to mm		Rubric for assessing processing data.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: PHYSICAL MEASUREMENTS AND UNITS

TOPIC: **S.I. SYSTEM OF UNITS**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr>
<td>Covert between units.</td>
<td>
<table>
<tr><td>Prefix</td><td>Prefix symbol</td><td>Prefix value</td></tr>
<tr><td>milli</td><td>m</td><td>1/1000 (or 0.001 or 10^{-3})</td></tr>
<tr><td>centi</td><td>c</td><td>1/100 (or 0.01 or 10^{-2})</td></tr>
<tr><td>kilo</td><td>k</td><td>1000 (or 10^{3})</td></tr>
</table>

Example 1
Convert 24.3 cm to m.
Solution: cm = c x m (just like ab = a x b)
Therefore, 24.3 cm = 24.3 x 0.01 x m = 0.243 m

Example 2
Convert 24.3 g to kg.
Solution: to “multiply by 1”. Since we are interested in kg, we choose 1 = kg/kg.
$24.3\ g = 24.3\ \cancel{g} \times \frac{kg}{k\cancel{g}} = \frac{24.3\ kg}{k} = \frac{24.3\ kg}{1000}$
= 0.243 kg
</td>
<td>4. **Challenge: Group activity in class**
Estimate, using S.I. base units, the width of this room the mass of the teacher the time taken by a student to recite the alphabet the temperature of the human body in degrees Celsius and in kelvins.

5. **Challenge: At-home activity**
(This must be written up)
Determine the time taken between successive pulse beats.</td>
<td></td>
<td>Rubric for assessing processing data.</td>
</tr>
</table>

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: PHYSICAL MEASUREMENTS AND UNITS

TOPIC: **OTHER MEASURING INSTRUMENTS** DURATION: **1 week**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Relate scales on measuring instruments to scales on graphs	**Using measuring cylinders**	1. **Determining the volume of a small bottle** Students use a measuring cylinder in this experiment. They figure out in groups how to do this and are allowed their own methods. They write a simple lab report. The report would be similar to the sample shown earlier, but could include a "diagrams" section and a simply written "method" section. The diagram(s) should be two-dimensional and the method could include any special precautions they took. They can also include a "discussion" section in which they point out possible sources of error.	**Measuring cylinders** **Small bottles**	**Lab report**
	A graphing exercise	2. **Graphing** Students carefully add water into a measuring cylinder, 10 teaspoons at a time, say. They make a table of number of total number of teaspoons and corresponding volumes of water in the cylinder. Then they plot a graph of volume (y-axis) against number of teaspoons (x-axis).	**Plastic teaspoons**	**Lab report including graph** **Processing information** Using graph to - infer the volume of, say, 36 teaspoons-ful of water. - predict the number of teaspoons corresponding to a

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: PHYSICAL MEASUREMENTS AND UNITS

TOPIC: **OTHER MEASURING INSTRUMENTS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
- Research how precision timing is done e.g. swimming, track races, use of multiflash photography.	**Using timing devices (analogue and digital)** **Using balances (analogue and digital)**	**Determining the volume of a stone by displacement** (The stone could be placed in the cylinder containing water or in a displacement can filled with water and the cylinder placed under the overflow spout of the displacement can.) **3 Measuring the period of a pendulum of length 1.00 m.** (Students must let the pendulum swing through a small angle. Students should write a simple lab report and include a diagram of the pendulum arrangement. The diagram should be two-dimensional.) **4 Challenge:** Teacher can demonstrate a cell-phone camera or a video camera and ask students how it can be used to measure how long it takes for an object (e.g. a stone) to fall a distance of 1 m?	**Stones** **Displacement cans** **Simple pendulum apparatus** **Watch capable of reading in seconds** **Spring balances**	volume larger than the largest volume (by extrapolating the graph) **Lab report** **Lab report** **Oral reports by student along with in-class demonstration**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: PHYSICAL MEASUREMENTS AND UNITS

TOPIC: **OTHER MEASURING INSTRUMENTS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
- Use the scientific notation to express numbers.	Check this link for a tutorial on how to use a triple beam mass balance: http://www.ohaus.com/products/education/weblab/TBBentry.html **Using electrical instruments** (This will be deferred for Grade 12) **Scientific notation (standard form)** Scientists often use this form of notation - to indicate the significant figures in a measured value - to simplify calculations - to make very large and very small values understandable Scientific notation consists of a number from 1 to less than 10 multilpied by 10 raised to a power. Example 1 466.2 cm = 4.662 x 10^2 cm Example 2 17.0 cm = 1.70 x 10^1 cm (Note: we must include the zero after the 7 since it represents a significant figure in the measurement.) Example 3 0.000600 m = 6.00 x 10^{-4} m	**5 Student research and reporting** Students research how precision timing is done e.g. swimming, track races, use of multiflash photography. They report their findings to the class. **6 Measuring frictional force** Using a spring balance, students measure the force of friction between the lab desk surface and a block of wood. The must first zero the balance or note the zero error. **7 Determining the mass of a stone** Students use mass balances (analogue or digital) to determine this. They must first zero the balances. **Practice writing measurements in using scientific notation**	**Mass balances**	**Oral reports by students** **Lab report** **Lab report** **Writing numbers correctly using scientific notation.**

UNIT: PHYSICAL MEASUREMENTS AND UNITS

TOPIC: **MAKING MEASURING INSTRUMENTS** DURATION: **½ week**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
5 MAKING MEASURING INSTRUMENTS • Make simple measuring instruments using chosen standards for comparison-balance, roller wheel.	**Measuring wheel** Instrument for measuring lengths	**Challenge: (At-home activity)** **Making a measuring wheel** The wheel should be calibrated such that one complete turn (the circumference) is known and divided up into 10 equal parts. A handle (e.g. a stiff piece of wire or a wooden rod) could be attached for convenience of use. (Even a bicycle could be used.) Students use the wheel to measure distances along the floor or on the ground.	**Students obtain resources from home**	**Testing the performance of the instrument in class**
	Mass balance For measuring mass either in grams or in units such as coin masses **Spring balance** For measuring force in newtons or in units such as coin weights	**Challenge: (At-home activity)** **Making a mass balance** **Making a spring balance** Students can check textbooks or the internet for ideas. They can either calibrate their balances in grams or in terms of "standard" masses or weights such as those of coins.		**Testing the performance of the instruments in class**
	Map perimeter measurer Instrument for measuring distances around a map of an island.	**Challenge: (At-home activity)** **Making a map perimeter measurer** Students make something, the simpler the better, for measuring the map distance around the edge of an island.	**A map of an island**	**Testing the performance of the device in class**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: FORCES

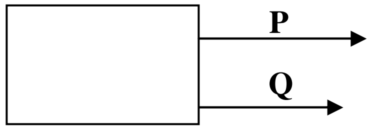
TOPIC: **FORCES AS VECTORS** DURATION: **2 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
FORCES • measure force using spring balance	**Using the spring balance** See "Activities" column on the right.	**1 Measuring forces** Students will have had experience in using the spring balance in Activity 6, *Using Other Measuring Instruments* under the topic *Physical Measurements and Units.*		
Forces as Vectors • Illustrate on diagrams, all forces acting on an object.	**Forces as vectors** Since force has both magnitude and direction, force is a <u>vector</u> quantity. **Representing forces by drawing** We can represent a force by a directed line segment drawn to scale.	**2 Practice exercises in vector representation of forces** Students draw, on graph paper, using a scale of 1 cm ≡ 10 N **(using the x-y system)** • a force F_1 = 50 N, pointing in the +x-direction (in this and other examples, the vector need not be drawn from the origin or even from the y-axis) • a force F_2 = 70 N, pointing in the +y-direction • a force F_3 = 86 N, pointing in the –y-direction • a force F_4 = 65 N, pointing in the -x-direction • a force F_5 = 50 N, pointing in a direction 65^o anti-clockwise from the +x-direction **(using the E-W-N-S- system)** • a force F_6 = 90 N, pointing at an angle of 70^o clockwise from north.	Graph paper Ruler Protractor	**Correct representation of vectors**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

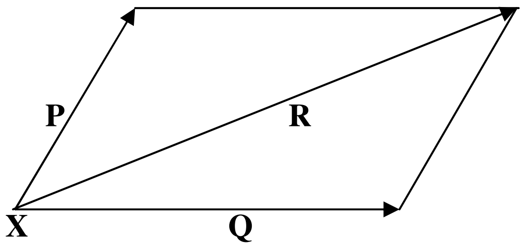
UNIT: FORCES

TOPIC: **FORCES AS VECTORS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
Construct and interpret force diagrams.	**Sketching Forces Acting On Objects** Students should be made aware of the following: • The weight of an object always acts vertically downward. • When an object presses against a surface, the surface presses back on the object with a normal contact force. • The force of tension along a tight string acts along the string and points away from the object to which the string is attached. • The force of friction on an object acts opposite to the direction of motion of the object as the object rubs against another object.	**3 Sketching Forces Acting On Objects** Students identify and sketch the forces on the following: • A book resting on a horizontal surface. • A box being pulled horizontally along a rough floor by a cord inclined at an acute angle to the horizontal. • A box sliding down a rough inclined plane. • A basketballer moving upwards in the air. • A pendulum bob when the string is at the maximum angle.	**The following resources will help students visualize the forces** Book and table Box and cord Box and inclined plane Basketballer jumping upwards Simple pendulum	**Correctly identifying, sketching and labeling forces**
Determine the resultant of forces.	**Resultant** The resultant of two (or more) forces is the single force that has the same effect as the other forces combined. If the resultant of forces on an object is **not zero**, the object will move (accelerate), because there is a net force. If the resultant of forces on an object **is zero**, the object will either not move, or move with zero acceleration (i.e. move at constant speed).	**4 Resultant of parallel forces**  Students exert parallel forces, P and Q, on a block (using spring balances to measure the forces) to just barely move the block. Then they exert a single force, F, to just barely move the block.	Block Spring balances	**Correct adding of parallel and anti-parallel forces and stating units**

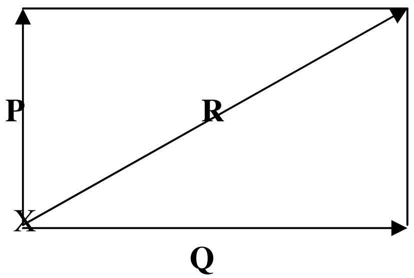
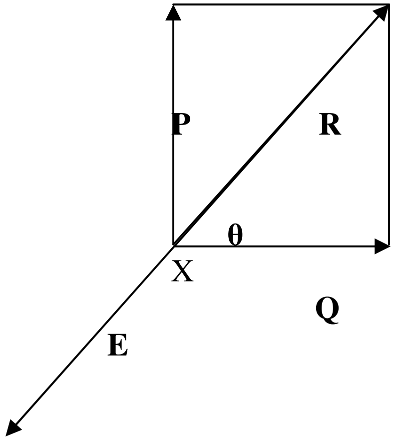
PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: FORCES

TOPIC: **FORCES AS VECTORS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Add parallel forces along a line.	**Resultant of parallel and anti parallel forces.** The resultant, F, of two parallel forces, **P** and **Q**, is given by: **F = P + Q** For anti-parallel forces, **P** and **Q**: **F = P - Q.**	This should help convey the idea that F is the resultant, and that F = P + Q. If a mass of known weight, W, is suspended by a spring balance and a force, P, registers on the spring, then, since the mass is stationary, it means that the net force F = 0. Therefore, for the two anti-parallel forces: **F = P – W**.		
• Determine the resultant of perpendicular forces (parallelogram law, Pythagoras Theorem scale drawings, trigonometry)	**Parallelogram of forces rule** The resultant, **R**, of two forces, **P** and **Q**, acting at an angle to each other on an object can be found by: • drawing the forces, **P** and **Q** to scale, acting at a point, X, and • completing the parallelogram The resultant is the diagonal of the parallelogram, drawn from X. 	**5 Finding the resultant of two forces acting at an acute angle by scale drawing** Students are shown how to draw parallelograms. Then they can be guided into finding the resultant (magnitude <u>and</u> direction) of a 70-N force and an 80-N force acting at angle of 60^o between them **6 Demonstrating resultant direction for mutually perpendicular forces** The teacher holds a small, folded paper about the middle of a rubber band. Two students exert pull on the rubber band with forces at right angles to each other.	Mass of known weight Geometry set	**Determining resultant:** • Correctly drawing a parallelogram • Determining magnitude and direction of resultant and specifying units correctly

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: FORCES

TOPIC: **FORCES AS VECTORS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
Determine the resultant of perpendicular forces.	 (Point out to students that a rectangle is a parallelogram.) 	(**Caution: this must be done so that in no way the paper can move in the direction of any student when the paper is released by the teacher.)** Students can be asked to predict the direction of the paper before the teacher lets go of it. Students are told that the paper moves in the direction of the resultant force. **7 Finding the resultant of two forces acting at a right angle to each other (two methods)** • By scale drawing • By Pythagoras' Theorem to find the magnitude of **R** and using the tan to find the direction (the angle between **R** and **Q**). **8 Finding the resultant of two forces acting at a right angle to each other (practical method)** Three strings are tied to a form a knot at a point X. The free ends of the strings are connected to spring balances such that three students exert forces **P, Q** and	Rubber band Small, folded paper *Physics for CSEC*, by Farley and Trotz, ch. 5	**Determining resultant of two forces at right angles to each other** • By scale drawing • By Pythagoras' Theorem **Lab report**

TOPIC: **FORCES AS VECTORS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
Resolve a force into its perpendicular components and determine the components	**Components of a force** Rectangular components of a force are two forces, acting at right angles to each other, that together produce the same effect as the single force. Since **P** and **Q** together produce the same effect as **R** in the diagram above, then **P** and **Q** are the <u>components</u> of **R**. From simple trigonometry, it can be shown that: $\mathbf{Q} = \mathbf{R} \cos \theta$, and $\mathbf{P} = \mathbf{R} \sin \theta$	**E** to keep the knot stationary. (The angle between the forces **P** and **Q** is kept at 90^o) When the knot is stationary, the magnitude of E is equal to the magnitude of **R**. (**E** is called the *equilibrant*, since it keeps the knot in equilibrium.) By drawing lines under the strings on a paper below, the direction of the resultant **R** can be obtained. **9 Finding components** Students can be asked to identify and calculate components in the following situations: • The horizontal and vertical components of a force of 75 N pulling at an angle of 40^o to the horizontal on a suitcase. The components of a weight of 60 N along and perpendicular to a plane inclined at 30^o.	Strings Spring balances *Physics for CSEC*, by Farley and Trotz, ch. 5 Demonstration using a box and a string Demonstration using a ball on an inclined plane	**Identification and calculation of components**

PHYSICS CURRICULUM
SCOPE OF WORK
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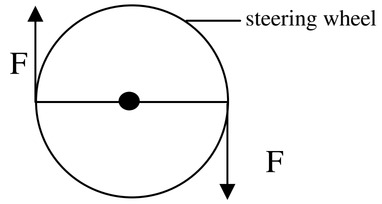
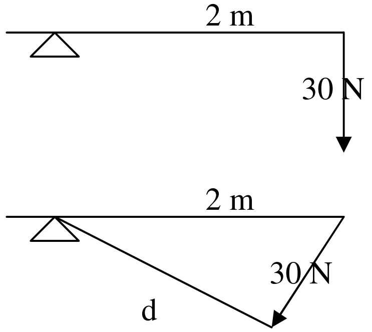
TOPIC: **MOMENTS** DURATION: **1 ½ weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe and identify force couples.	**Moment** The moment, M, of a force, F, about an axis is the product of the force and the perpendicular distance , d, from the axis to the line of action of the force. Thus, **M = F d**. A moment produces a turning effect (rotation) about an axis. The rotation could be clockwise or anti-clockwise. Moment is sometimes called *torque*. **Couple** A *couple* is a pair of forces, equal in magnitude, applied on opposite sides of and the same distance from an axis of rotation, that produce the same type of moment (clockwise or anti-clockwise). The forces on the steering-wheel shown below form a couple.  	**1 Calculating moments** Students calculate moments in the two types of situations shown below:  Note: In the second case, they use d as the perpendicular distance from the axis to the line of action of the force. **2 Investigating factors affecting moment**	*Physics for CSEC*, by Farley and Trotz, ch. 6	**Calculating moments**
• Investigate factors which affect the moment (turning effect) of forces.		1. Place a metre rule on a pivot (e.g. the side of a pencil) so that the ruler balances (approximately). Note the balance point and use this pivot at this point throughout the experiment.	Metre rule Pencil as pivot (or hang by a string) Masses (50 g, 100 g 200 g)	Rubric for assessing **Conducting an investigation** - correct placement of masses - identifying factors affecting moment

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: FORCES

TOPIC: **MOMENTS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
- Apply the formula moment = force x perpendicular distance (review). - Apply the principle of moments to solve problems.	The moment of a couple in which each force is a distance, r, from the axis (in the steering-wheel, the axis is at the centre of the circle) is given by **M = F r + F r = F x 2r** **Principle of moments** For rotational equilibrium, the sum of the clockwise moments about an axis must be equal to the sum of the anti-clockwise moments about the same axis.	2. Place a 100-g mass on the ruler at a distance of 20.0 cm from the pivot. The ruler becomes overbalanced. 3. Balance the ruler using - a smaller mass (e.g. 50 g) - a larger mass (e.g. 200 g) Ask students how enough moment is obtained to balance the ruler (with the 100-g mass at a given position) using - a smaller mass - a larger mass In other words: what are the factors affecting moment? **3 Applying the principle of moments** Types of practice exercises can include: - children on a see-saw - a wheelbarrow lifting a load - a crow-bar overcoming a load (Note: Caution students that moment due to a mass is not mass x d, but weight x d, since moment deals with forces and weight, not mass, is a force.)	See end-of chapter questions, *Physics for CSEC*, by Farley and Trotz, ch. 6.	**Solving numerical problems**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: FORCES

TOPIC: **MACHINES** DURATION: **2 ½ weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
MACHINES • Describe the use of inclined planes, screws & gears as machines.	**Machine** A machine is a device that makes doing work easier. This is achieved either by - using a small force to overcome a large load, or - applying a force from a convenient position		See text and end-of chapter questions, *Physics for CSEC*, by Farley and Trotz, ch. 10.	Rubric for assessing oral/viewed presentations. Relationship clearly shown **Lab report**
• Determine and use the relationship between mechanical advantage, efficiency and velocity ratio for pulley systems and inclined plane. • Calculate mechanical advantage, velocity ratio and efficiency of given simple machine.	**Mechanical advantage (MA), velocity ratio (VR) and efficiency (Eff) of a machine** - Mechanical advantage is defined as the ratio of the load (L) to the effort (E). Thus: $MA = L / E$ - Velocity ratio is the ratio of the distance (x_E) moved by the effort to the distance (x_L) moved by the load in the same time. Thus: $VR = x_E / x_L$ - Efficiency is the ratio of useful work W_L done on the load to the work W_E done by the effort. Thus: $Eff = W_L / W_E$ (To obtain *percentage* efficiency, we multiply Eff by 100%.)			Rubric for assessing processing data.

PHYSICS CURRICULUM
SCOPE OF WORK
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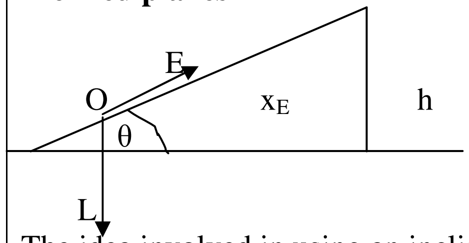
TOPIC: **MACHINES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Relationship among MA, VR and Eff Since $W_L = L x_L$ and $W_E = E x_E$, Then, $Eff = \frac{L x_L}{E x_E} = (L/E)\ x\ (x_L / x_E)$ Hence, **Eff = MA / VR** **Inclined planes** Inclined planes make work easier by requiring a smaller force to overcome a larger load. See activity in column on right. **Screws** Screws make work easier through an effort that travels a large distance (the circumference of a circle e.g. the circumference of a screwdriver handle) while the load advances a tiny distance. This tiny distance is called the *pitch* (p) of the screw i.e. the distance between successive threads. Assuming an efficiency of 1, $E x_E = L x_L = L p$ Hence, $L / E = x_E / p = 2\pi R / p$ Or, $\mathbf{MA = 2\pi R / p}$	**Inclined planes**  The idea involved in using an inclined plane is to raise a load (L) a certain height (h), by means of an effort that is smaller than the load. Students measure: L, E, h, θ, and x_E. They compute MA, VR and Eff from the data. (Note that Eff can be calculated in two ways: Eff = MA/VR and $Eff = L h / E x_E = MA \sin\theta$.) **Screws** Students observe the action of screws penetrating wood or car jacks. They identify: pitch, the radius R, the effort and the load.	Inclined plane Spring balance Large protractor Metre rule Wood screws Screwdriver Machine screws Spanner Car screw jack	**Identifying situations in which inclined planes, screws and gears are used.** **Calculation of:** mechanical advantage, velocity ratio and efficiency of given simple machines

TOPIC: **MACHINES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	In other words, a large MA is obtained by using a screw with a small pitch (p) and a screwdriver handle with a large radius (R). **Pulleys** <u>Single fixed pulley</u> The load is equal to the effort since the force throughout a tight string is the same. This arrangement makes work easier through being able to apply the effort from a convenient position.	**Pulleys** <u>Single fixed pulley</u> - Students set up a single fixed pulley arrangement and determine MA, VR and Eff. Students verify that MA ≈ 1. - Students draw forces E and L. <u>Single movable pulley</u> - Students set up a single movable pulley arrangement and determine MA, VR and Eff. - Students observe that there are <u>two</u> portions of string that support the movable pulley and load and that therefore MA ≈ 2. - Students draw forces E and L. <u>One pulley in the upper, fixed block and two in a lower, movable block</u> - Students draw the arrangement to show that <u>three</u> portions of strings support the lower block and the load - Students set up the arrangement and determine MA, VR and Eff. - Students verify that MA ≈ 3.	Laboratory pulleys Clothes-line pulleys Pulley systems made by students (using thread reels, stiff wire and ribbons) Block and tackle pulleys	**Numerical Problem-S**olving Solving problems involving inclined planes, pulleys and gears

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: FORCES

TOPIC: **MACHINES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Gears Gear A, radius R, no. of teeth N.  Gear B, radius r, no. of teeth n. Velocity ratio (Let us consider A as the driving gear.) When the effort at A moves through1revolution, the load at B makes $2\pi R / 2\pi r$ revolutions i.e. R/r revolutions. Since number of teeth on a gear is proportional to the radius of the wheel, then the load gear (B) makes N/n revolutions. Considering 1 revolution of A, we get **VR = 1/(N/n) = n/N**	Two pulleys in the upper, fixed block and one in a lower, movable block - Students draw the arrangement to show that three portions of strings support the lower block and the load - Students set up the arrangement and determine MA, VR and Eff. - Students verify that MA ≈ 3. Two pulleys in the upper, fixed block and two in a lower, movable block - Students draw the arrangement to show that four portions of strings support the lower block and the load - Students set up the arrangement and determine MA, VR and Eff. - Students verify that MA ≈ 4. *Students should observe that the velocity ratio in all cases is equal to the number of strings supporting the load.*		

TOPIC: **MACHINES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Thus, when A (with the larger number of teeth) is the driving gear, the velocity ratio is less than 1. Mechanical advantage For the above arrangement, assuming Eff = 1, we get MA = VR and hence, **MA = n/N** The MA is less than 1, meaning that a large effort is applied where the gears meet to overcome a smaller load. As far as forces are concerned, this is a mechanical disadvantage. However, the smaller gear spins faster than the larger gear. The reverse is true. To overcome a large load at A, a smaller effort is applied at B. In other words, B must be the driving gear. A will spin at a slower rate than B. Bicycles and car engines make use of these facts.			

UNIT: FORCES

TOPIC: **FRICTION AND DRAG** DURATION: **½ WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
FRICTION AND DRAG • Demonstrate that an object falling through a fluid achieves terminal velocity.	**Friction** One of the factors that contributes to inefficiency in machines is the force of friction due to solid parts rubbing against each other. An activity to measure frictional force is given under *Physical Measurements and Units*, Topic 4 : *Using Other Measuring Instruments*, Activity 6. **Drag** Drag is a force, like friction, that opposes motion. Drag is experienced when an object moves through a fluid (e.g. a boat moving through water, or a plane moving through the air). Drag increases with speed, and therefore, when an object falls through a fluid, it reaches a constant speed (called terminal speed) when the force of drag is equal to the force of gravity (we neglect the upthrust force for a small object).	**Drag** Students design and conduct an investigation to determine the terminal velocity of a small ball bearing falling through two different types or grades of oil in a measuring cylinder. Students can also investigate how terminal velocity varies with area of falling paper “parachutes”.	Types or grades of oil Measuring cylinder Stop-clock Ruler Tissue	**Lab report**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: WORK, ENERGY AND POWER

TOPIC: **WORK AND ENERGY** DURATION: **3 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
WORK AND ENERGY • Apply the relationship work = force x displacement to calculate energy transferred	**Work and energy** If something can do work, we say it possesses energy. Thus, we define **energy** as the ability to do work. We define **work** as the product of force, F, and displacement, d, in the direction of the force. Thus. **Work = F x d (Nm)** ………..(1)	**1 Measuring work done** - Students connect a spring balance (calibrated in N) and measure the work done against friction in pulling horizontally on a block placed on the lab desk. (Work = F x d) - Students connect a spring balance (calibrated in N) and measure the work done against gravity in raising a block through a vertical distance, h. (Work = F x h)	Spring balance Metre rule Wooden block	**Lab worksheet report**
	Lord Kelvin found that whenever work was done, an energy conversion took place. In fact, the more work done, the more energy is obtained. Thus there is an equivalence between work and energy. 1 Nm of work done is equivalent to 1 joule (J) of energy converted. Work can be regarded as a process in which one form of energy is converted to another.	**2 Calculating work done** Students are given practice in using the equation, Work = F x d.		**Student calculations**
• Solve problems using the relationships - P.E.$_g$ = mgh and - K.E. = ½ mv^2 • Explain that moving bodies have kinetic energy which is converted into other forms when stopped	**Potential energy** We define **potential energy** as stored energy. - An object at a height above the ground can do work. It possess gravitational potential energy. - A stretched spring (or rubber band) can do work. It possesses elastic potential energy.	**3 Demonstrations of pote**ntial energy (stored energy) - Place a 30-cm ruler partly protruding over the edge of a lab table surface. Hold a board eraser at a safe height over the protrusion. The fact that when the eraser is released it moves the ruler shows that the eraser had (gravitational) potential energy.	30-cm ruler Board eraser	

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: WORK, ENERGY AND POWER

TOPIC: **WORK AND ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
POWER - Manipulate and use the equation Power = $\frac{energy}{time}$ **ENERGY USAGE IN THE WORLD** **FOSSIL FUEL ENERGY** - Discuss the impact/implications of using fossil fuels as an energy source Investigate the effects of using fossil fuels on global warming and on the ability of presently harmless micro-organisms to become pathogenic)	- A battery can do work when connected to an electric motor. We say the battery possesses <u>chemical potential energy</u>. We derive the equation for gravitational potential energy, PE, as follows: Consider a mass, m, being raised a height, h. The force, F, required to raise the mass (at constant speed) must be equal to the weight, mg, of the mass. The potential energy, PE, gained by the mass is equal to the work done in lifting the mass. Therefore, PE = F x d, that is, **PE = mgh** ……………..(2) **Kinetic energy** Consider a mass whose initial velocity, v_o, is changed to a final velocity, v, by the action of a force, F. The force causes the mass to undergo an acceleration, a. through a distance, d. We get the following: Work = Fd But, by Newton's Second Law, F = ma Therefore work = mad Bu $a = \frac{v^2 - v_0^2}{2d}$ (since $v^2 = v_0^2 + 2\,ad$)	- Show that a stretched rubber band can do work in moving a small folded paper (do this with attention to safety). **4 Calculations involving gravitational potential energy** - Students are given practice in using the equation PE = mgh. **5 Demonstration of kinetic energy** A force is exerted on a dynamics cart for a short distance. Work is done and the cart gains kinetic energy. The kinetic energy of the moving cart can do work in moving a chalkboard eraser some distance along the desk surface. **6 Calculations involving kinetic energy and/or work-energy theorem, e.g.** **-** KE of a moving car. (Discuss what happens to the initial KE In a crash where the car comes to a stop,) - KE of a moving car. The car skids to a stop. (Calculate the force of friction, F. Show students how to use equation (3).)	Rubber band Small, folded paper Dynamics trolley Board eraser	Low-voltage d.c. motor Solar cell Voltmeter (or light-emitting diode)

TOPIC: **WORK AND ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Design & conduct investigations/ simulations to demonstrate the effects of using fossil fuels on the environment • Describe the importance of one aspect of the work of: **James Joules, Robert Boyle, Jacques Charles, Michael Faraday**, **Albert Einstein**. **ALTERNATIVE SOURCES OF ENERGY** • Discuss the impact/implications of using alternative sources of energy (hydro, geothermal, solar, wind, nuclear, bio-fuels) • Construct models to demonstrate the use of alternative sources of energy	Therefore work done = $m\frac{(v^2 - v_0^2)}{2d} \times d$ That is, **Work (Fd) = $\frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$** ….(3) The quantity, $\frac{1}{2}mv^2$ (or $\frac{1}{2}mv_0^2$) is <u>energy</u>, since, when work is done, an energy conversion takes place. The quantity, $\frac{1}{2}mv^2$ (or $\frac{1}{2}mv_0^2$) is called <u>kinetic energy</u> (KE), since it is energy due to motion. We therefore get, for a mass, m, moving with speed, v, the kinetic energy of the mass is given by **KE = $\frac{1}{2}mv^2$** ………..(4) Equation (3) shows that, **Work done, Fd = final KE – initial KE** Or work done = change in kinetic energy (ΔKE) This last statement is called the **Work-Energy Theorem.** **Power** Power is the rate of doing work or converting energy. Thus, power, P = work done, Wk (or energy converted, E) divided by the time taken, t. In terms of an equation:	**7 Measurement of power** - The teacher can demonstrate how to measure power of a small motor lifting a mass a height, h. ($P = mgh/t$) - The class can calculate the power of a student of mass m by measuring his/her mass and time taken to walk up a flight of stairs of vertical height, h, at normal pace. **(Note: In the interest of safety, do NOT let the student run up the stairs!)** **8 Calculation of efficiency** - e.g. the efficiency of a pulley system if a 100 N force, applied using a rope pulled a distance of 1.2 m, lifts a 20 kg mass a height of 40 cm. (Discuss the apparent "loss" of energy.) **9 Pie chart** Students can make a pie chart to show current energy usage in the world.	Small d.c. motor and battery Mass, thread Clock Metre rule Bathroom scale Means of measuring height of stairs (e.g. string and metre rule or measuring tape) Clock Kerosene "lamp" Test tube Lime water (calcium hydroxide) Internet photos and clips showing: Effects of acid rain Effects of oil spills	Internet video clips

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: WORK, ENERGY AND POWER

TOPIC: **WORK AND ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
ENERGY: THE WAY FORWARD • Critically appraise current events reports involving use of energy- renewable & non-renewable • Discuss the importance of energy conservation • Discuss energy conservation tips/strategies • Select scientists of interest including at least one Bahamian/ Caribbean scientist and describe their contribution(s) to the field of physics	**P = Wk/t (or P = E/t)** …… (5) Power is measured in joules per second. 1 J/s is called a watt (W). **Efficiency** The efficiency (Eff) of an energy conversion is defined by: $\textbf{Eff} = \dfrac{\underline{\textbf{Useful work done}}}{\textbf{Total work put in}} \times \textbf{100\%}$ ….. (6) Energy conversions are never 100% efficient, since some of the energy put in is invariably wasted as heat or some other form of energy. **Current energy usage in the world** Most of the energy used in the world today comes from fossil fuels, of which oil usage is greatest. Approximate percentages are given below: Oil (35%), Coal (26%), Gas (19%), Biomass (11%), Nuclear (6%), Hydroelectric (2%), Solar/Wind/Geothermal (1%).	**10 Class discussion (or debate)** Students do research and then participate in discussion/debate on "Advantages and disadvantages of using fossil fuels**".** **11 Demonstration** Burn some kerosene oil and show that soot, carbon dioxide and acidic gases are given off (**Note: on account of safety issues it is NOT recommended that students do these types of investigations.)** **12 Simulation** Show the effect of a very dilute solution of sulphuric acid or nitric acid on limestone or metals (these acids are formed from oxides released in the air when engines use fossil fuel in combustion. **13 Student research** - Find out how the internal combustion engine works. - Internal combustion engine principles are based on work done by Boyle and Charles on pressure, volume and	Low-voltage d.c. motor	

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: WORK, ENERGY AND POWER

TOPIC: **WORK AND ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Fossil fuel energy Fossil fuels take millions of years to form. Plants trapped energy by photosynthesis and became buried by layers of earth where they slowly changed form into fossil fuels. **Some advantages of using fossil fuel energy** - relatively cheap - easily transported - plenty of energy per unit mass of fuel - many devices have been invented that can make use of fossil fuels **Some disadvantages of using fossil fuel energy** - not renewable in our lifetime; known oil resources are expected to last to only about the middle of this century - very polluting to the air, water and land: oil spills are toxic in water and also smother aquatic life; the air becomes acidic and toxic - much carbon dioxide is produced when combustion takes place and this is believed to contribute to global warming - only a few countries are the major suppliers and they can manipulate world prices	temperature of gases. Find out about Joules, Boyle and Charles and about one aspect of each of their work. **14 Student research** Find out the meaning of OPEC and list the countries that form OPEC and their geographic location. **15 Making working models** Teacher makes simple models of the following using small low-voltage d.c motors (to which a turbine is attached) - hydroelectricity - wind-generated electricity Students make models of trapping solar thermal energy to warm up water. **16 Student research** Students find out a little about Faraday (he showed how to obtain electricity from magnetism), and Einstein.	Low-voltage d.c. motor Solar cell Voltmeter (or light-emitting diode) Internet video clips	

TOPIC: **WORK AND ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	The need for developing and using alternative sources of energy - The effects of fossil fuel use are very damaging to the planet - Fossil fuels will soon run out - As the world becomes more developed and also as the world population keeps growing, there is an increasing demand for energy The following are some sources being pursued: Hydroelectric Potential energy of water stored in reservoirs at a height is transformed into kinetic energy at the base of the reservoir as the water falls. The running water causes turbines connected to generators to spin. The generators convert the kinetic energy into electrical energy. Wind Wind causes turbines connected to generators to spin. The generators convert the kinetic energy into electrical energy. Solar voltaic Solar cells convert light into electricity	**17 Discussions** - Current events concerning energy use - importance of energy conservation - energy conservation tips and strategies that students can employ **18 Student research** Students find out about - Bahamian/Caribbean scientist doing work on development of alternative sources of energy or energy conservation. - Career involving alternative sources of energy and what area of physics is involved - Pros and cons of using various alternative sources of energy.		

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: WORK, ENERGY AND POWER

TOPIC: **WORK AND ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	<u>Solar thermal</u> Blackened metal objects containing water heat up the water when exposed to sunlight. Also, water gets heated up inside a closed glass container by the "greenhouse effect". <u>Nuclear</u> Energy is obtained from nuclei of atoms when fission or fusion takes place. The energy comes from mass that is converted according to the Einstein equation, $E = mc^2$. <u>Bio-fuels</u> Energy is obtained by combustion of ethanol or wood. Biogas fuel is also produced by decaying organic materials. **Energy: The way forward** - More use of alternative sources (e.g. drying clothes in the sunshine) - Improvement of present efficiencies of appliances - More use of energy efficient appliances - Energy conservation practices: Less use of motor cars; car- pooling; Turn off appliances when not in use;			

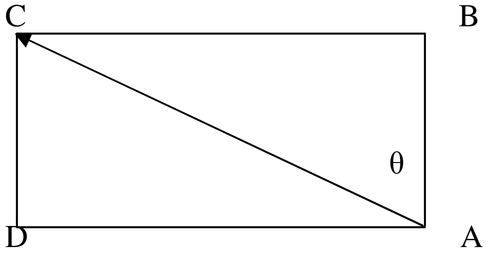
TOPIC: **WORK AND ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Make sure windows and doors are closed and cracks are sealed when using air-conditioning; Use light colours on roofs and buildings; Design buildings to make use of natural ventilation and cooling.			

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: LINEAR MOTION

TOPIC: **VECTOR & SCALAR QUANTITIES (Distance, Displacement, Speed, Velocity)** DURATION: **1 week**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
1 VECTOR AND SCALAR QUANTITIES • distinguish between vector and scalar quantities e.g. distance and displacement, speed and velocity **2 DISTANCE AND DISPLACEMENT** **3 SPEED AND VELOCITY** • distinguish between vector and scalar quantities e.g. distance and displacement, speed and velocity • distinguish between instantaneous speed, average speed and constant speed • manipulate and use the equation speed=$\frac{total\ dist.}{total\ time}$	**Linear motion** Linear motion is motion in a straight line. **Vector and scalar quantities** A vector quantity has magnitude (size) and direction. A scalar quantity has magnitude but no direction. **Distance and displacement** The distance between two points, A and B, is the length of the path taken to get from A to B or from B to A. Since the path could be straight or wiggly, distance has no specific direction. Distance is therefore a *scalar* quantity. The displacement between two points, A and B, is the straight distance from one of the points to the other. Displacement therefore takes place along a specific direction and is therefore a *vector* quantity. **Teachers may wish to consider these:** • Although arrows can be drawn to represent vectors, vector addition etc. could probably be treaded in more detail later on in the section FORCES.	**1 Determining distance and displacement**  Students move an object (e.g. an eraser) along the edge of a desk from one corner, A, to the corner, C, diagonally opposite. They move the eraser along the path ABC. They measure: (i) the distance travelled to the nearest cm (ii) the displacement (magnitude and direction – for direction, they measure the angle θ and state the direction in degrees anticlockwise from the direction AB). **2 Determining average speed and average velocity**	**Distance and displacement (equipment)** - Student's desk or lab desk - Small object (e.g. eraser) - Metre rule (or cm ruler) - protractor - some means of getting a thin, straight line, AC; (you can ask students for ideas – perhaps a string or thread might work, or a long straight board and chalk to mark the straight line, AC). **Speed and velocity (equipment)** - Clock or stopwatch (in addition to equipment listed above) **See also** *Physics for CSEC*, by Farley and Trotz, p 74-76.	**Questioning** - Defining scalar and vector quantity - Defining distance and displacement - Classifying distance and displacement as scalar and vector, respectively **Simple lab report** Correctly measuring and recording - distance - displacement (magnitude and direction) **Note:** Teachers are encouraged to insist on correct terminology in definitions in these very early lessons. This will help set the stage for straight thinking. "Definitions" like: 'speed is how fast something is going', or 'distance is how far something has travelled', should not be encouraged.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: LINEAR MOTION

TOPIC: **VECTOR & SCALAR QUANTITIES (Distance, Displacement, Speed, Velocity)**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
(It is important for students to keep track of S.I. units for each physical quantity they come across. Also, if they work numerical problems using S.I. units, the answer turns out automatically in an S.I. unit, since S.I. is a coherent system of units.)	• After students have completed the activities in the right-hand column, you can show them briefly how AC could have been calculated using Pythagoras' Theorem, and θ from tan θ = CB/AB. However, do not spend too much time on this. **Speed and velocity** Speed is the rate of change of *distance* with time. Thus, constant speed = distance ÷ time. In terms of an equation, $s = d/t$, where s represents constant speed, d, distance travelled and t, time taken. The S.I. unit symbol for speed is m/s, since speed is a distance (i.e. a length) divided by a time. The speedometer in motor vehicles measure speed either in miles per hour (mph) or kilometers per hour (km/h). Speed is a *scalar* quantity since it involves distance and time, both being scalar quantities. Average speed (when speed is not constant) is the total distance travelled ÷ total time taken. Thus, $s_{av} = d_{total} / t$.	Let students measure the time taken for the small object to be moved from A to C. They then calculate the following: (i) the average speed of the trip ABC; (ii) the average velocity of the trip ABC (they must state the magnitude and direction of the velocity). **3 Demonstration/discussion** The teacher walks completely around the class and asks students to time the walk. Students are challenged to determine (i) the distance walked (ii) the displacement (iii) the average speed (iv) the average velocity **4 Solving simple numerical problems based on equations** $s_{av} = d_{total} / t$ $v = x/t$		**Questioning** - Defining speed, average speed, constant speed, instantaneous speed, velocity - Classifying speed and velocity as scalar and vector, respectively **Calculating** Correctly calculating - speed - velocity (magnitude and direction) Calculations should be done in S.I. units and answers given in S.I. units.

TOPIC: **VECTOR & SCALAR QUANTITIES (Distance, Displacement, Speed, Velocity)**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Constant speed is speed in which an object travels equal distances in equal times no matter how small time intervals are chosen. Instantaneous speed is the actual speed at a particular time during a trip. The car speedometer gives the actual speed (instantaneous speed) at any time during a trip. Velocity terms are similar to those for speed. Velocity is the rate of change of *displacement* with time. Thus, velocity = displacement ÷ time. In terms of an equation, $\boldsymbol{v = x/t}$ for motion taking place along the x-axis, where v represents velocity, x displacement and t, time taken. The S.I. unit symbol for velocity is m/s, since velocity is a displacement (i.e. a length) divided by a time. Velocity has the same direction as displacement. Since velocity has direction, velocity is therefore a *vector* quantity.	Simple change of subject of an equation skills could be attempted here. Doing the same things to both sides of an equation should be encouraged rather than either the triangle method or carrying over. These last two do not encourage thinking and will prove a disadvantage to students later on.		

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: LINEAR MOTION

TOPIC: **ACCELERATION** DURATION: **1½ weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
4 ACCELERATION - define acceleration as rate of change of velocity. **5 EQUATIONS OF MOTION AT CONSTANT ACCELERATION** - derive & manipulate equations of motion: $a = \frac{v - v_o}{t}$ $v = v_o + at$ ……………. (i) $x = v_o t + \frac{1}{2} at^2$ …………(ii) $v^2 = v_o{}^2 + 2ax$ …………(iii) $v_{av} = x/t$ ……………...(iv) $v_{av} = \frac{v_o + v}{t}$ ……………(v) to solve motion problems	**Acceleration** Acceleration is the rate of change of velocity with time. The direction of an acceleration is the same as the direction of the change in velocity. Acceleration therefore has direction and, as such, is a vector quantity. Acceleration = change in velocity / time A change is a final value minus an initial value. Therefore, acceleration = Final velocity – initial velocity . In equation form, $a = \frac{v - v_o}{t}$ The S.I. unit for acceleration is (m/s)/s or m/s^2. The equation a = (v - v$_o$)/t can be rewritten as v = u + at by a simple change of subject. **Equations of motion at constant acceleration** The equations (i) to (v) shown in the left column are equations of motion at constant acceleration. Students can be expected to derive equation (i) from the definition of acceleration. However, the teacher should	**1 Demonstrating acceleration** A low-friction cart or a ball can be given an initial push along a horizontal board and then on the board inclined at about a 30° angle. **2 Calculating acceleration** Example A car increases its velocity from 5.0 m/s to 11.0 m/s in 4.0 s. What is its acceleration? Solution *It is important at this early stage to insist on a methodical approach. The 4-step approach below is strongly recommended as a 'norm' for most numerical problem-solving situations.* To find: acceleration, a = ? Given: initial velocity, v$_o$ = 5.0 m/s final velocity, v = 11.0 m/s time, t = 4.0 s Solution: $a = \frac{(v - v_o)}{t} \quad \frac{m/s}{s}$ $= \frac{11.0 - 5.0}{4.0} \quad m/s^2$ $= 1.25\ m/s^2$	**Equipment** - Low-friction cart or (ball) - Smooth board about 1 to 1.5 m in length **Textbook practice examples** *GCSE Physics* by Tom Duncan, p ….. *World of Physics* by John Avison, p ….	**Defining** Students define acceleration **Deriving** Students deriving at least equation (i) **Numerical problem-solving** Students use a methodical approach in solving problems involving equations (i) to (v).

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: LINEAR MOTION

TOPIC: **ACCELERATION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
DETERMINING ACCELERATION EXPERIMENTALLY • determine experimentally acceleration due to gravity using the free fall method **INTERPRETING TICKER TAPE CHARTS** • interpret ticker tape charts to describe motion and determine instantaneous speed, constant speed, average speed and uniform acceleration 9,14	go through the derivations of (ii) and (iii) (found in most textbooks) but not necessarily emphasize student derivations, especially if the class appears mathematically challenged. **Acceleration due to gravity** Experiments show that all objects, regardless of mass, accelerate to the ground with the same acceleration in the absence of air resistance. This acceleration of free-fall is caused by gravity and is often called 'acceleration due to gravity' and given the symbol *g*. **Free-fall methods for determining acceleration due to gravity, *g*** Free-fall methods typically involve very short time intervals and special equipment. Methods that can be tried include: - Simulations - Special free-fall timing equipment - Ticker-tape equipment - Cell phone, digital camera or camcorder	= 1.3 m/s^2 (to 2 s.f.) Ans: 1.3 m/s^2 Other examples These can be taken from textbooks. However, the teacher must be careful to use examples that, initially at least, do not overwhelm the students. **3 Simulations** A fun simulation is the Colorado PhET *Vacuum Drop*, where objects are dropped from a given height near the surface of a planet and the time taken to reach the surface is read. The values for *g* near the surface of each planet can be calculated using equation (ii). **4 Special free-fall timing equipment** These include photogates and ball-and-pad equipment connected to a millisecond timer. These can be used in a teacher demonstration and the students calculate *g* using equation (ii). They can test if the mass of the falling object makes a difference to the value for *g*.	**Free-fall simulations** http://phet.colorado.edu/teacher_ideas/view-contribution.php?contribution_id=88 Run the *Vacuum Drop* simulations. **Special free-fall timing equipment** **Ticker-tape equipment** **Textbooks:** *GCSE Physics,* by Tom Duncan, p …. *World of Physics* by John Avison, p … and *Physics for CSEC*, by Farley and Trotz, p 88-90.	**Calculating *g* from experimental data**

TOPIC: **ACCELERATION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
		5 Ticker-tape equipment Descriptions of the equipment can be found in textbooks shown in the column on the right. The method can be demonstrated experimentally by the teacher and students can then be given copies of a tape from which to determine *g*. In order to determine *g*, students would need to determine two 'instantaneous' velocities (average velocities in the vicinity of two dots on the tape), separated by a suitable time interval. **6 Challenge: Cell phone, digital camera or camcorder** Students might love this. A cell-phone, digital camera or camcorder which can display time can be used to make an actual video-clip of free fall. From measurements and time taken, they can determine *g*.		

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: LINEAR MOTION

TOPIC: **LINEAR MOTION GRAPHS** DURATION: **1 ½ weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
GRAPHS OF MOTION • draw, interpret & use motion graphs (displacement-time and velocity-time) qualitatively and quantitatively to determine displacement, time, speed, acceleration etc	**Graphs of motion** In plotting these graphs, we put the time variable on the horizontal axis. **Displacement vs. time graphs** - The slope of a displacement vs. time graph gives the *velocity* of an object. If the graph is a sloping straight line, the velocity is constant. If the graph is curved, the slope, and hence the velocity, is changing. The slope represents the velocity at a given time, i.e. the *instantaneous* velocity. - The height of a displacement vs. time graph gives the displacement of the object at a given time. **Velocity vs. time graphs** - The slope of a displacement vs. time graph gives the *velocity* of an object. If the graph is a sloping straight line, the *acceleration* is constant. - The area under a displacement vs. time graph gives the *displacement* that took place during the corresponding time interval. - The *height* of a displacement vs. time graph gives the *velocity* of an object at a given time, i.e. the *instantaneous* velocity.	**7 Simulations and corresponding graphs** (See information in the Resources column.) **8 In-class walking demonstrations followed by class discussions** A student can walk slowly next to a wall in the classroom. The wall is marked in 1-m intervals. As the student passes each metre, students record the time. Then a graph of the walk is plotted. The following walks might be done: - slowly at constant speed from one wall to the next - slowly at constant speed, stopping for about 2 seconds, then resuming at the same speed to the other wall - slowly at constant speed from one wall, then turning back and walking to the starting point at the same speed. (The above activity might even be adapted to outdoors.)	**Colorado PhET simulations** file:///C:/Program%20Files/PhET/simulations/sims0048.html?sim=The_Moving_Man The *Moving Man* simulation found at the above link allows you to set initial velocity, initial position and acceleration. Three graphs are displayed as the simulation runs: - displacement vs. time - velocity vs. time - acceleration vs. time **Textbooks e.g.** *Physics for CSEC*, by Farley and Trotz, Chapter 7.	**Drawing/sketching of graphs** - from a motion (e.g. a walk) - from data given **Interpreting of graphs of motion** Obtaining the following from suitable graphs - a verbal description of the motion - displacement at a given time - displacement during a given time interval - instantaneous velocity - constant velocity - constant acceleration

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: LINEAR MOTION

TOPIC: **LINEAR MOTION GRAPHS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
		Plotting graphs from data You can give students tables of data and have them practice plotting of graphs of motion e.g. - displacement vs. time - velocity vs. time **Reading data from graphs** Students can be given exercises in simply reading data from graphs of motion. **Obtaining information from graphs** Students can be given graphs and asked to obtain information from them such as: - velocity - displacement - time Since students tend to be swayed by the shape of a graph (e.g. a sloping line to them invariably means acceleration), it is important to have students pay attention to the variable on the vertical axis as they try to read and interpret graphs of motion.		

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: LINEAR MOTION

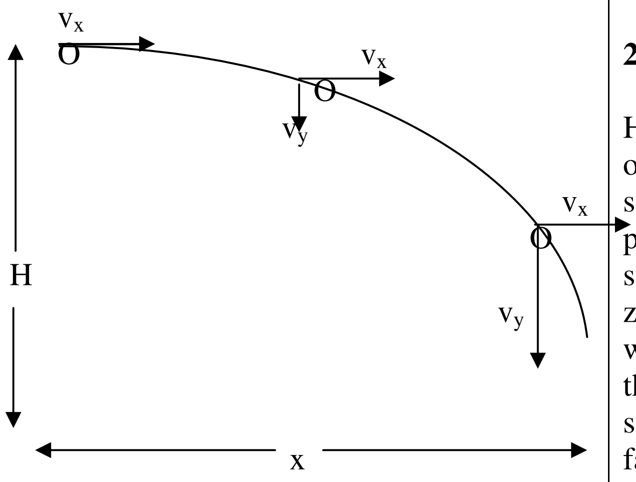
TOPIC: **LINEAR MOTION GRAPHS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
		Sketching of graphs Students sketch graphs (not on graph paper) such as: - velocity vs. time involving constant acceleration and constant velocity during parts of a trip - displacement vs. time involving constant velocity, stopping and constant acceleration.		

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

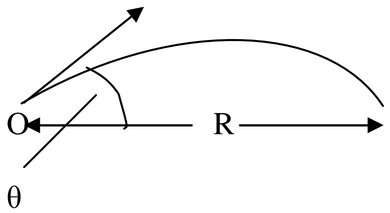
UNIT: TWO DIMENSIONAL MOTION

TOPIC: **PROJECTILE AND CIRCULAR MOTION** DURATION: **2 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
PROJECTILE MOTION • State examples of projectile motion in everyday life. (sports- shot putt, soccer, discus, missiles) • Show experimentally that the horizontal and vertical motion are independent (drop an object vertically while projecting another horizontally, note time taken by each to drop.)	**Projectile motion** A projectile is any object that moves through the air in which the only forces acting on the object are the force of gravity and the force of friction (drag) on the object. In projectile motion, horizontal velocity remains constant (assuming negligible friction through the air). The vertical motion is just like free-fall; the object accelerates downward with the acceleration due to gravity. The two motions are **independent** of each other and can be treated separately.	**1 Discussion** Discuss with the class whether the following are examples of projectiles or not as they move through the air; - shot putt ball - soccer ball - high jumper - long jumper - discus - airplane - rocket taking off - other examples from students		
		**2 Demonstration** Have two students each hold an object, A and B, of the same size (e.g. small block of wood, a tennis ball or a pencil) at the same height. A third student counts down 3 – 2 – 1- 0. At zero, one throws the object forward while the other drops the object – at the same time. The rest of the students note whether A falls first, B falls first, or they fall together. The experiment is repeated about 3 times and the class results tallied and	Two similar objects (e.g. tennis balls, wooden blocks or pencils)	**Discussion of results of Demonstration 2**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: TWO DIMENSIONAL MOTION

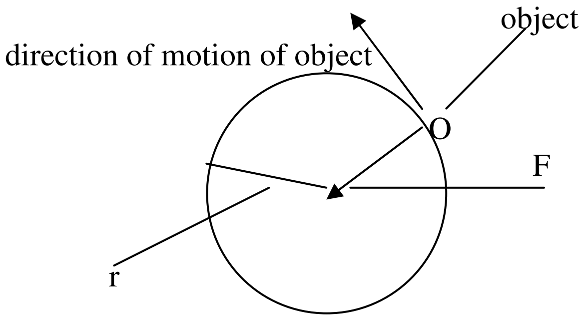
TOPIC: **PROJECTILE AND CIRCULAR MOTION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Investigate how the range of a projectile varies with angle of projection. (Catapult expt.)	Projectile motion: vertical velocity, v_y , increases; horizontal velocity, v_x , remains constant. The time taken to fall a distance H is equal to the time taken to cover a horizontal distance x as shown in the diagram. **Projectile range** The range, R, of a projectile is the horizontal distance travelled from the starting point to the landing point at the same level. 	discussed. (They take the same time to reach the floor **if the object thrown forward is thrown horizontally** **3 Numerical problem-solving** Discussion and practice in solving problems (and variations) like: A tiger leaps horizontally with a speed of 5.0 m/s from a 4.0 m hign tree. (a) How much time is the tiger in the air? (Use $y = ½ gt^2$) (b) How far from the base of the tree does the tiger land? (Use $x = v_x t$) **4 Investigation** A toy pop-gun shoots a relatively safe "bullet" (e.g. a foam dart or a ping-pong-like ball) at various angles of projection, θ, The range, R, is measured. A graph plotted of R against θ to find the angle for which the range is largest. This investigation also provides good opportunity to discuss control of variables and the need to take averages of data.	Toy pop-gun (or rubber band and paper pellet) **Safety goggles** Large protractor (could be made from cardboard and graduated in 10^o steps).	**Numerical problem-solving** Solving problems (and variations) like those shown in Activity 3: **Student Lab Report** Even if Investigation 3 is done as a class exercise, students could write a lab report with the following sections: - Title - Purpose - Diagram - Method - Tabulated Results - Discussion - Conclusion

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: TWO DIMENSIONAL MOTION

TOPIC: **PROJECTILE AND CIRCULAR MOTION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
CIRCULAR MOTION - Recognize that a centripetal force is needed for circular motion. - Recognize the relationships between centripetal force, mass, distance and speed. $(f=(mv^2)/r)$ - Identify examples of centripetal force. (gravity in planetary and satellite motion, friction in moving around curves- roundabouts, tension in string whirling objects around,)	**Uniform Circular Motion** For an object to move uniformly in a circle, two things are necessary: - the object move with constant speed - that must be constant force F acting at right angles to the direction the object is moving at every instant of time. Since the force F acts at right angles to the velocity, F points towards the centre of the circle. F is called a **centripetal force**. 	Applications of the results can be discussed in terms of sports. **5 Discussion** Ask students to identify the centripetal forces in each of the following situations: - The Earth moving in circular orbit around the Sun - A satellite moving in circular orbit around the Earth - A car moving in a circle on a horizontal roundabout - A ball being whirled in a circle horizontally on a string. **6 Numerical problem solving** Make up problems based on the equation $F = mv^2 /r$ and have students practice solving them. Encourage them to use the format:		**Numerical problem solving involving** **$F = mv^2/r$** **Students sharing findings in class** **Numerical problem solving** Students solve problems based on the equation $F = mv^2/r$

UNIT: TWO DIMENSIONAL MOTION

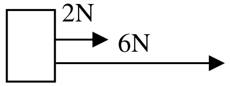
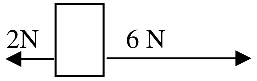
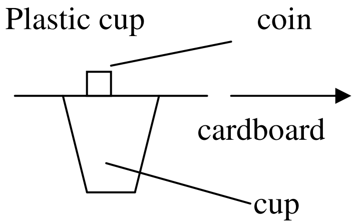
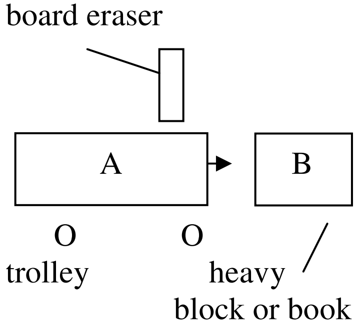
TOPIC: **PROJECTILE AND CIRCULAR MOTION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Example of centripetal forces See Discussion 5 Calculating centripetal force The centripetal force, F, on an object if mass m, moving in a circle of radius, r is given by $\mathbf{F = mv^2 / r}$	- To find - Given - Solution - Ans.		
CAREERS • Describe careers which rely on the study of physics • Describe the use of physics in various careers (including emerging careers)		**7 Reading or Internet Research** Students find out careers involving projectile motion or circular motion.		**Students sharing findings in class**
HISTORY/ SCIENTISTS • Describe the importance of one aspect of the work of each of the following scientists: Isaac Newton, Copernicus, Galileo, Kepler, Hubble, • Select scientists of interest including at least one Bahamian/ Caribbean scientist and describe their contribution(s) to the field of physics		**8 Reading or Internet Research** Students are asked to find out one aspect of the work of the following scientists in either projectile motion or circular motion: Newton Copernicus Galileo Kepler Hubble A Bahamian or Caribbean scientist		**Students sharing findings in class**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: NEWTON'S LAWS OF MOTION

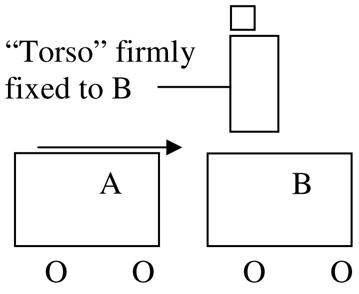
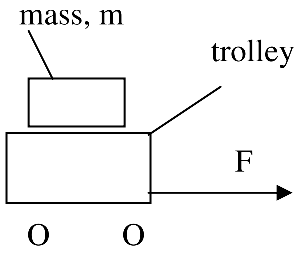
TOPIC: **NEWTON'S LAWS OF MOTION** **DURATION: 2 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
HISTORY - Describe the importance of one aspect of the work of each of the following scientists in the area of linear motion: **Isaac Newton**, **Galileo**. **NEWTON'S FIRST LAW** - State Newton's First law of motion. - Define inertia. - Illustrate on diagrams, all forces acting on an object. - Identify and model examples where Newton's first law is demonstrated. (use of seat belts, &head rests in vehicles.)	**Newton's First Law of Motion** Every object remains in its state of rest or of uniform motion in a straight line, unless a net force acts on it. **Inertia** Inertia is the tendency of an object to remain at rest, if originally at rest, or to continue its state of uniform motion in a straight line. Mass is a measure of an object's inertia. The more mass an object has, the greater its inertia. **Net force** When forces are parallel to each other, the net force is the sum. When they are anti-parallel, the net force is the difference.  Net force = 8N  Net force = 4N	**1 Student reading/internet research** Find out two experiments Galileo did that showed that Aristotle's ideas of motion were wrong. **2 Student reading/internet research** Find out three things for which Issac Newton was famous. **3 Demonstrations of inertia** (a) Place a coin on a cardboard over an open plastic cup. Quickly pull the cardboard off the cup. The coin falls into the cup because its inertia - its tendency to remain at its original position when the cardboard was quickly pulled away. If the cardboard is pulled slowly, the coin does not fall into the cup. This is because the force has enough time to change the coin's position of rest. (b) Place a suitable object (e.g. a board eraser) on a trolley. Set the trolley moving on a horizontal surface with the object on it. When the trolley bumps into a fixed object (e.g. a heavy book), the board eraser falls forward. You can discuss this observation in terms of <u>inertia</u> and also with the need for a <u>seatbelt</u>.	Coin Cardboard Plastic cup  	**Student presentations to class on** - Galileo - Newton **Calculation of net force** - parallel forces - anti-parallel forces **Hypothesizing** - reason for board eraser "flying forward" after trolley has come to a stop

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: NEWTON'S LAWS OF MOTION

TOPIC: **NEWTON'S LAWS OF MOTION** **DURATION: 2 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
NEWTON'S SECOND LAW (in terms of acceleration) • State Newton's second law of motion in terms of acceleration. • Investigate the relationship between mass, applied force and acceleration • Manipulate and use the relationship Force =mass x acceleration to solve problems	**Equilibrium** When the net force on an object is zero, the object either stays at rest or moves in a straight line with constant speed. We say that such an object is in equilibrium. The diagrams show two cases of equilibrium and the forces involved. **Newton's Second Law of Motion (in terms of acceleration)** The acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass. In equation form, $a = F/m$ or $\mathbf{F = ma}$ **………… (1)** **Definition of the newton** The newton of force is defined using equation (1) above. 1 newton is the force that gives a mass of 1 kg an acceleration of 1 m/s^2.	(c) Using blocks of wood or metal, make a "torso" with a "head" and a "neck". Fix the body on a trolley so that the body cannot move in the trolley. Let a trolley A collide with B, which is at rest but is free to move. The "head" jerks back because it wants to remain where it was originally, i.e. because of the head's inertia. The jerking causes whiplash, a crushing of tender bones and nerves in the neck. Discuss the role of head rest in cars. **4 Demonstration of Newton's Second Law** The apparatus on the right can be used to demonstrate Newton's Second Law qualitatively. - A constant force F is applied to a trolley of mass m by means of a spring balance. The acceleration is observed. The trolley is loaded so as to double the mass and the same force F is applied. The acceleration becomes reduced. - Using a constant mass the force F is doubled and the acceleration observed. The acceleration increases.	"Head" attached with tape at the back to the "torso". The tape represents the flexible "neck".  	**Hypothesizing** - reason for "head" jerking backwards when trolley B hits stationary trolley A." **Student observations** - a larger mass gives rise to a smaller acceleration for the same force. **-** a larger force gives rise to a larger acceleration for the same mass

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: NEWTON'S LAWS OF MOTION

TOPIC: **NEWTON'S LAWS OF MOTION** **DURATION: 2 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
NEWTON'S THIRD LAW • State Newton's third law of motion • Identify and model examples where Newton's Third Law is demonstrated. (launching rockets etc.)	**Newton's Third Law of Motion** If an object A exerts a force on an object B, the object B exerts an equal and opposite force on the object A. <u>Discuss the following, asking students if they illustrate Newton's Third Law of Motion:</u> Two people pulling a rope or string at opposite ends (Yes.) Jet aircraft: the force of the engines on the air they expel is equal and opposite to the force of the air on the engines. The engines are connected to the aircraft and this force of the air therefore causes the aircraft to move forward. (Yes.) Launching a rocket (Yes.) Athletes are able to do high jump because the force they press on the ground is equal and opposite to the force the ground pushes on them. (Yes.)	**5 Numerical problem solving** Students are given practice in solving numerical problems involving F = ma. They must be encouraged to follow the steps: To find/Given/Solution. **6 Demonstrations: Jet aircraft principle** Blow up a balloon and then release it with its neck open. The stretched balloon forces air backwards and the air forces the balloon forward. Launch a water-rocket (a toy) (outdoors in a safe place, of course) **7 Student demonstration** Two students, each with a spring balance, pull on the ends of a string and measure the forces. The forces are equal in magnitude, even if a tiny student does the demonstration with a large student.	Balloon Toy water-rocket Two spring balances	**Numerical problem solving** Students solve numerical problems involving F = ma. **Students make balloon rockets**

TOPIC: **NEWTON'S LAWS OF MOTION** **DURATION: 2 weeks**

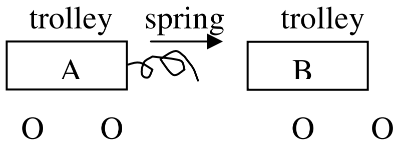
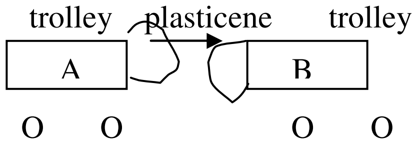
LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
CAREERS • describe careers which rely on the study of physics • describe the use of physics in various careers (including emerging careers)	A book remains stationary on a table because the normal contact force is equal and opposite to the weight of the book. (No! Although the forces are equal and opposite, this is NOT a case of the force of A on B being equal and opposite to the force of B on A. Weight is provided by the pull of the Earth, not the pull of the table. Actually, these equal and opposite forces can be explained by Newton's Second Law. Since the book is in equilibrium, the net force on the book is zero, and therefore the two forces must be equal and opposite.) **Important note:** *This last example shows that we must avoid teaching Newton's Law as "action and reaction are equal and opposite", as this tends to result in misconceptions in students' minds. The Law should be taught in terms of two objects exerting forces on each other.*	**8 Reading/Internet research** Students find out and list careers in which Newton's Laws of Motion are applied.		Lists of careers presented to the class by students.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: COLLISIONS

TOPIC: **MOMENTUM** **DURATION: 2 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
MOMENTUM • Define momentum as a product of mass and velocity and use this formula to solve problems **NEWTON'S SECOND LAW (in terms of momentum)** • State Newton's second law in terms of rate of change of momentum. ($F = (mv – mv_o)/t$: substituting for a) • Apply Newton's second Law of motion to the transfer of momentum e.g. popping a string, catching a ball, hammering a nail and packaging of eggs	**Momentum** ***Momentum is the mass times the velocity of an object.*** Momentum, p, is given by the equation $\mathbf{p = mv}$ **……… (1)** The S.I. unit for momentum is kilogram meters per second or kg.m/s. Note that since velocity has direction, then momentum also the same direction as velocity. Momentum is therefore a ***vector*** quantity. **Newton's Second Law in Terms of Momentum** ***The net force applied to an object is directly proportional to its rate of change of momentum, and the change of momentum takes place in the direction of the net force***, In equation form $F \; \alpha \; \frac{\text{change in momentum}}{\text{time taken to make the change}}$	**1 Discussion of cases relating to equation (2)** Large force required (Momentum change in a short time) - hammering a nail - hitting a baseball Small force required (Momentum change in a long time) - catching a ball - packaging of fragile objects - "breaking" a fall on landing from a high jump.		**Solving numerical problems involving** • Momentum • Momentum change and force for short and longer times **Statement of laws and definitions** • Newton's Second Law in terms of momentum • Momentum **Identifying Applications of Above laws and definitions**

TOPIC: **MOMENTUM** **DURATION: 2 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
COLLISIONS AND MOMENTUM - State the law of conservation of linear momentum - Differentiate between elastic and inelastic collisions	or $F \alpha \frac{mv - mv_o}{t}$ Therefore $\mathbf{F = \frac{mv - mv_o}{t}}$ **……… (2)** (since the unit of force i.e the newton is defined in such a way that the constant of proportional is 1). Note that equation (2) shows that if the change in momentum takes place in a short time, the force is large. That is why cars are built with crumple zones at the front and back. In a crash, the car folds and this increases the time taken for the car's momentum to change to zero and come to a stop. The overall force on the car and the occupants therefore becomes reduced. From equation (2) we also get (assuming that the mass of the object is constant) $F = m\frac{(v - v_o)}{t}$, that is, $F = ma$ which is the equation for Newton's Second Law in terms of acceleration.	**2 Investigation of packaging required** - e.g. for a stick of chalk dropping from a height of 1 m without breaking **3 Demonstrations of elastic and inelastic collision**  (a) Elastic collision  (b) Inelastic collision	Sticks of chalk Packaging material Metre rule Two trolleys A and B Compression spring. Plasticine	**Statement of laws and definitions** - Law of conservation of momentum - Elastic collision - Inelastic collision **Solving numerical problems of the type** - Two objects colliding - A person jumping from a small boat. - Kinetic energy in collisions **Student presentations to class on careers in which Newton's Laws or an understanding of collisions are useful.**

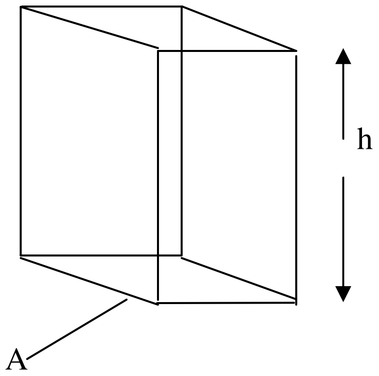
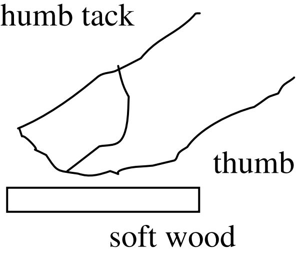
PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: COLLISIONS

TOPIC: **MOMENTUM** DURATION: **2 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Use the law of conservation of linear momentum to solve problems involving elastic and inelastic collisions CAREERS • describe careers which rely on the study of physics • describe the use of physics in various careers (including emerging careers)	**Law of Conservation of Momentum** ***In any system where there is no net external force, the total momentum of the system remains constant***, In equation form, $\mathbf{m_A v_A + m_B v_B = m_A v_A' + m_B v_B'}$ ………… (3) (initial condition) (final condition) **Elastic and Inelastic collision** In all collisions involving no net external force, momentum is conserved. In an elastic collision, kinetic energy is also conserved. Thus total KE before collision = total KE after collision. That is $\mathbf{½ m_A v_A^2 + ½m_B v_B^2 = ½m_A (v_A')^2 + ½ m_B (v_B')^2}$ In an inelastic collision, kinetic energy is not conserved. Some or all of the initial kinetic energy ends up as heat.	**4 Numerical problem solving** Discuss problems of the following types. • Car a collides with car B • A person jumping from a small boat Students can be shown how to calculate: 1. final velocity of one object or of two objects (if they stick together); 2. initial and final KE of the system and hence determining if the collision is elastic or inelastic. **4 Student research activity** Students find out specifically how Newton's Laws or an understanding of collisions apply (e.g. athletics and athletic coaching, motor vehicle design, packaging material design.)		

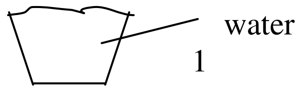
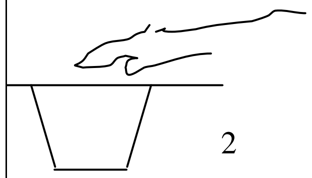
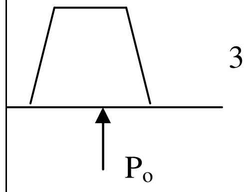
PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: HYDROSTATICS

TOPIC: **PRESSURE** DURATION: **6 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
HYDROSTATICS PRESSURE • Recognise the relationships existing between pressure, force and area • Manipulate the equation $\text{Pressure} = \frac{force}{area}$ to solve problems • solve problems using $p = h\rho g$	**Hydrostatics** Hydrostatics is the study of forces on and in fluids at rest. **Pressure** Pressure is defined as the perpendicular force per unit area on a surface. In equation form. $\mathbf{P = F / A}$ **………….** (1) **Pressure in fluids**  Consider a column of fluid of height, h, cross-section area, A, mass, m, and density, ρ. Since $\rho = \text{mass / volume} = m / Ah$ Then, $m = \rho Ah$ But weight of fluid, $W = mg = \rho Ahg$ Therefore, pressure on the base, $P = \rho Ahg / A$, or $\mathbf{P = h\rho g}$ **……….** (2)	**1 Demonstrating pressure** Press hard with your thumb on a piece of soft wood. Let students observe. Then press with the same force on a thumb tack with the point placed on the wood. Discuss observations in terms of $P = F / A$. **2 Numerical problem solving** Students solve simple numerical problems involving $P = F / A$. **3 Numerical problem solving** Students solve simple numerical problems involving $p = h\rho g$.	Many of the concepts and activities in this topic are treated quite clearly in *Conceptual Physics* by A. Farley and C. Trotz. Piece of soft board Thumb tack 	**Student observations** Students describe the effect of the thumb alone, and then the thumb with the thumb tack, on the wood. Students deduce that pressure causes the difference since force was the same in both cases. **Student solutions** Students solve problems using a logical format e.g. To find, Given, Solution, Ans. **Student solutions** Students solve problems using a logical format e.g. To find, Given, Solution, Ans.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: HYDROSTATICS

TOPIC: **PRESSURE, ATMOSPHERIC PRESSURE** DURATION: **6 weeks**

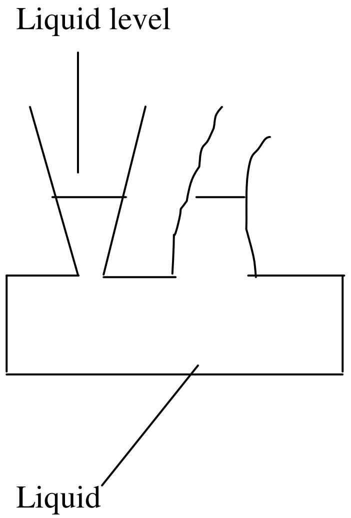
LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
ATMOSPHERIC PRESSURE • Perform experiments to demonstrate atmospheric pressure • Describe how atmospheric pressure varies with height and from day to day e.g. weather systems	**Pressure of the atmosphere** The weight of air above the Earth exerts a pressure on all objects on the Earth. This pressure is called atmospheric pressure. We shall use the symbol, P_o, to represent this pressure. On the average, at sea-level, $\mathbf{P_o = 1.01 \times 10^5 N/m^2}$ As we go higher up the atmosphere, there is less air above us. Hence the pressure of the atmosphere gets less. Thus, the atmospheric pressure on mountain tops is lower than the pressure at sea level. The pressure of the atmosphere varies from day to day, due to factors such as temperature. When the atmospheric pressure is high, the weather tends to be fair or sunny. A low pressure is usually associated with rainy conditions. Some parts of the atmosphere may also be at high pressures and others at low pressures. Winds rush from areas of high pressure to areas of low pressure, sometimes giving rise to hurricanes. Weather stations usually measure pressures in milli-bars, where 1 bar = 1.01×10^5 N/m^2. There are 1000 milli-bars in 1 bar.	**4 Demonstrating atmospheric pressure** Fill a cup (or plastic bottle) with water (diagram 1). Place a smooth cardboard over the mouth of the filled cup of water so there are no air spaces between the cardboard and the water. Press the cardboard in place with your fingers (diagram 2). Invert the cup with your fingers on the cardboard, then remove your fingers. The cardboard remains in place and water does not run out of the cup. Ask students why. (The pressure of the atmosphere presses on the cardboard and keeps it in place.) **5 Making and using a simple barometer** Students can make a simple barometer by following instructions on the link below. Students can calibrate their barometers on a scale of 1 to 5, 1 being low pressure and 5 being high pressure. They can make measurements just before rain, just after rain and when it is sunny. They can also make charts of atmospheric pressure variations at regular intervals throughout a day.	Plastic cup (or water bottle) Smooth cardboard    **Laboratory barometer** A simple aneroid barometer can work.	**Construction of barometer** **Charts of variation of pressure readings** - using home-made barometer - using laboratory barometer **Charts of daily atmospheric pressure readings** **Student lab reports**

TOPIC: **PRESSURE, ATMOSPHERIC PRESSURE** DURATION: **6 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
		http://starryskies.com/try_this/baro1.html **6 Listening to weather reports** Students plot daily readings of atmospheric pressure from weather reports. Daily readings from the local weather station could be compared with readings done in the lab using the laboratory barometer.	Manometer Large container (e.g. large measuring cylinder) Metre rule Oil Salt Mass balance Measuring cylinder	

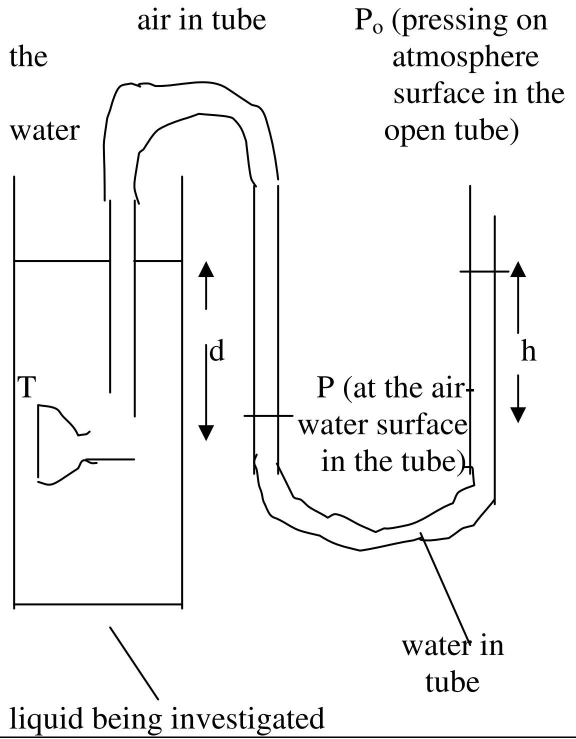
PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: HYDROSTATICS

TOPIC: **PRESSURE IN FLUIDS** DURATION: **6 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
PRESSURE IN FLUIDS • Investigate factors that affect pressure in fluids - depth, density • Design/conduct experiments to investigate/demonstrate that pressure acts equally in all directions at the same depth • Design/conduct experiments to investigate/demonstrate that liquid pressure is independent of shape, width or area of container base (liquid finds its own level) • Perform calculations to determine force and pressure in hydraulic systems	**Factors affecting pressure in fluids** Pressure in fluids can be investigated using a manometer. The manometer consists of a thistle funnel, T, with a sheet of rubber stretched over its mouth and secured with a rubber band. The stem of the thistle funnel is connected to a flexible tubing which, in turn, is connected to a U-tube containing water. (See diagram below.) The pressure of the liquid at the surface of the rubber sheet over the mouth of the thistle funnel (i.e. the pressure at a depth, d, in the liquid) is equal to the pressure of the air trapped in the manometer.	**7 Investigating factors affecting pressure in fluids** - Students investigate the variation of pressure, P, with depth, d, using the water manometer. (Note: the U-tube must be adjusted so that the level at P is the same as the level at T.) - Using other fluids of known density (e.g. oil or salt water) in the fluid container, students investigate the variation of fluid pressure, P, with density of the fluid. (In both of the above examples, discuss control of variables. For example, in the first investigation, the kind of liquid and temperature are kept constant; in the second example, the depth and temperature are kept constant.)		**Student lab reports** **Student observations** **Student observations**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: HYDROSTATICS

TOPIC: **PRESSURE IN FLUIDS** DURATION: **6 weeks**

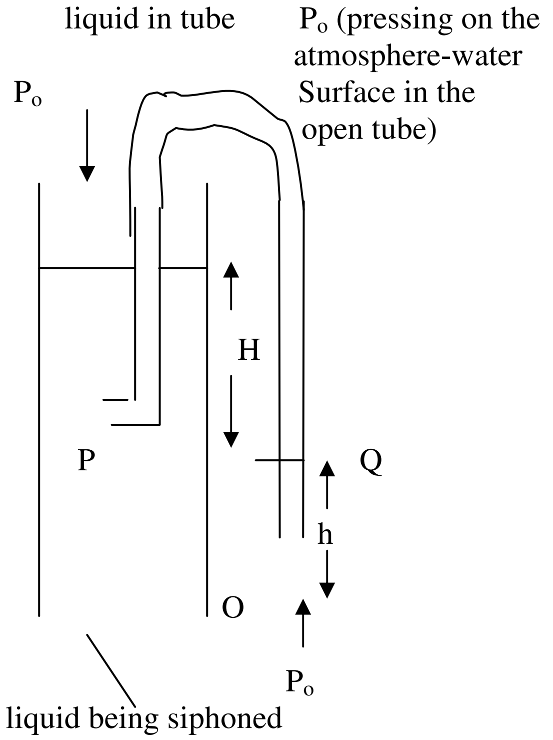
LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	This pressure, P, is given by $P = h\rho g + P_o$ where ρ is the density of the water in the manometer U-tube.  	**8 Investigating direction of pressure within a fluid** By keeping the depth constant, and swiveling T in various directions, students investigate if the fluid pressure varies with direction within the fluid. A thistle funnel with a straight glass tube, or with a U-tube, can also be used to point in the downward or upward direction at the depth, d. **9 Investigation of liquid level** The teacher sets up the apparatus shown on right in which the liquid in all the tubes is exposed to atmospheric pressure. The fact that all surfaces exposed to the atmosphere are at the same height shows that the pressure at their bases depend only on vertical height and not on shape or size of tube or area of base.		

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: HYDROSTATICS

TOPIC: **PRESSURE IN FLUIDS** DURATION: **6 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Applications - Dams are built thicker and stronger at their bases because the pressure of the water increases with depth. - Siphons work as follows: The pressure, P, inside the liquid = $P_o + h\rho g$ The pressure at Q is therefore $P_o + h\rho g$ Therefore the pressure at the open end, O, due to the liquid = $P_o + H\rho g + h\rho g$. The atmospheric pressure outside the open end is P_o and is therefore less than the pressure of the liquid at O. Hence the liquid will run out, as long as O is below the horizontal level with P.	**10 Demonstrating siphon action** The teacher can set up the siphon apparatus shown on the left in column 2.	Siphon arrangement made by teacher or students - large measuring cylinder - rubber tubing (the straight pieces of glass tubing are optional (**CAUTION!** Students must NOT use their mouths to get their siphons going. They must simply fill the rubber tube with water, close one end, and then dip the open end under the water in the container. Then they open the closed end. Explain why it is not safe ever to use one's mouth to make a siphon.)	**Siphon made by students**

TOPIC: **PRESSURE IN FLUIDS** DURATION: **6 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
				

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: HYDROSTATICS

TOPIC: **ARCHIMEDES PRINCIPLE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Design and perform experiment to demonstrate/verify Archimedes principle • Use Archimedes Principle to explain floating and sinking • Perform experiment to investigate the ease of flotation in fluids of different densities. • Discuss everyday applications of Archimedes principle- such as Andros water barge, cruise ships, shipping between waters of different densities.	**Archimedes' Principle** *The upthrust on an object placed in a fluid is equal to the weight of fluid displaced by the object*: i.e. Upthrust = weight of fluid displaced For an object to float, the upthrust on the object must be equal the weight of the object: i.e. Upthrust = weight of object Thus, *a floating object displaces its own weight of fluid in which it floats.* This last statement is sometimes called the *Principle of flotation.* **Archimedes' Principle and flotation** If an object displaces a volume, V, of fluid of density, ρ, the mass, m, of the fluid displaced is given by $m = \rho V$. The weight of the fluid displaced is therefore given by $W = \rho V g$. Since upthrust is equal to weight of fluid displaced, then upthrust is greatest when density of fluid is greatest and volume of liquid displaced is greatest. That is why ships and barges are made with large volumes (to displace large volumes of water so as to obtain large upthrusts) but	**11 Verifying Archimedes' Principle** Students design and carry out an experiment to verify Archimedes' Principle. You can show them the following equipment they can use: spring balance, thread, stone, overflow can, suitable beaker and top-pan (or beam) balance. They may request other equipment if they wish. **12 Investigating floatation in fluids** A narrow test tube, loaded with some sand for stability, is placed in liquids of various densities (e.g. fresh water, oil, salt water, ice water, warm water). Students observe and record the depths the test tube sinks in the liquids of various densities and make a conclusion. Students can even calibrate their test tubes using the known densities and given a liquid of unknown density (e.g. milk or a sugar solution made up by the teacher) to infer its density from the depth the test tube sinks. In effect, they would have made a hydrometer. **13 A discussion** could follow as to ease of floatation of ships in the following	Spring balance Thread Stone Overflow can Suitable beaker Top-pan (or beam) balance Narrow test tube Liquids of various densities Metre rule (or graph paper placed in the inside wall of the test tube)	**Design submitted by each group** **Lab report submitted by each group** **Student lab reports** **Student observations** **Hydrometer made and calibrated by students**

TOPIC: **ARCHIMEDES PRINCIPLE** DURATION: **6 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	hollow so that their weights are smaller than the upthrust on them.	waters: Cold and fresh Cold and salty Warm and fresh Warm and salty Students can then do research as to what are the Plimsoll Lines in international shipping.		**Student reports to class on findings about Plimsoll Lines**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: HYDROSTATICS

TOPIC: **PASCAL'S PRINCIPLE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• State Pascal's principle and describe its application to hydraulic systems eg. braking systems, hydraulic press. • Perform calculations to determine force and pressure in hydraulic systems	**Pascal's Principle** Pascal's Principle states that pressure is transmitted equally in all directions in a fluid. Therefore, for a liquid in a narrow tube of cross-section area, A_1 , connected to a wide tube of cross-section area, A_2 , it follows that $F_1 / A_1 = F_2 / A_2$ Therefore, $F_2 = (F_1 / A_1) \times A_2$ It follows that a large force, F_2 , can be obtained from a smaller force, F_1 , if the smaller force is applied on fluid in a narrow tube that is connected to a wider tube. This principle is applied in hydraulic braking systems in vehicles and hydraulic lifts at vehicle service station and tyre repair workshops.	**14 Numerical problem-solving** Students are given practice in solving problems involving $F_1 / A_1 = F_2 / A_2$. **15 Demonstration of hydraulic system** Some labs might have a hydraulic demonstration system. A small weight placed on the narrow cylinder side overcomes a large weight placed on the wide cylinder side.	Laboratory hydraulic demonstration system (Teacher may improvise by linking cylinders of different diameters with a rubber tubing).	**Student lab reports** **Student solutions to numerical problems** (Done in the usual format: To find, Given, Solution and Ans.)

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10
UNIT: HYDROSTATICS

TOPIC: **BERNOULLI'S PRINCIPLE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• State Bernouille's principle and discuss its application to sailing, flight, soccer, roof tops lifting off in hurricanes etc.	**Bernouille's Principle** When a fluid is moving smoothly in a horizontal direction (that is, particles follow each other in the same line), the sum of the pressure and kinetic energy per unit volume of the fluid is constant. This is Bernouille's principle applied to a fluid flowing in a horizontal direction. In equation form $\mathbf{P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2}$ **….. (3)** A garden hose with an adjustable nozzle illustrates this principle. The rate of flow of liquid in the hose and the nozzle is the same (because water is not backing up). Hence, the speed of the particles of liquid through the nozzle, $\mathbf{v_2}$ **,** is greater than the speed of the fluid, $\mathbf{v_1}$, through the hose. By equation (3), the pressure in the hose, P_1 , is greater than the pressure in the nozzle, P_2 . Thus, where the speed of fluid flow is greatest, the pressure of the fluid is lowest. <u>Examples of Bernouille's Principle</u> - In hurricanes, roofs may get lifted off houses due to the lowered pressure above the roof caused by the high wind speed.	**16 Demonstrating Bernouille's Principle** A strip of paper is held at one end so that the other end hangs downward. By blowing horizontally over the strip, the paper rises. This is because the pressure above the paper is lowered due to the speed of the air blown above the strip. The atmospheric pressure under the strip is greater than the pressure above the strip. Hence the strip rises. Students can be encouraged to try the above in class.**17 Student discussions of sail-boating** Students with experience with sail-boating discuss their experiences with class.	Pictures showing difference between laminar (smooth) flow and turbulent flow of fluids Pictures of cross-section of aeroplane wings and laminar flow of air over them Pictures or video clips showing sailboats in action, e.g. at a Regatta Perfume spray bottle	**Students blowing above strips of paper and getting them to show lift** **Student discussions of their experiences** **Student discussions of their experiences** **Student discussions of their experiences**

TOPIC: **BERNOULLI'S PRINCIPLE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	- The wings of an aeroplane are more curved at the top than at the bottom. Hence air flows faster over the top. The pressure at the top being, as a result, less at the top than at the bottom, causes the wing to experience a lift. - Boats can sail against wind by angling the sail so that wind flows past one side faster than another. - When the pressure is increased inside a perfume bottle, the liquid exits with a high speed through a fine nozzle. - Balls curve through the air if they are spinning. This is because, as the ball moves forward through the air, the speed of the 'boundary layer' of air on one side of the spin is increased by that of the on-coming air, while that on the other side is decreased since it is flowing opposite to the direction of the on-coming air. The ball curves toward the side where the net speed of the air near to the ball is greater.			

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 10

UNIT: HYDROSTATICS

TOPIC: **HYDROSTATICS- SCIENTISTS AND CAREERS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
HISTORY/ SCIENTISTS • Describe the importance of one aspect of the work of Bernouille, Pascal and Archimedes. • Select scientists of interest including at least one Bahamian/ Caribbean scientist and describe their contribution(s) to the field of physics CAREERS • Describe careers which rely on the study of physics • Describe the use of physics in various careers (including emerging careers)		**17 Student research** Students find out a little of who Bernouille, Pascal and Archimedes were and a little about their work. **Student research** Students find out in which careers or occupations a knowledge of Archimedes' Principle, Pascal's Principle and Bernouille's Principle are useful.		**Student reports to class** **Student reports to class**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **SCIENTISTS/CAREERS** **DURATION: 6 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
HISTORY/SCIENTISTS • Describe the importance of one aspect of the work of each of the following scientists: Boyle, Charles. • Select scientists of interest including at least one Bahamian/ Caribbean scientist and describe their contribution(s) to the field of physics		**1 Reading / Internet Research** Students can be asked to find out a little about Boyle and Charles and their respective contributions to the understanding of the behaviour of gases.		**Student presentations to class or student reports**
CAREERS • Describe careers which rely on the study of physics • Describe the use of physics in various careers (including emerging careers)		**2 Reading / Internet Research** Students can be asked to find out about careers that require an understanding of pressure, volume and temperature of gases, or in which such understanding is helpful.		**Student presentations to class or student reports**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **KINETIC THEORY OF MATTER**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
KINETIC THEORY • State the postulates of the kinetic theory.	**Assumptions of the Kinetic Theory of Matter** • Matter is made up of tiny particles. • The particles are always in motion • Particles exert strong forces (of attraction or repulsion) on each other when their separation distance is very small. • Collisions between particles are perfectly elastic i.e. energy is not lost overall by the particles during collisions. **Particles of matter** An atom is the smallest particle of an element that retains the chemical characteristics of the element. (An element is a substance that cannot be broken down into any simpler substance by chemical means. Oxygen and hydrogen are elements. Water is not an element since it can be broken down into simpler substances, namely, hydrogen and oxygen.) A molecule is the smallest particle of a			**Observations stated by students**

TOPIC: **KINETIC THEORY OF MATTER**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
KINETIC THEORY	substance that can exist by itself. A molecule can consist of one atom (e.g. the helium molecule), more than one atom of the same kind (e.g. the oxygen molecule has two atoms of oxygen), or atoms of different kinds (e.g. the water molecule has two atoms of hydrogen and one atom of oxygen). An ion is an atom that is charged, either by gain or loss of electrons. *Only certain kinds of substances are made up of molecules*. Gases are one example. Organic compounds, e.g. wax, are also made up of molecules. (Solid conductors consist of a vibrating lattice of positive ions among which electrons move freely. Compounds like salt (sodium chloride) consist of ions of sodium bound tightly with ions of chlorine to form giant structures.)			

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **KINETIC THEORY OF MATTER: BROWNIAN MOTION, DIFFUSION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe and demonstrate phenomena which provide evidence for the kinetic theory of matter (Brownian motion, diffusion) • Relate temperature to molecular speeds	**Evidence for the Kinetic Theory** Evidence that particles of matter are actually moving can be seen from the following: Brownian motion in liquids Robert Brown, looking at tiny pollen grains through a microscope, noticed that the pollen showed continuous, irregular vibrations. He suggested that the vibrations were due to the motion of water molecules that were bombarding the pollen grains. Hence the name *Brownian motion*. Brownian motion in gases Particles of smoke in a transparent container illuminated with very bright light themselves look like tiny specks of light when viewed under a microscope. These specks of light are observed to move about randomly in jerky fashion. This is explained by assuming that molecules of the air in the container are colliding with the smoke particles. Diffusion in liquids When a crystal of potassium permanganate is dropped gently in a beaker of water, the purple colour gradually spreads throughout the water.	**3 Brownian motion of pollen in water** Set up a microscope slide with water on it and sprinkle a few pollen grains (or very fine powder) on the water. Have students state their observations. Students can also be encouraged to check the internet for video clips of this kind of experiment. **4 Brownian motion in gases** Set up a smoke-cell apparatus (e.g. Figure 11.6, *Physics for CSEC,* by A. Farley and C. Trotz). Let students describe their observations. **5 Diffusion in liquids** Have students gently drop a crystal of potassium permanganate in a beaker of water. Let students sketch their observations at the start, 1 hour later, several hours later and 24 hours later.	Microscope with bright illumination Slide Pollen grains (or fine powder grains) Brownian motion smoke-cell apparatus Potassium permanganate crystals Beaker	**Website addresses stated by students** **Observations stated by students** **Drawings sketched by students**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **KINETIC THEORY OF MATTER: BROWNIAN MOTION, DIFFUSION** DURATION: **6 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Diffusion in gases See Activity 5 in the column on the right.	**6 Diffusion in gases** Open a bottle of highly scented perfume in the middle of the classroom at the start of the class. After 15 minute intervals, students are to show hands if they had got the scent. Discuss with students how a record could be made to show where the scent spread.	Highly scented perfume	**Record of data submitted by students**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **STATES OF MATTER**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
STATES OF MATTER • Account for the properties of solids, liquids & gases in terms of motion, energy & arrangement of particles, and forces between particles. • Name the states of matter as solids, liquids, gases, and demonstrate an awareness that there are other states e.g. plasma and Bose-Einstein Condensate.	**States of matter** Solid Solids have fixed shapes. This is because particles that make up a solid are, on the average, very close to each other and therefore the forces between them are very large. As the particles vibrate, when they move closer to each other, repulsion forces are very large. When they move away from each other (from the close mean separation distance), forces of attraction are also very large. That is why solids are "incompressible" and are also not easy to pull apart. Liquid Liquids take the shape of their containers. But the particles that make up a liquid generally stay together. This is because the vibrating particles, on the average, are still close to each other, but not as close as in solids. As they move toward each other, they experience large forces of repulsion. Hence, like solids, liquids are fairly "incompressible". However, as particles move away from each other, the forces of attraction between the particles are not so great because the	**7 Demonstrations involving states of matter** Solid Let students try to compress and also to try to pull apart a nail or metal cylinder. Students can also try tearing apart a rubber band by pulling on it. (The first "elastic" stretching is due to molecules arranged in coils like a spring. When the band is straightened out, the molecules are now straight and the strong forces between molecules become evident.) Liquid - Fill a syringe with water. Close the bottom end of the syringe. Let students try to compress the water in the syringe. The water does not reduce in volume. - Place the same amount of water in containers of different shapes to show that liquids take the shapes of their containers. Gas - Pull the plunger of a gas syringe upward to let air inside the barrel. Seal the bottom with your finger and have students try to compress the air. The air will show some reduction in volume.	Gas syringes	

TOPIC: **STATES OF MATTER**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	average separation distance is larger. Particles can therefore move away from each other fairly easily, resulting in a liquid taking the shape of its container. Particles in a liquid therefore show both translation and vibration motions. However, the forces of attraction, though not as great as in solids, are large enough to keep most of the particles together. (A few particles at the surface of the liquid do, however, gain enough energy to escape from the liquid.) <u>Gas</u> Gases have no fixed shape. They fill any container in which they are put. This is because, on the average, particles of a gas are very far apart and so, hardly exert any force on each other. Gases are therefore compressible and easy to expand as well.	(You can discuss why there is still a pressure exerted by the gas that tends to oppose compression – the pressure is due to molecular bombardment of the particles with the walls of the container and <u>not</u> due to individual molecules of gas repelling each other.) - Place a drop of bromine liquid in a gas jar and cover the jar. After a while, the bromine colour <u>fills</u> the jar. **7 Reading/internet research on other states of matter** Students find out about other states of matter, e.g., plasma and Bose-Einstein condensate.		Reports presented by students to class

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **CHANGE OF STATE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Temperature and molecular speeds By a theoretical analysis of molecular motion, it has been shown that temperature of a gas varies directly with the mean square speed per molecule in the gas. At *absolute zero* of temperature, all motion of molecules cease. **Pressure and molecular speeds** When molecules of a gas bombard the walls of its container, their rebound causes a change in their momentum. This change in momentum results in a force being exerted on the walls of the container. It follows that at absolute zero of temperature, since all molecular motion ceases, the pressure exerted by the gas on the walls of its container is theoretically zero as well. **Changes of state** Solid-liquid change The change from solid to liquid can be brought about by imparting energy to the solid by heating. During this change of state, the temperature of the substance does not change. The mean vibrational energy per particle does not change. The energy	**8 Heating/cooling curves** The teacher can perform demonstration of heating (or cooling as appropriate) the following in a small beaker in which a thermometer is inserted. The teacher gives temperature readings at regular time intervals. Students use the data to plot temperature vs. time graphs. - crushed ice starting below 0 ^{o}C - solid naphthalene Students identify melting points and boiling points from their graphs. **(CAUTION!** Since naphthalene vapour is toxic and flammable, this experiment should be carried out in a fume chamber and done by a qualified person)	Beaker Thermometer Ice below 0 ^{o}C Naphthalene (See *Physics for CSEC* by A. Farley and C. Trotz, pages 167-168.)	Student lab reports Student drawings

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **CHANGE OF STATE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
CHANGE OF STATE - Perform experiment and plot heating/cooling curve and identify phase change (for wax, naphthalene-only in fume chamber!) from constant temperature.	taken in causes work to be done, resulting in an increase of the average separation distance between particles. The change from solid to liquid at constant temperature is called melting and the temperature at which it occurs is called the melting point of the solid. The reverse process at constant temperature is called freezing (or fusion or solidification). The temperature at which freezing occurs is called the freezing point of the liquid. During freezing, heat is given up by the liquid to the surroundings. Liquid-gas change The change of state from liquid to gas can also be brought about by heating. During the change of state, the temperature of the substance remains constant and the average separation distance between the particles increases tremendously. The mean separation is so large that particles hardly exert forces of attraction or repulsion on each other and so they move about practically freely at high speeds. The change from liquid to gas at constant temperature is called boiling. The temperature at which boiling occurs is called the boiling point of the liquid at the	9 Observation of boiling and condensation Students observe bubbles of steam rising during boiling. Condensation should be observed on the cooler parts of the beaker.	Heat source	

TOPIC: **CHANGE OF STATE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	pressure at which the boiling occurs. Boiling takes place throughout a liquid and bubbles of gas formed rise to the top of the liquid and burst, releasing the gas. The change from gas to liquid at constant temperature is called condensation. During condensation, heat is given up to the surroundings by the condensing gas as it turns to liquid.			
• Determine the effect of dissolved solids (impurities) and pressure changes (eg. altitude, pressure cookers) on the boiling point of liquids.	Factors affecting boiling point and freezing point Dissolved solids Dissolved solids cause boiling point temperatures to be elevated and freezing point temperatures to be lowered. When ice at temperatures below zero is mixed with salt, the ice melts (and freezes) at a lower temperature. The solution formed is not only colder than pure, melting ice, but can also make good contact, say, with the metal container in an ice-cream can, resulting in quicker formation of ice cream.	10 Effect of dissolved salt on boiling and melting points of water Students design an investigation (involving control of variables) to show the effect of dissolved salt on boiling point of water. After discussion of students' ideas, the teacher can carry out the experiment, paying due attention to safety. Students can also design investigations on the effect of dissolved salt on melting or freezing point of water.	Beaker of water Thermometers Salt Small beakers Thermometers Salt Refrigerator Ice cubes	
	Pressure A high pressure above a liquid surface causes boiling point to be higher. (This is because more energy has to be imparted to the molecules of liquid to create enough	11 Pressure cooker demonstration Show students a pressure cooker and its rubber seal. Show the pressure	Pressure cooker	

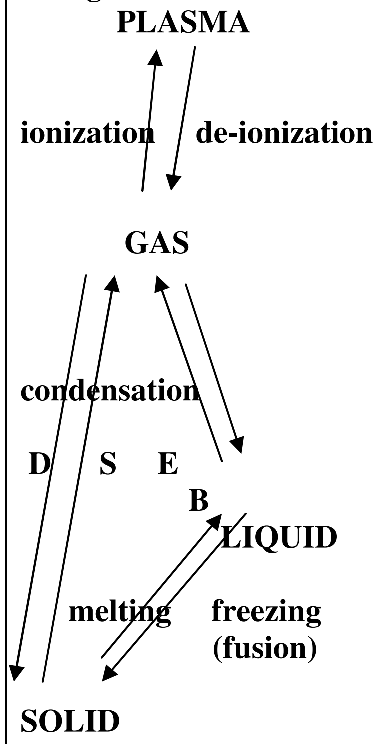
TOPIC: **CHANGE OF STATE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	pressure in the bubbles of gas formed to overcome the external pressure and burst.) A pressure cooker makes use of this fact. Its tight cover prevents steam from escaping and hence a build up of pressure due to the hot steam occurs above the surface of the contents of the pot. The liquid therefore boils at a higher temperature, resulting in food cooking more quickly. A low pressure, e.g. up in a mountain, causes liquids to boil at lower temperatures. That is why boiling an egg up a mountain takes so long and may require using a pressure cooker.	weights and the safety valve. Point out that a pressure-cooker should never be opened when contents are boiling as the pressure under the cover can cause steam to escape under high pressure, leading to severe steam burns. Show how the pressure-cooker is first left to cool naturally, and then tap water is run over the pot for further cooling. Read the manufacturer's instructions to the students.		

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **PHASE CHANGE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
- **Define and demonstrate phase changes. (sublimation, resublimation-deposition, melting, freezing condensation and vaporization.)**	Changes of phase Above a certain temperature, called the critical temperature, substances cannot become liquid, no matter how much pressure is exerted. Below this temperature, a substance can show various transitions between solid, liquid and gas. We refer to these transitions as changes in phase. The following are some phase changes: Vaporization Vaporization is the change of solid, or liquid, to the vapour phase. - Evaporation is the change of liquid to vapour at the surface of a liquid. Molecules near the surface of the liquid may transfer some of their kinetic energy by collisions to molecules at the surface. The latter may acquire enough energy to overcome the forces of attraction of the rest of the molecules in the liquid and escape from the liquid surface. Since the liquid loses energy to the molecules of gas that escape, the average kinetic energy of the rest of the molecules of the liquid decreases. Hence, the temperature of the liquid drops, since temperature is directly related to the mean square speed of	12 Demonstrations of the following: - Sublimation and deposition using naphthalene (naphthalene becomes vapour at room temperature, that is why it smells so strongly) - Boiling and condensation of water that is heated and vapour is cooled - Evaporation of water in a shallow petri dish	**Diagram showing phase changes**  **D – deposition** **S – sublimation** **E – evaporation** **B – boiling** (Note that vaporization can be produced by sublimation, evaporation or boiling.)	

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **PHASE CHANGE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	molecules, which, in turn, is proportional to the average kinetic energy per molecule (KE = ½ mv2). Unlike boiling, evaporation occurs at any temperature. - Boiling is the change from liquid to vapour at a particular temperature and pressure. During boiling, the temperature of the substance does not change. - Condensation is the reverse of boiling. It is the change from the vapour phase to the liquid phase.		Test tube Bunsen burner Naphthalene Petri dish	

UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **PHASE CHANGE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	- Sublimation is the change from solid directly into vapour without passing through a liquid phase. Solid carbon dioxide sublimes at atmospheric pressure. At standard pressure, ice goes through the liquid phase before becoming vapour. However, at very low pressures, ice also sublimes. - Deposition is the change from the vapour phase directly to the solid phase. Like sublimation and boiling, deposition depends on the prevailing pressure. - Melting is the change from the solid to the liquid phase. The reverse, freezing is the change from the liquid to the solid phase. - Ionization produced by high temperatures, results in substances being converted into plasmas. The reverse, deionization is the conversion of plasmas to liquids.			

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **PHASE CHANGE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Demonstrate and account for the cooling effect of evaporation. • Explain how phase changes are useful in the operation of refrigerators and air conditioners	**Usefulness of liquid-vapour phase change** A large quantity of energy is needed to convert a liquid into vapour. Certain substances easily undergo this change by taking energy from the container in contact with them. The container becomes cooled as a result. (Such substances are said to be ***volatile*** and are used refrigerants.) Refrigerants are used in refrigerators and air-conditioners. The refrigerant is circulated in metal pipes and allowed to expand through fine holes to become vapour. In the vaporization process, the refrigerant takes heat from the metal pipes, which in turn take heat by conduction from the food or air in contact with the metal pipes. The vapour then passes through a condenser which is usually painted black to assist in radiating heat from the vapour, causing the vapour to condense back to liquid.	**Diagrams and/or inspection of:** Refrigerator Air-conditioner	**Diagrams and/or inspection of:** Refrigerator Air-conditioner	**Designs suggested by students lab** **Student lab reports** **Student observations** Students draw and make notes of their observations.

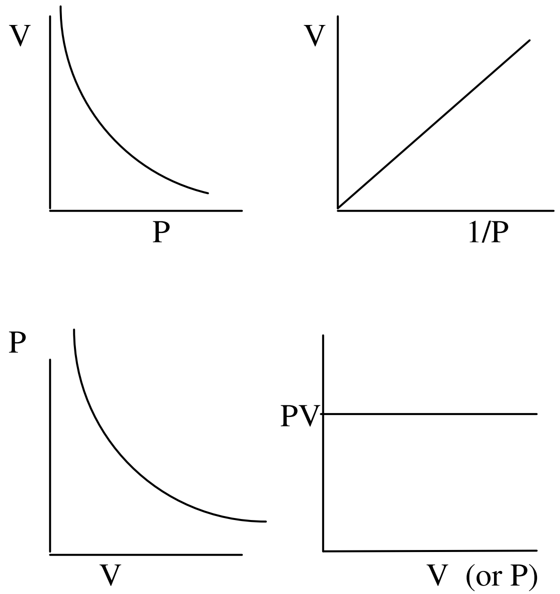
TOPIC: **PHASE CHANGE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Examine the use of environmentally safe refrigerants, proposing of legislation, strategies for preventing/dealing with pollution by refrigerants.	Certain refrigerants, called *chlorofluorocarbons* (CFCs), are very damaging to the ozone layer that protects the Earth from very damaging ultraviolet rays. By international agreement (The Montreal Protocol), these types of refrigerants are now banned.	**13 Student research** Students do research on the following: - The Montreal Protocol - Environmentally safe refrigerants - Products other than refrigerants that contain CFCs and other volatile substances in their homes that are damaging to the ozone layer **14 Class discussion** Strategies for dealing with pollution by refrigerants and other volatile substances.		**Student reports** Students can report their research findings as "news".

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

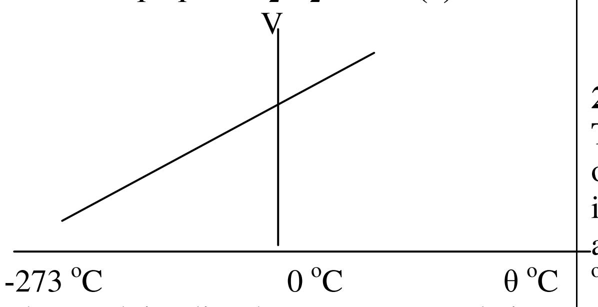
UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **KINETIC THEORY OF MATTER, GAS LAWS: BOYLE'S**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
GAS LAWS BOYLE'S LAW - Relate volume of a fixed mass of gas to its pressure at constant temperature.(Boyle's law) - Express relationship between volume and pressure of a fixed mass of gas at constant temperature as an equation and use equation to solve problems. ($P_1 V_1 = P_2 V_2$) Make graphical representations of the relationships between volume, temperature and pressure for each gas law.	**Boyle's Law** According to Boyle's Law: *The volume, V, of a fixed mass of gas is inversely proportional to the pressure, P, exerted on it, providing the temperature is kept constant.* This can expressed as follows: $V \alpha 1/P$, or $V = \text{constant} \times 1/P$, or $PV = \text{constant}$, and therefore, $\mathbf{P_1V_1 = P_2V_2}$ **……. (1)** 	**15 Gas syringe demonstration** Students can be shown that if pressure is increased on air trapped in a gas syringe, the volume decreases and vice-versa. **16 Boyle's Law experiment** Students use a Boyle's Law apparatus to investigate Boyle's Law. **17 Discussion of Boyle's Law graphs** The teacher discusses the graphs shown on the left with the students. **18 Numerical problem-solving** Students solve simple problems involving the equation, $P_1V_1 = P_2V_2$.	Gas syringe Boyle's Law apparatus (See diagrams and experimental details, including precautions, in *Physics for CSEC* by A. Farley and C. Trotz, pages 218-221.) .	**Student solutions in a logical format** e.g To find, Given, Solution, Ans.

UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

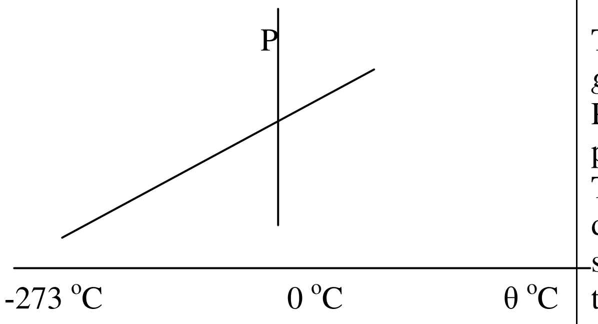
TOPIC: **KINETIC THEORY OF MATTER, GAS LAWS: CHARLES'**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
CHARLES' LAW - Relate volume of a fixed mass of gas to its' absolute temperature at constant pressure (Charles' Law) - Express relationship between volume and absolute temperature of a fixed mass of gas at constant pressure, as an equation and use equation to solve problems. ($V_1 / T_1 = V_2 / T_2$) - Make graphical representations of the relationships between volume, temperature and pressure for each gas law.	**Charles' Law** According to Charles' Law: *The volume, V, of a fixed mass of gas is directly proportional to its absolute temperature, T, providing the pressure is kept constant.* This can expressed as follows: $V \alpha T$, or $V = \text{constant} \times T$, or $V / T = \text{constant}$, and therefore, $\mathbf{V_1/T_1 = V_2/T_2}$ **……. (2)**  The graph implies that, upon extrapolation, there is an absolute zero of temperature at -273 ^{o}C.	**19 Gas syringe demonstration** Students can be shown that if pressure of air trapped in a gas syringe is kept constant and the temperature is increased, the volume increases, and vice-versa. **20 Charles' Law experiment** The teacher can carry out an experiment to investigate Charles' Law, using capillary tube equipment described on the right. **21 Discussion of Charles' Law graph** The teacher discusses the graph shown on the left with the students. The graph implies that, upon extrapolation, there is an absolute zero of temperature at -273 ^{o}C. **22 Numerical problem-solving** Students solve simple problems involving the equation, $\mathbf{V_1/T_1 = V_2/T_2}$.	See page 560, *Physics for CSEC* by A. Farley and C. Trotz for a simple experiment (Investigating Charles' law using air.) Charles' Law apparatus (See diagrams and experimental details, including precautions, in *Physics for CSEC* by A. Farley and C. Trotz, pages 222-223.)	**Student solutions in a logical format** e.g To find, Given, Solution, Ans.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: STRUCTURE AND BEHAVIOUR OF MATTER

TOPIC: **KINETIC THEORY OF MATTER, GAS LAWS: PRESSURE LAW**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
PRESSURE LAW • Express relationship between pressure and absolute temperature of a fixed mass of gas when volume is constant, as an equation and use equation to solve problems. ($P_1 / T_1 = P_2 / T_2$) • Relate pressure of a fixed mass of gas to its absolute temperature when volume is constant. (Pressure Law) • Express absolute zero in Kelvins and degrees Celsius. • Make graphical representations of the relationships between volume, temperature and pressure for each gas law.	**Pressure Law** According to the Pressure Law: *The pressure, P, of a fixed mass of gas is directly proportional to its absolute temperature, T, providing the volume is kept constant.* This can expressed as follows: $P \alpha T$, or $P = \text{constant} \times T$, or $P/T = \text{constant}$, and therefore, $\mathbf{P_1/T_1 = P_2/T_2}$ **……. (3)**  As with Charles' Law, the graph of pressure against Celsius temperature implies that, upon extrapolation, there is an absolute zero of temperature at -273 °C. If the temperature of -273 °C is called zero, and if 1 Celsius degree change is the same as 1 Kelvin change, then Kelvin temperature, T is given by	**23 Pressure Law experiment** The teacher can carry out an experiment to investigate the Pressure Law, using the equipment described on the right. **24 Discussion of Pressure Law graph** The teacher discusses the graph shown on the left with the students. The graph implies that, upon extrapolation, there is an absolute zero of temperature at -273 °C. Temperatures on the *constant volume gas thermometer* are based on the Pressure Law, since pressure is directly proportional to (absolute) temperature. The constant-volume gas thermometer is deemed the most accurate thermometer since the behaviour of the gas in the thermometer is in conformity with the Kinetic Theory of gases. **25 Numerical problem-solving** Students solve simple problems involving the equations, $\mathbf{V_1/T_1 = V_2/T_2}$, and $\mathbf{T(K) = \theta\ (^oC) + 273.}$	See pages 224-225, *Physics for CSEC* by A. Farley and C. Trotz for apparatus.	**Student solutions in a logical format** e.g To find, Given, Solution, Ans.

TOPIC: **KINETIC THEORY OF MATTER, GAS LAWS: COMBINED**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	$T(K) = \theta (^oC) + 273$ …… (4) . Temperatures on the *constant volume gas thermometer* are based on the Pressure Law, since pressure is directly proportional to (absolute) temperature.			
COMBINED GAS LAW - Express the relationship between volume, pressure and temperature of a gas when number of particles is constant, as the general gas law equation and use this equation to solve problems ($P_1V_1 / T_1 = P_2V_2 / T_2$) Predict changes in gas pressure due to changes in temperature, volume and number of particles (observe models)	**According to the Combined Gas Law**: *The (pressure* x *volume)/absolute temperature of a fixed mass of gas is constant.* This can be expressed as follows: PV/T = constant, and therefore **$P_1V_1 / T_1 = P_2V_2 / T_2$ …… (5)** It can be shown also that **PV = nRT …………………..(6)** for n moles of any gas, where R is the gas constant, given by, R = 8.31 J/mol.K.	**26 Numerical problem-solving** Students solve simple problems involving the equations, **$P_1V_1 / T_1 = P_2V_2 / T_2$,** and **PV = nRT.**		**Student lab reports** **Student solutions in a logical format** e.g To find, Given, Solution, Ans.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: HEAT ENERGY

TOPIC: **HEAT ENERGY** **DURATION: 4 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe heat as the transfer of thermal energy from one object to another due to a temperature difference between them.	• Heat is defined as the energy that flows from hotter objects to colder objects. Heat passes form one object to another in the form of infrared rays. When heat is absorbed by a body it increases the kinetic and/or potential energy of its molecules. Temperature describes how hot or cold a body is with respect to a given standard. Temperature is a measure of the average kinetic energy of the particles of the body.	Correct use of thermometers • Heating of water • Cooling of water	Thermometers Bunsen burners Electrical heaters	Practical skills assessed: observation, measurement, recording, identifying sources of errors, identifying anomalous results. Processing data (graph). Lab report assessed.
• Define internal energy of a substance and describe the factors (mass, temperature, nature and state of substance) that affect the total internal energy of an object	• Thermal energy, internal energy: the total (kinetic and potential) energy of all the particles of a substance. The greater the number of particles (& therefore mass) and temperature of the substance, the greater will be its internal energy (thermal energy) Two bodies can be the same temperature and have different internal energy because they have different masses.			

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: HEAT ENERGY

TOPIC: **HEAT ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Define and demonstrate an understanding specific heat capacity	• The specific heat capacity of a substance is the quantity of heat energy required to change (increase or decrease) the temperature of 1Kg of the substance by 1 Kelvin (^{0}C).	Compare the temperature changes when heating oil and water. (Use a water bath) Record observations in table. Plot graph to record measurements Experiment to estimate specific heat capacity of substances by method of mixtures and by direct heating methods.	Assorted lab materials and apparatus – thermometers, metal samples e.g. Al or Zn, calorimeters, heaters, Bunsen burners, tripod, gauge, retort stands and clamps, water bath, beakers, tongs, triple beam balance/ top pan balance, water, oil (paraffin) Pg 191-193 CXC physics Alex Farley, Clarence Trotz	Observe temperature changes for same amount of heat. Graph represents the data. Practical skills assessed: processing data (graph), observation, measurement, recording, calculating, identifying sources of errors, identifying anomalous results. Lab report assessed.
• Define and demonstrate an understanding of specific latent heat.	• Specific latent heat of a substance is the quantity of heat required/removed to change the state of 1Kg of the substance without a change in temperature.	Experiment to estimate latent heat of ice by method of mixtures.		
• Distinguish between latent heat of fusion and latent heat of vaporization	• Specific latent heat of fusion is the quantity of heat required/removed when 1Kg of the substance melts/freezes without a change in temperature. • Latent heat of vapourization is the quantity of heat required/ removed when 1kg of the substance evaporates/ condenses without a change of temperature.			
• Use the equations $Q = mc\Delta T$ and $Q = ml$ to perform calculations involving heat energy, specific heat capacity, specific latent heat.	• To find the quantity of heat energy needed to change (increase or decrease) the temperature of a certain mass of substance find the product of the mass, the specific heat capacity and the temperature change of the substance. To find the quantity of heat energy needed to change the state of a certain mass of a substance, find the	Perform calculations.		

TOPIC: **HEAT ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	the mass and the specific latent heat of the substance. (The equations can be rearranged to determine any unknown. **Specific heat capacity of a solid by method of mixtures.** assumption: total heat lost/given out by one substance is equal to the heat gained by the other substance/s			
• Determine the specific heat capacity of a solid or liquid using direct heating method and method of mixtures • Perform experiments to determine the specific latent heat of fusion or vaporization of a substance.	• **Specific heat capacity of liquid by direct heating method**: assumption: • total heat lost/given out by one substance is equal to the heat gained by the other substance/s.	Perform expt. To estimate the specific heat capacity using electrical method. ("Skills B&C")	Assorted lab materials and apparatus – thermometers, metal samples e.g. Al or Zn, calorimeters, immersion water heaters, electrical kettles retort stands and clamps, water bath, beakers, tongs, triple beam balance/ top pan balance, a.c./d.c power supply	Accurately applies the equation. Practical skills assessed: processing data (graph), observation, measurement, recording, calculating, concluding, identifying sources of errors, identifying anomalous results. Lab report assessed. Students complete worksheets with problems involving heat energy, specific heat capacity, specific latent heat, state change and temperature change, power, time taken

UNIT: HEAT ENERGY

TOPIC: **HEAT ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe applications of specific heat capacity and specific latent heat (e.g. use of water as a coolant)	• Water has a large specific heat capacity. 1 kg of water has to absorb 4000J of energy to change its temperature by 1K. Water is therefore useful as a coolant, to extinguish most fires, substances like metals with lower heat capacities may be used to make pots, since it requires a small amount of heat to cause a large temperature rise, so heat is not wasted on the pot itself – • The refrigerator and air conditioner utilize the principle of the cooling effect of evaporation: volatile liquids absorb heat to change state from liquid to gas, giving rise to a lower temperature of the surroundings. Also, the gas readily loses heat to change back to liquid. Therefore refrigerators and air conditioners act as heat pumps. Sweating cools the body in the same manner. As sweat evaporates from the skin, it requires energy, this energy is absorbed form the skin, thus lowering the temperature of the skin.	Research and present applications of latent heat and specific heat capacity	Research materials - Suitable texts - internet pg 200 CXC Physics Farley & Trotz	Presentations assessed: accurate presentation of concepts, (content), demonstrations, answering questions, creativity in presenting, resourcefulness

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

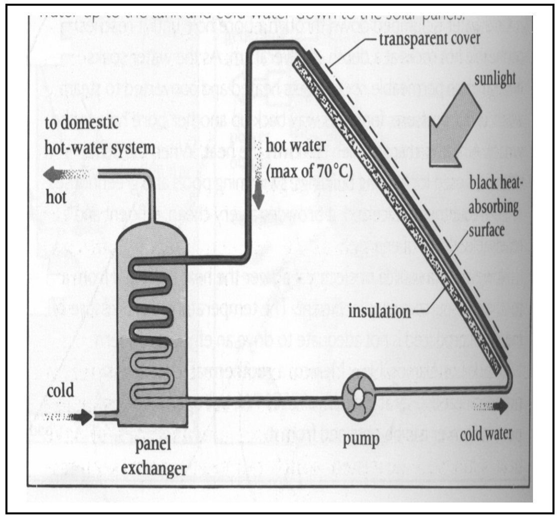
UNIT: HEAT ENERGY

TOPIC: **HEAT ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Relate temperature changes to thermal expansion/contraction of various materials • Describe the anomalous expansion of water between 0^{o}C and 4^{o}C. • Interpret volume/temperature, density/temperature graphs for water. • Use the anomalous expansion of water to account for phenomena such as the freezing over of lakes, bursting of containers as their contents freeze e.g. water pipes	• Usually as temperature increases the particles average energy and thus they vibrate more, pushing against each other resulting in expansion. Recall / examine the ball & ring, bar & gauge. • Water contracts when cooled steadily up to 4^{0}C for the same mass of water the volume therefore gets smaller giving rise to a larger density. Water is densest at 4^{0}C. As cooling continues below 4^{0}C, water behaves anomalously because it starts to expand. As it expands water becomes less dense. As cooling continues water will freeze at 0^{0}C (at sea level, at atmospheric pressure)	Students research and demonstrate the following (as review where necessary): 1. solids conduct heat at different rates 2. metals expand when heated 3. water is a poor conductor of heat 4. convection in liquids 5. convection in gases 6. dark surfaces absorb more radiation the shiny surfaces 7. bimetallic strip used as switches. 8. the greenhouse effect 9. land and sea breezes 10. The cooling effect of evaporation relating this to the operation of the refrigerator/air conditioner.	Resources provided by students as much as possible: burner, water, ice, potassium permanganate, wire gauze, convection box, light bulb, discarded clothes iron, glass sheet, alcohol, Ball and ring apparatus	Practical skills assessed: observations, noting relationship between temperature and length Projects assessed for functionality.
• Recognize and demonstrate that different materials expand by different amounts for the same change in temperatures (linear expansivity)	• The linear expansivity of a substance is the fraction of its original length by which a rod of the substance expands per Kelvin rise in temperature. (Abbott pg. 162)	Using the bi-metallic strip Students examine thermostats in clothes irons. Students use bimetallic strips obtained from discarded appliances to demonstrate operation or the operate other circuits	Bi-metallic strip	

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: HEAT ENERGY

TOPIC: **HEAT ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Discuss applications of linear expansion (building of bridges, concrete pavements, steel bridges, aluminium power lines, Removing tight-fitting caps from bottles)	• Expansion & contraction precautions & uses Pg 165 Physics for CXC Avison.			
• Construct/design thermostats using bi-metallic strip and thermometers	• Examine the functioning of a thermostat in a clothes iron.			
• Apply methods of heat transfer in the design and construction of model water heating systems, solar water heating systems, solar ovens/ cookers, complete solar homes, solar cars etc • Explain the greenhouse effect in terms of changes in wavelength of UV radiation • Construct models to demonstrate the greenhouse effect. • Discuss the greenhouse effect and its implications for global warming.	Simple Solar Panel  pg 390 Physics for CXC Avison	Students construct - solar ovens and cookers -solar panels and make simple solar water heaters. -model solar cars -model solar homes	Using their own resources: cartoon boxes, newspaper, spray paint, foil, etc. copper pipes & fittings,	Model to demonstrate green house effect assessed for analogy. Uses thermometer and heat source safely Practical skills assessed. Presentations assessed: accurate presentation of concepts, (content), demonstrations, answering questions, creativity in presenting, resourcefulness.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: HEAT ENERGY

TOPIC: **HEAT ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Critically analyze choices which contribute to global warming, • Predict changes associated with global warming and propose viable solutions with special reference to small island countries like the Bahamas		Students will: Propose the use of solar energy sources as alternative to fossil fuel use. To raise public awareness of the need to use alternative sources of energy, present advertisements: record jingles, make posters, etc. to encourage the public to use solar energy. Conduct debates, science talks and discussions.		Students personal choices surveyed before and after activity. Assessed by students activity in encouraging others to make wise choices. Models, items assessed for functionality, presentation of items- concepts clearly outlined, Assessment of items based on appropriateness, creativity, facts,

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: WAVES

TOPIC: MECHANICAL WAVES **DURATION: 3 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
Mechanical Waves • Demonstrate that mechanical waves transfer energy along matter. • Recognize that a medium is needed for mechanical wave propagation. • Make simple models of transverse and longitudinal waves • Define the terms: frequency, wavelength, speed, and period as they apply to waves. • Label and use simple displacement-time and displacement-position graphs to find and show amplitude, frequency and wavelength of waves. • List behaviours shown by waves: rectilinear propagation, reflection, refraction, diffraction. • State and apply the wave equations: $v = f\lambda$ and $v = x/t$ • Recognize that longitudinal and transverse waves show similar behaviours and obey the same laws.	• Energy is transferred in the form of waves. • Classified as **Mechanical waves:** need media for transmission. **Electromagnetic waves**. Waves: no medium needed, travel through a vacuum. **Longitudinal waves:** cause the particles over which they pass to vibrate parallel to the direction in which the waves are moving. **Transverse waves:** cause the particles over which they pass to vibrate perpendicular to the direction in which the waves are moving. • Mechanical waves are either transverse or longitudinal. • Water waves are mechanical and transverse Sound waves are mechanical and longitudinal. • Frequency is the number of waves/vibrations/oscillations, cycles that pass a given point in 1 second.(cycles per second or Hertz) • Wave: each crest and its adjacent trough make up a wave.	• Use slinky to show transverse and longitudinal waves. (Mark a position on the slinky with a coloured cloth.) • Make "ballpark" waves with students as particles, to demonstrate transverse and longitudinal waves. • Use ripple tank experiments, demonstrations. (Use large aluminium baking pans). • (Students construct simple ripple tank given diagram). in ripple tank: • identify parts of water wave • Create circular and plane wave fronts in ripple tank. • Observe and construct ray diagrams for reflection of plane wave incident upon plane surface along the normal and at an angle.	ripple tank or materials which can be used to construct ripple tank. Slinky http://www.acoustics.salford.ac.uk/feschools/waves/super.htm#phase appropriate animations.	Written quizzes, unit tests, home work, project assignments (eg constructing ripple tank and demonstrating aspects of unit.) Group presentations to class. Observation skills assessed. Processing skills assessed.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: WAVES

TOPIC: **MECHANICAL WAVES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	• Wave front: an imaginary line which joins a set of particles which are in phase in a wave motion. • Wavelength: the distance between two successive crests or two successive troughs. (The distance between successive identical parts of the wave…the distance between two successive particles which are at exactly the same point in their paths and are moving in the same direction –exactly in phase.) • Amplitude: the maximum displacement of a particle from its rest position. (measure of the energy of the wave) • Speed: $v = x/t$, $v = f\lambda$, where v is the speed of the wave, f is the frequency and λ is the wavelength of the wave. Perform calculations. Note S.I. units for quantities. • Period: the time it takes for 1 wave, oscillation to be completed. • The period of a wave and its frequency are the inverse of each other.	• Observe and draw general diagrams to show reflection of plane waves from concave and convex surfaces. • Observe and draw general diagrams to show the reflection of circular wave from a plane surface. • Demonstrate refraction of waves in ripple tank. Set up thick glass plate or tiles in bottom of ripple tank to produce boundary between deep and shallow water. Observe plane wave as it crosses the plane boundary along the normal. Observe and sketch refraction of plane wave as it crosses the plane boundary at an angle of incidence other than 90^0. • Set up gaps in the ripple tank and observe and sketch interference. • Observe and sketch diagrams to show diffraction of water waves in ripple tank by setting up gaps of various sizes and creating plane wave fronts to pass through the gaps. • Perform calculations using the wave equation.	http://www.physicsclassroom.com/Class/waves/u10l1a.cfm some animations, many questions to check understanding, answers provided. CXC Physics Alec Farley & Clarence Troz Macmillan Publishers Limited 2007. A World of Physics Avison Encyclopedia Britanica GCSE Physics waves	Observations & diagrams assessed quiz

PHYSICS CURRICULUM
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UNIT: WAVES

TOPIC: **MECHANICAL WAVES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	• Reflection of waves governed by the laws of reflection: the incident, normal and reflected waves are in the same plane and the angle of incidence and reflection are equal. • Include construction of ray diagram to show reflection of plane waves from plane surface. • Include reflection of plane waves from concave and convex surfaces- sketches only- plane wave incident upon a concave surface is reflected as a circular wave front converging at the principal focus of the surface. • Plane wave incident upon a convex surface is reflected from the surface as if there is a circular disturbance spreading out from the virtual principal focus of the surface. • Refraction of waves follows the laws of refraction: (1)the incident and refracted rays are on opposite sides of the normal at the point of incidence and all 3 are in the same plane, (2) Snell's law: the ratio of sine the angle of incidence to sine the angle of refraction is a constant fro a given pair of media.	• Plot or interpret displacement-time graphs and position graphs given appropriate information. Sketch graphs to compare waves of different amplitudes, frequencies, wavelengths.		

TOPIC: **MECHANICAL WAVES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	• Also refractive index of the second medium = sin i/ sin r, speed of wave in the first medium/speed of wave in the second medium, or wavelength of wave in the first medium / wavelength of wave in the second medium. • Note that refraction causes the speed and wavelengths to change but the frequency remains the same. Do not include refraction of waves across curved boundaries. • Interference of waves: interference is the name given to the effects which occur when two separate wave fronts overlap. Waves pass through each other and merge or combine their effects. The ability of waves to combine is called superposition and the effects of the combination are called interference. • The principle of superposition of waves: the displacement of any particle caused by overlapping waves is the sum of the separate displacements caused by each wave at a particular moment.			

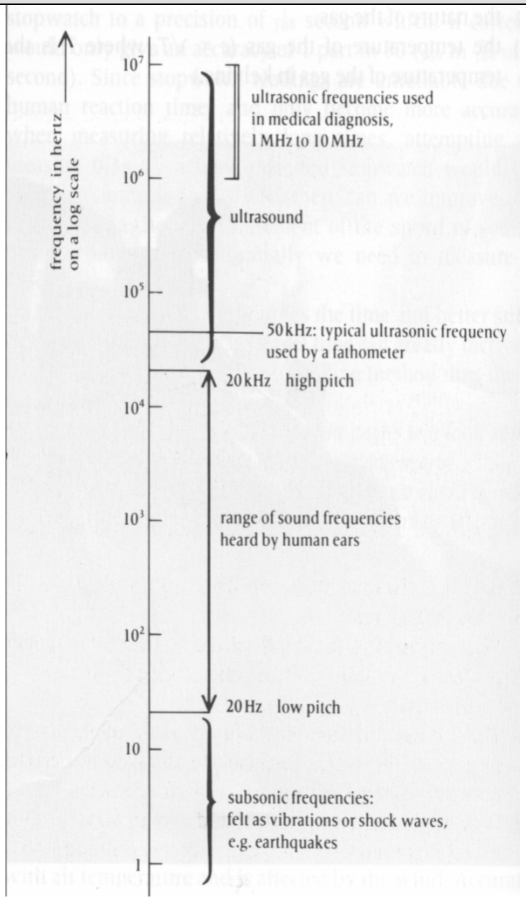
PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: WAVES

TOPIC: **MECHANICAL WAVES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	• Constructive interference: when 2 waves meet, and the vibrations are in phase (particles move in the same direction at same time) the amplitude at that point increases. • Destructive interference: when 2 waves meet and the vibrations are out of phase (particles move in opposite directions at that time), the amplitude becomes smaller. • Diffraction: the spreading out of waves around corners and edges of barriers. The ratio of the wavelength of the wave to the width of the opening indicates the extent of the diffraction (spreading out). The diffraction increases becoming more circular as the ratio increases. When the ratio is equal to 1, there is maximum diffraction. The smaller the ratio, the less the diffraction.			

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: WAVES

TOPIC: SOUND WAVES **DURATION: 2 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• **Sound Waves** • Explain that sound waves are produced when objects vibrate, e.g. vibrating tuning forks, speakers, strings etc. • Recognize that sound waves require a medium for propagation. (bell-jar expt.) • Construct a simple model to show the transmission of sound. • Describe characteristics of sound (pitch, loudness, quality) and their relation to frequency and amplitude. • Describe the qualitative effects (relationship between) of thickness, tension and length on (and) the frequency/pitch of a vibrating string or skin. • Classify sound into major frequency bands: infrasound, audible sound and ultrasound • State the audio frequency range in humans and compare to that of other animals. • Determine the speed of sound from echo experiments.	 • The audio frequency range for humans are: 20 Hz to 20 kHz.	• Examine waves produced by tuning fork, vibrating speakers, strings of a guitar, insect rubbing wings together • Bell jar experiment: if bell jar with pump not available-challenge students to construct an apparatus in which this experiment can be done. Brainstorm other ways to demonstrate that sound need a medium to travel. • Make a model to demonstrate transmission of sound using cups, string. • Pluck guitar strings and listen to how pitch varies with length, thickness and tension of string. Write expressions for the relationships • Convert diagrams showing longitudinal waves movement into standard wave diagram (eg areas of maximum contraction represents a crest and areas of maximum rarefraction represent a trough) • Use Snapple bottles with varying amounts of water to make simple tunes.	tuning forks, bell jar apparatus, CRO, speakers, stop watches, hand towel rolls, meter stick,	Quizzes, unit tests, practical demonstrations, cooperative group activities, presentations, construction of musical instruments, projects presentations, video presentations, research presentation, debates. Quiz Model to show transmission of sound assessed for creativity and functionality. (sound must be transmitted from place to place. Musical instruments assessed for functionality. Research assessed.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: WAVES

TOPIC: **SOUND WAVES**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr>
<td>

- Describe echoes and their applications (e.g. in depth sounding using sonar and in ultrasound scans).
- Critically evaluate the use of sonar in aquatic environments.
- Describe cathode ray oscilloscope traces and their relationships to frequency (pitch), amplitude (loudness) and wave shape (quality) of sound waves.
- Describe acoustic resonance and its application in musical instruments.
- Make musical instruments.

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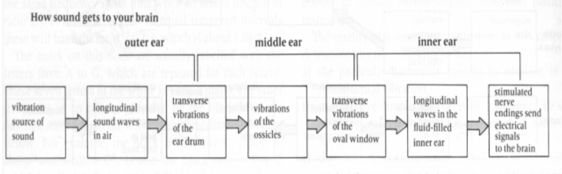
<td>



Physics for CXC John H. Avison 1998 pg 240

- Sound waves exhibit the same properties as water waves: reflection, refraction, diffraction.

- Sound waves travel at about 330 m/s in air All sounds in air at the same pressure and temperature travel at the same speed. Higher frequency sounds have shorter wavelengths and lower frequency sounds have longer wavelengths.
- The speed of sound in a medium depends on the density and elasticity of the medium. Sound travels faster through denser more elastic materials.

- If the speed of ultrasound in a medium is known, a pulse can be sent out and the time taken for that pulse to be received from a reflecting surface is noted. The distance to the reflecting surface can be

</td>
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- Research the audio frequencies range for other animals (eg whales, bats, dogs etc)

- Estimate the speed of sound in air using what ever is available. Discuss sources of errors, ways to improve etc. also degree of accuracy of measurement of time and distance.

- Speed of sound by echoes. Speed= distance/time. Measure a distance of 50m-100m at right angles from a large wall. Make a sharp clapping sound by banging 2 blocks of wood together. Repeat the sound at regular intervals to coincide exactly with the echoes. Starting at zero as a stopwatch is started, count the number of claps and stop the stopwatch at 50 or 100 claps. Calculate the speed of sound in air using the equation speed=distance/time.

- Research and debate the pros and cons of activities which result in noise pollution in aquatic environments (particularly in Bahamian waters) (PHSchool.com Web code cch-2173)

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<td>

Planning and conducting investigation assessed.

Debates assessed for points made, clarity of presentation,

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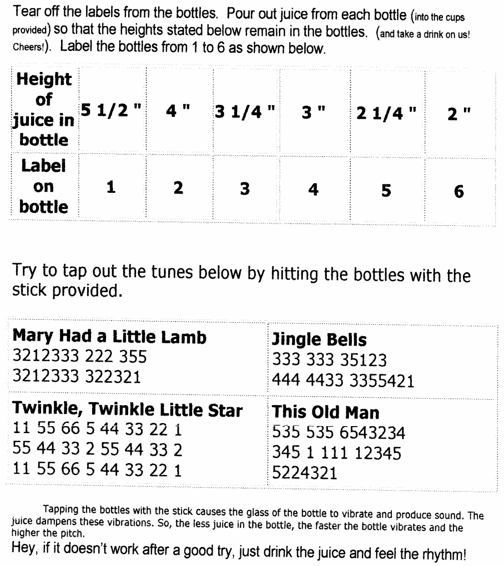
</table>

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: WAVES

TOPIC: **SOUND WAVES**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr>
<td></td>
<td>• determined using distance = speed x time. This echo method is used to estimate the depth of ocean floors by ships and the instrument is called a fathometer.
• Ultra sound scans: ultra sound is used to obtain images of of internal parts of the body. Ultra sound pulses are sent into the body by a transmitter placed in contact with the skin. Reflections or echoes are received from ant surfaces within the body which have different density, structure, or elasticity. The time delay of the echoes gives the depth within the body of the reflecting surfaces, and the reflections in different directions can be used to construct an image of the internal body. CXC Physics Avison pg415
• Doppler effect: when waves are created in a medium by a moving source, the frequency observed at a point towards which the source is moving becomes greater. When the source moves away from that point, the frequency (pitch) becomes less.</td>
<td>http://www.phschool.com/webcodes10/index.cfm?wcprefix=cch&wcsuffix=2173&fuseaction=home.gotoWebCode&x=16&y=12
• Research the effect of sonar used in navy operations on marine mammals. (eg beaching of whales & dolphins)
• make a Snapple Bottle xylophone. Obtain 6 bottles of Snapple Juice
Tear off the labels from the bottles. Pour out juice from each bottle (into the cups provided) so that the heights stated below remain in the bottles. (and take a drink on us! Cheers!). Label the bottles from 1 to 6 as shown below.
<table>
<tr><td>Height of juice in bottle</td><td>5 1/2 "</td><td>4 "</td><td>3 1/4 "</td><td>3 "</td><td>2 1/4 "</td><td>2 "</td></tr>
<tr><td>Label on bottle</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
</table>
Try to tap out the tunes below by hitting the bottles with the stick provided.
<table>
<tr><td>Mary Had a Little Lamb
3212333 222 355
3212333 322321</td><td>Jingle Bells
333 333 35123
444 4433 3355421</td></tr>
<tr><td>Twinkle, Twinkle Little Star
11 55 66 5 44 33 22 1
55 44 33 2 55 44 33 2
11 55 66 5 44 33 22 1</td><td>This Old Man
535 535 6543234
345 1 111 12345
5224321</td></tr>
</table>
Tapping the bottles with the stick causes the glass of the bottle to vibrate and produce sound. The juice dampens these vibrations. So, the less juice in the bottle, the faster the bottle vibrates and the higher the pitch.
Hey, if it doesn't work after a good try, just drink the juice and feel the rhythm!
• http://www.musicwithmelissa.com/index_files/Page892.html</td>
<td></td>
<td>Quiz, homework assignments assessed</td>
</tr>
</table>

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: WAVES

TOPIC: **SOUND WAVES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	• Reverberation: when many echoes merge into one prolonged sound. • Acoustics: the sound reflecting and absorbing properties of a room. Acoustics are controlled by using different kinds of materials on the walls and in the room- some are sound absorbing and some reflecting- until the right balance is determined.	• Students can construct other simple musical instruments using the principles learned. • Demonstrating destructive interference of sound waves. • Tuning forks of same frequency (about 400Hz), stethoscope: carefully strike tuning forks and hold them about 10 cm apart. Using a stethoscope about 20 cm from the tuning forks, move it to find a node where the volume is greatly reduced. • *Prentice Hall Physical Science Concepts in action Teachers edition 2006 pg 522* Sound waves obey the laws of reflection: place a ticking clock or watch in the closed end of a long cardboard tube. Hold the open end of the tube at an angle (of incidence) to a hard wall. Place another cardboard tube (open at both ends) to the wall at about the same angle, in the same plane as the first. Try to hear the sound made by the clock or watch. By trial and error using different angles, students should find that the sound is heard best when the tubes are in the same plane and the angle of		

PHYSICS CURRICULUM
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GRADE: 11
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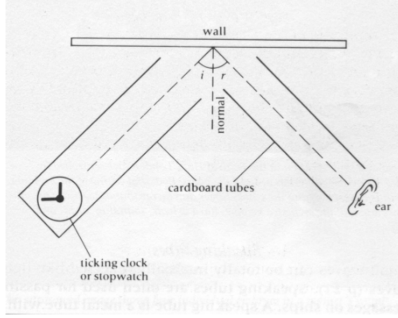
TOPIC: **SOUND WAVES**

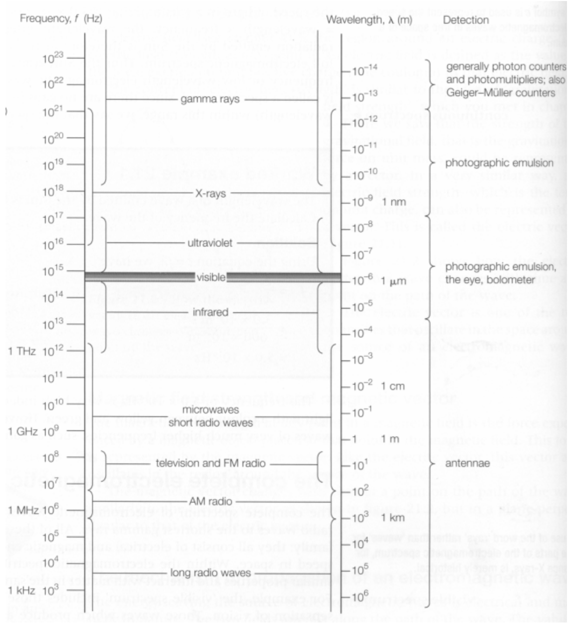
LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
		incidence = the angle of reflection.  Physics for CXC John H. Avison 1998 pg 413 • Perform calculations involving depth sounding by echo. • Demonstrate diffraction of sound: • CXC Physics Alec Farley & Clarence Troz Macmillan Publishers Limited 2007. pg 282. • Using a microphone connected to the y-input plates of a cathode ray oscilloscope, observe the traces for tuning fork, and various musical instruments. Increase the loudness and observe. Compare the traces for quality of the sound. • CXC Physics Alec Farley & Clarence Troz Macmillan Publishers Limited 2007. pg 284		

TOPIC: **SOUND WAVES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
		• Research the use of ultra sound in distance judging for blind persons. (how bats judge distance) • Make a speaking tube (internally reflected sound waves. Use a long piece of garden hose with funnels at the end place the ends far enough like in separate rooms and listen to sounds made even when the tube is curved (bent)		

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: WAVES

TOPIC: **ELECTROMAGNETIC SPECTRUM** **DURATION: 2 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• **Electromagnetic Spectrum** • State general properties of electromagnetic waves: possess electric and magnetic properties, transfer energy, travel at the speed of light, do not need material medium for propagation. • Infer that light is an electromagnetic wave (using knowledge that there is empty space between the Earth and the Sun). • Describe, using frequency or wavelength bands, the major constituents of the electromagnetic radiation spectrum. • Describe properties and applications/ uses of X-rays, gamma rays, UV rays, infrared, microwaves and radio waves. • Critically appraise applications of electromagnetic waves.	• Properties of electromagnetic waves: -They travel through space at $3x10^8$ m/s (the speed of light) -They exhibit interference, diffraction and polarization. -They obey the wave equation $v = f\lambda$, where v=speed of light, f= frequency and λ=wavelength -They carry energy and can be absorbed by matter to cause heating and other effects. Pg 50 GCSE Physics T. Duncan  	• students research, collect photographs, construct charts, scrap books, etc. present on the uses and precautions of electromagnetic waves: gamma waves, x-rays, ultra violet, visible rays, infrared radiation, microwaves, • make models of the spectrum. • Debate the applications of electromagnetic waves eg in sterilization of foods, treatment of cancer, microwaves in communications (cell phones)	GCSE Physics cd	Students research, presentations and models assessed for accuracy, creativity. Debates assessed for substantiated facts,

TOPIC: **ELECTROMAGNETIC SPECTRUM** **DURATION: 2 weeks**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	• Uses infrared radiation: anything that is hot but not glowing emits IR radiation alone, IR is detected by temperature sensitive photographic films used for taking photographs in the dark. Infrared sensors used on satellites and aircrafts for weather forecasting etc., ir lamps used for drying of paint on cars during manufacture, remote control keypads for tv. • Ultraviolet: cause sun tan, produce vitamins in skin, causes skin cancer, causes fluorescent paints and clothes washed in some detergents to fluorescence, UV lamps. • Radio waves: longest wavelengths in the spectrum, radiated from aerials, used to transmit sound, pictures etc. over long distances, radar detection of ships and aircrafts and missiles, • Microwaves: international telecommunications, television relay, mobile phone networks, satellite communications cooking, • X-Rays: X-Ray photography, imaging, • Gamma rays: kill cancer cells, sterilize food. • pg 52 GCSE Physics T. Duncan.			

UNIT: OPTICS

TOPIC: **PIN-HOLE CAMERA & PROPERTIES OF LIGHT** **DURATION: 1 week**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Construct a pin-hole camera (model –viewing images, real-taking actual pictures)	A pinhole camera consists of a closed box with a screen and a small pinhole at the other end. Johnson, Keith (2006) **New Physics for You** 6^{th} Ed. Pg. 174 • The image formed in a pinhole camera is real and inverted. • The closer the pinhole camera is to the light source, the bigger the image. • A wider hole produces a brighter image which is blurred (not sharp). • Multiple holes produce multiple images.	Construction of a pinhole camera Viewing real inverted images using: • Single pin hole • Enlarged hole • Multiple holes Drawing diagrams illustrating formation of real inverted images in pinhole camera	cardboard box, translucent paper, black construction paper, scissors, glue, Jackson B. & P. Whiteley (2007) **Longman Physics for CSEC** 3^{rd}. Ed (pgs. 153-155) Johnson, K. (2006) **New Physics for You** 6^{th} Ed. Pg. 174	Assessment of model of Pinhole camera for functionality and creativity
• Describe the image formed by optical devices (nature- real, virtual, orientation upright, inverted, vertically or laterally inverted, size- magnified or diminished, position- in relation to device).	The image formed by an optical device may be real or virtual; upright/erect or vertically inverted; laterally inverted; magnified or diminished and its position may vary in relation to object position from device.	Practical activity involving viewing images formed by an assortment of optical devices with plane mirrors, curved mirrors, concave and convex lenses.	Candles, pins, ray boxes, plane mirrors, curved mirrors, light boxes and accessory kit	Assessment of practical skills: • Observation • Communication • Measurement • Collection, processing and interpretation of data

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: OPTICS

TOPIC: **PIN-HOLE CAMERA & PROPERTIES OF LIGHT** **DURATION: 1 week**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr>
<td>Compare images formed by a pin-hole camera with images formed by a plane mirror.</td>
<td><table>
<tr><td>Image in Pinhole Camera</td><td>Image in Plane Mirror</td></tr>
<tr><td>Real</td><td>Virtual</td></tr>
<tr><td>Vertically inverted</td><td>Laterally inverted</td></tr>
<tr><td>Varies depending on object position ... the closer the object is to pinhole camera, the larger it is</td><td>Same size as object</td></tr>
<tr><td>-</td><td>Same position behind mirror as object is in front</td></tr>
</table></td>
<td>Practical demonstration using pinhole cameras and plane mirrors</td>
<td>Pinhole cameras,
Plane mirrors
Suitable objects (pins, light, candles, bulbs)
Longman Physics for CSEC 3rd. Ed (pgs. 158-160)</td>
<td>Assessment of Practical skills:
Observation
Classification</td>
</tr>
</table>

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: OPTICS

TOPIC: **REFLECTION – PLANE MIRRORS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Investigate relationship between angles of reflection and angles of incidence for light reflected by a plane surface.	**LAWS OF REFLECTION FROM A PLANE MIRROR** (1) The angle of incidence (i) is equal to the angle of reflection r.	Practical Activity involving investigating reflection in plane mirrors. Drawing diagrams showing parallel, converging and diverging beams of light	Plane mirrors Raybox, pins Paper, plasticine, protractor Tom Duncan (2001) GCSE Physics 4th Ed. Jackson B. & P. Whiteley (2007) **Longman Physics for CSEC** 3rd. Ed (pgs. 153-155) Johnson, K. (2006) **New Physics for You** 6th Ed. Pg. 174 http://www.physicsclassroom.com/Class/refln/u13l1c.cfm	Lab Report Assessment of skills: • Observation • Measurement • Collection, processing and interpretation of data • Recognizing relationships • Predictions
• Demonstrate that incident, reflected & normal rays form in the same plane.	(2) The incident ray, the reflected ray and the normal all lie in the same plane.	Practical Activity involving investigating reflection in plane mirrors	Plane mirrors, plastic bottle, tape, scissors (or retort stand and clamps) Jackson B. & P. Whiteley (2007) **Longman Physics for CSEC** 3rd. Ed (pg. 157) Johnson, K. (2006) **New Physics for You** 6th Ed. Pg. 177	Assessment of model of simple periscope for functionality and creativity

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: OPTICS

TOPIC: **REFLECTION – PLANE MIRRORS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Construct simple periscope, kaleidoscope using plane mirrors.	A simple periscope may be constructed with a tube containing two plane mirrors that are face each other and are parallel. Light is turned through a 90^o angle at each reflection enabling the viewer to see over an obstacle or crowd. Kaleidoscopes employ the use of plane mirrors to give multiple images of objects placed between them e.g. two mirrors at right angles to each other give three images of an object placed between them. A greater number of images are formed when the angle between the mirrors decrease.	Construction of simple periscope using two plane mirrors Construction of a kaleidoscope using two or more mirrors	Picture or painting, multiple plane mirrors Tom Duncan (2001) GCSE Physics 4th Ed.	Assessment of model of simple periscope for functionality and creativity

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: OPTICS

TOPIC: **REFLECTION – CURVED MIRRORS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Define optical terms associated with spherical mirrors- (principal focus, principal axis, center of curvature, pole, focal length, radius of curvature.)	• The pole, **P** of a mirror is the centre of its reflecting surface. • Centre of curvature, **C** is the centre of the sphere of which the mirror is a part. (located in front of a concave mirror and behind a convex mirror). • The principal axis is the line joining the pole P or centre of the mirror to the centre of curvature C. • Radius of curvature, **r** is the radius of the sphere of which the mirror is apart. It is the distance between the centre of curvature, **C** and the pole, **P**. • Focal length, ***f*** is half the radius of curvature. The focal length f is the distance FP. FP =CP/2 or f = r/2. Focal length = ½ the radius of curvature.	Simulations http://www.physicsclassroom.com/mmedia/#optics Discussion Labelling of optical terms on illustrations of spherical mirrors	table spoons, ray-box, concave and convex mirrors http://www.physicsclassroom.com/mmedia/#optics GCSE Physics The World of Physics Johnson, K. (2006) **New Physics for You** 6th Ed. Pg. 181	Written Assessment • Quiz • Worksheet Oral questions
• Relate images formed by concave & convex mirrors to their common uses.	• The principal focus, **F** refers to the point at which rays converge in a concave mirror, or the point from which they appear to diverge in a convex mirror. A concave mirror has a real principal focus, while the convex mirror has a virtual principal focus	Investigating images formed in convex and concave mirrors	ray-box, concave and convex mirrors,	Practical Assessment of skills • Observation • Measurement • Collection, processing and interpretation of data • Recognizing relationships • Predictions

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: OPTICS

TOPIC: **REFLECTION – APPLICATIONS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Investigate the use of concave mirrors in solar cookers. (eg. rotary cooking)	Convex mirrors diverge, while concave mirrors converge parallel rays of light. Convex mirrors produce virtual, upright, diminished images and reflect a large part of the surroundings (i.e. they give a wide field view). They are therefore used as driving mirrors on cars and for surveillance e.g. in aisles of stores. Duncan T. (2001) **GCSE Physics** 4th Ed. Concave mirrors produce virtual, magnified and upright images of close up objects. They are therefore used as shaving mirrors, in the field of dentistry and as reflectors (in torchlights or vehicle headlamps). As parabolic mirrors, they can be used to obtain a parallel beam of light. For distant objects, concave mirrors produce inverted real images. Johnson, K. (2006) **New Physics for You** 6th Ed. Pg. 183 Concave mirrors collect energy and converge it to a principal focus in front of mirror. An application of this is their use in solar cookers	Research Making and/or using solar reflectors to converge light energy and heat substances Drawing of images formed in concave and convex mirrors	solar reflectors, thermometers, water	Oral questions Assessment of model of simple periscope for functionality and creativity

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: OPTICS

TOPIC: **REFLECTION – RAY DIAGRAMS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Experimentally locate the principal focus of a concave mirror (rough method using screen)	Light may be converged towards a focus point in front of concave mirrors. The principal focus of a concave mirror may therefore be roughly determined using a screen as the point where the rays appear to converge.	Practical Activity – Determining the principal focus of a concave mirror..	Concave mirror Screen Ray box	Practical Assessment Written Assessment • Quiz • Worksheet
• Construct ray diagrams (and scale drawings) to describe images formed by concave and convex mirrors.	The images formed by spherical mirrors can be found by drawing two of the following rays: (a) A ray drawn parallel to the principal axis, is reflected through the principal focus, F. (b) A ray drawn through the centre of curvature C which hits the mirror normally, is reflected back along its own path. (c) A ray drawn through the principal focus, F is reflected parallel to the principal axis. Duncan, T. (2001) GCSE Physics 4th Ed.	Construction of ray diagrams to illustrate the position and height of images formed in concave and convex mirrors	Ruler, pencil, graph paper Duncan, T. (2001) GCSE Physics 4th Ed.	Written Assessment • Quiz • Worksheet
• Apply the mirror formula using the real is positive sign convention, and the magnification formula to solve problems.	Calculations involving <u>Magnification (m)</u> and the <u>Focal length (f)</u> of a Mirror may be determined using the following formulae: Magnification (m) = $\frac{\text{height or size of image (hi)}}{\text{height of size of object (ho)}}$	Worksheet with Calculations on magnification and focal length	Worksheets	Written Assessment • Quiz • Worksheet

UNIT: OPTICS

TOPIC: **REFLECTION – RAY DIAGRAMS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Magnification (m) = $\frac{\text{distance of image from mirror (v)}}{\text{distance of object from mirror (u)}}$ $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ where f = focal length of mirror u = object distance v = image distance **Note:** (1) Distance to real images are positive. The focal length of a concave mirror is positive. Distance to virtual images are negative. The focal length of a convex mirror is negative.			

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: OPTICS

TOPIC: **REFRACTION** **DURATION: 3 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Observe, predict and account for the effect of light rays passing from one optical medium to another. (refraction)	Refraction is defined as the change in direction of a wave due to its change in velocity. (http://en.wikipedia.org/wiki/Refraction). Light travels through transparent materials e.g. air, glass, Perspex, and water. However it refracts, when the medium it is travelling in changes.	Practical demonstration: Pencil in water Coin in water Drawings illustrating refraction of Pencil in water Coin in water Discussion: Simulation: presentation from website: http://www.s-cool.co.uk/ http://www.physicsclassroom.com	GCSE PHYSICS: 4th Edition, CHAPTERS 5 & 6: PAGES 14 – 19 Computer Projector Internet Access	Practical Assessment of skills: • Observation • Making inferences and interpreting data • Predictions Written Assessment • Worksheet • Quiz
• Relate the degree of bending (change of speed) of light rays to the refractive index of the material it passes through.	The greater the refractive index of the medium, the greater the change in velocity and hence direction of the light wave. The lower the refractive index, the slower light travels and the smaller the deviation.	Ray box Light accessory kit (collection of prisms, rectangular glass boxes, semi-circular blocks)	electricity pencil, water, refraction tanks, beakers, coins, ray boxes, light accessory kit	Written Assessment • Drawing of refracted rays • Recognizing relationships
• Verify Snell's law of refraction experimentally.	Snell's Law states that the sine of the angle of incidence divided by the sine of the angle of refraction is a constant. This is equal to the refractive index of a medium.	Discussion Laboratory Practical Measure at least five values of angles of incidence (i) and the associated angles of refraction (r)	rectangular glass block, raybox or pins, ruler, protractor, white sheet of paper and Styrofoam, graph paper, scientific calculator	Practical Assessment of skills: • Handling of Experimental data • present data in a tabular manner, find sine of the angle of incidence and angle of refraction, plot graph of sine i against sine r and find the gradient ($\frac{\Delta \sin i}{\Delta \sin r}$)

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: OPTICS

TOPIC: **REFRACTION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Define refractive index in terms real-apparent depth, wave speeds, angle of incidence & refraction. • Use the following relationships in calculations $n = \frac{real\ depth}{apparent\ depth}$ $n = \frac{speed\ \ in\ incident\ \ medium\ \ (c1)}{speed\ \ in\ refracted\ \ medium\ \ (c2)}$ $n = \frac{\sin i}{\sin r}$	The **refractive index** of a medium is a measure of how much the speed of light (or other waves such as sound waves) is reduced inside the medium. (http://en.wikipedia.org/wiki/Refractive_index) $_1n_2 = \frac{\sin i}{\sin r}$ $_1n_2 = \frac{\text{real depth}}{\text{apparent depth}}$ $_1n_2 = \frac{speed\ \ in\ incident\ \ medium\ \ (c1)}{speed\ \ in\ refracted\ \ medium\ \ (c2)}$ $_1n_2 = \frac{wavelength\ \ in\ incident\ \ medium\ \ \lambda 1}{wavelength\ \ in\ refracted\ \ medium\ \ \lambda 2}$	Discussion Critical Analysis and Problem Solving	Worksheets Text	Written Assessment • Worksheet • Quiz
• Experimentally determine the refractive index of a material (glass, water) by real & apparent depth method.	An object partially immersed in water (such as a stick or pencil) appears bent due to the refraction of light rays. The depth of object in a body of water appears closer to the surface than it really is. The apparent depth is less than the real depth due to refraction of light rays.	Discussion: Simulation: presentation from website: http://www.s-cool.co.uk/ http://www.physicsclassroom.com Practical Activity: Observing the apparent depth of a dot painted at the base of a 1000 ml measuring cylinder, with different heights of water	Measuring cylinder Indelible ink markers Water Metre Rule Graph Paper Calculator Internet	Practical Assessment • Handling of experimental data • Measure real depth and apparent depth of dot in water, present data in a tabular manner, plot graph of real depth against apparent depth and find the gradient $(\frac{\Delta\ real\ depth}{\Delta\ apparent\ \ depth})$

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SCOPE OF WORK
GRADE: 11
UNIT: OPTICS

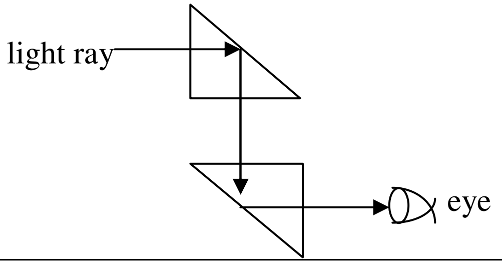
TOPIC: **REFRACTION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• define critical angle	**The Critical Angle (c)** is defined as the threshold angle of incidence beyond which total internal reflection takes place.	Simulation from websites: http://www.s-cool.co.uk/ http://www.physicsclassroom.com Discussion Practical Activity Drawing diagrams to illustrate total internal reflection and the critical angle	Rectangular glass blocks, semi-circular glass blocks, prisms, fibre optic cables, lenses, coiled glass tubes, ray box, protractors Internet	Assessment of skills • Observation • Communication
• Measure critical angle for a material using a semi-circular block.	The critical angle for various transparent media (e.g. glass) may be measured as the angle of incidence producing an angle of refraction of 90^o.	Practical Activity Determining the critical angle of a semi-circular glass block	Semi-circular glass block, ray box, protractor , paper	Practical Assessment of skills; • Observation • Measurement • Recording Experimental data • Making inferences and drawing conclusions
• state the conditions for total internal reflection	Total internal reflection occurs when light travels from (1) a medium of higher refractive index to one of lower refractive index and (2) when the angle of incidence exceeds than the critical angle	Simulation from websites: http://www.s-cool.co.uk/ http://www.physicsclassroom.com Discussion Practical Activity	Rectangular glass blocks, semi-circular glass blocks, prisms, fibre optic cables, lenses, coiled glass tubes, ray box, protractors	Written Assessment • Worksheet • Quiz

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: OPTICS

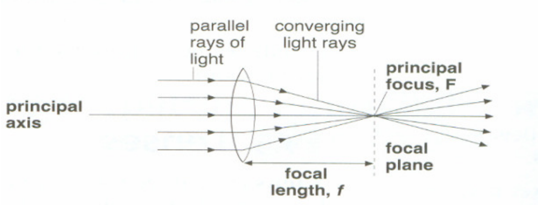
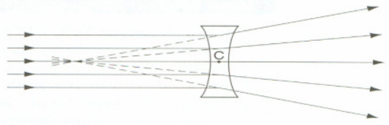
TOPIC: **REFRACTION** **DURATION: 3 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
- Use the relationship sin c= 1/n to solve problems.	The refractive index (n) and the sine of the critical angle (c) are inversely related. $\mathbf{n = \frac{1}{\sin c}}$ $\mathbf{\sin c = \frac{1}{n}}$	Problem solving and Critical analysis	Worksheets Text	Written Assessment - Worksheet - Quiz
- Discuss how total internal reflection is employed in fiber optical cables (and endoscopes)	Total Internal Reflection can be very useful. Its effect is evident in prisms, optical fibres, periscopes, bicycle, cable television, formation of mirages, diamonds. Optical fibres are used in endoscopes and for telecommunications. Since light enters one end of the fibre, at an angle greater than the critical angle, total internal reflection occurs. In endoscopes, other optical fibres in the bundle collect the reflected light using lenses and send it to a computer, where the information is displayed as a picture on a monitor.	Practical Demonstration Simulations: http://www.s-cool.co.uk/ http://www.physicsclassroom.com Discussions Illustrating applications of total internal reflection Research and presentations Field Trip to BTC/ Cable Bahamas Guest Speakers form BTC/ Cable Bahamas	Physics Text Guest Speaker Assortment of Fibre Optic Cables Coiled glass tubes Computer Projector	Oral Questions Written assessment Illustrations of applications of total internal reflection in endoscopes and fibre optic cables
- Draw diagram to show arrangement and path of light through 45^0 prisms as used in periscopes.	A right angle prism can be used to change the direction of a light ray. When light enters at 45^o (an angle greater than the critical angle of glass), total internal reflection occurs at the back face of the prism. Two right angle prisms can therefore be used to form a periscope.  	Construction of model periscope using right-angled prisms Simulations: http://www.s-cool.co.uk/ http://www.physicsclassroom.com	Light source Prisms Clamp stands	Assessment of model of simple periscope for functionality and creativity

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: OPTICS

TOPIC: **LENSES & OPTICAL EQUIPMENT** **DURATION: 2 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Define optical terms associated with lens- (principal focus, principal axis, optical center, focal length, power.)	**Principal Focus (F)** … is the point on the principal axis to which initially parallel rays converge, or from which they appear to diverge after refraction at the lens. **Focal length (f)** … is the distance from the center of the lens to the principal focus. **Principal Axis** …is the line joining the centers of curvature of the lens at its surfaces. **Focal Plane** is the plane, of which the principal axis is a part in which sharp images of the object are formed.  **Convex lens**  **Concave Lens** **Source (CXC Physics)** The power of a lens is defined as the reciprocal of its focal length (in metres). The unit of	Practical demonstration Discussion Simulations: http://www.s-cool.co.uk/ http://www.physicsclassroom.com Drawing lenses and labelling associated optical terms - principal focus; principal axis; optical centre; focal length Worksheet Calculating power of a lens	Ray boxes Concave and Convex lenses Paper	Assessment of skills • Observation • Communication Written Assessment • Worksheet • Quiz

TOPIC: **LENSES & OPTICAL EQUIPMENT**

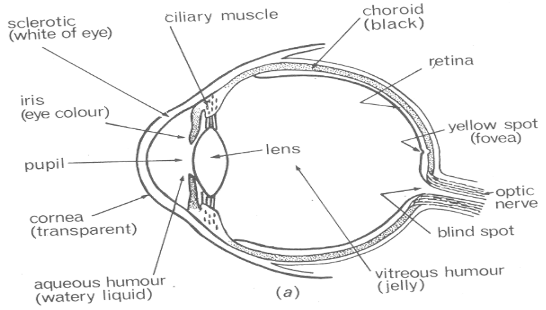
LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	power is the Dioptre (D). Power (D) = $\frac{1}{f(m)}$			
• Experimentally determine the relationship between thickness and focal length of a convex lens.	The shorter the focal length (the fatter the lens), the greater its power. Thick lenses have a shorter focal length than thinner lenses.	Discussion Practical Activity Finding the focal length of thin and thick lenses	Ray boxes Assorted convex lenses of different thickness Rulers Paper	Assessment of skills • Correct use of materials and apparatus • Observation • Measurement • Recording Experimental data • Making inferences and drawing conclusions
• Construct ray diagrams (& scale drawings) to describe images formed by convex and concave lenses.	In order to locate the image formed by a converging lens, any two of three types of rays may be used to construct ray diagrams: • A ray of light parallel to the principal axis which is refracted through the principal Focus (F) • A ray of light through the optical center which is undeviated for thin lens • A ray of light through the principal Focus (F) which is refracted parallel to the principal axis. In order to locate the image formed by a concave (diverging) lens, any two of three types of rays may be used to construct ray diagrams:	Discussion Construction of Ray Diagrams to illustrate image formation in convex and concave lenses Practical activity Observe images formed when object is placed between F and 2F, 2 F and beyond F	Graph paper ruler pencil calculators Screen Lenses Metre Rule Raybox/ light source	Written Assessment • Worksheet • Quiz • Construction of Ray Diagrams

TOPIC: **LENSES & OPTICAL EQUIPMENT**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	• An incident ray parallel to the principal axis is refracted through the lens so that its extension passes through the focal point • A ray of light through the focal point will refract through the lens and travel parallel to the principal axis. • A ray of light through the center of the lens will continue undeviated (i.e. in the same direction as it entered the lens).			
• Apply the lens formula using the real is positive sign convention, the magnification formula and the power of a lens formula to solve problems.	The nature and position of an image may be found through calculations, by applying the Lens Formula, which is as follows: $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ where f = focal length v = image distance u = object distance Sign conventions when applying formulae: • Distances to real images are positive. The focal length of a convex lens is positive. • Distances to virtual images are negative. The focal length of a concave lens is negative	Problem Solving	Worksheets Calculators Text book	**Written Assessment** • **Worksheet** • **Quiz**

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: OPTICS

TOPIC: **LENSES & OPTICAL EQUIPMENT**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
- Construct models of the human eye and relate structures to the function.	Light undergoes successive refraction from cornea and is focused on retina after successive refractions. The retina is sensitive to light and sends messages to the brain by way of the optic nerves. Although the image on the retina is inverted, the brain interprets it correctly  	Practical Activity: Construction of Models of Human Eye Discussion of Structure of Eye in relation to function	Suitable materials such as plasticine, Styrofoam, cardboard, markers, marbles	Assessment of model of simple periscope for functionality and creativity
- Examine/dissect a cow's/goat's eye and compare structure to human eye.		Practical Activity Dissection of cow's/ goat eye	Dissection kit Cow/ goat eye	Assessment of skills - Correct use of materials, apparatus and techniques - Observation - Recognising relationships

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: OPTICS

TOPIC: **LENSES & OPTICAL EQUIPMENT**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Perform experiments to demonstrate blind spot, binocular vision, inversion of image on retina,	The blind spot is the area on the retina without receptors that respond to light. Therefore an image that falls on this region will not be seen. http://faculty.washington.edu/chudler/chvision.html	Practical activity to demonstrate blind spot. Make a small dot on the left side of paper separated by about 12 – 15 cm from a small cross (+) on the right side. Close right eye. Hold the image 30 cm away. With left eye, look at the +. Slowly bring the image (or move head) closer while looking at the +. At a certain distance, the dot will disappear from sight...this occurs when the dot falls on the blind spot of the retina. Repeat with right eye. http://faculty.washington.edu/chudler/chvision.html	Paper Pencils Ruler	Assessment of skills • Observation • Making inferences and drawing conclusions
	Binocular vision is vision in which both eyes are used together. Advantages include a spare eye in case one is damaged, a wider field of view, the ability to detect faint objects is enhanced (binocular summation) and precise depth perception may be provided by the different positions of the two eyes on the head. http://en.wikipedia.org/wiki/Binocular_vision	Practical activity to demonstrate binocular vision. hold the ends a pencil one in each hand, facing each other, either vertically or horizontally at arms-length from the body. With one eye closed, try touching the ends of the pencils together. When repeated with two eyes: the task should be much easier because each eye looks at the image from a different angle. http://faculty.washington.edu/chudler/chvision.html	Paper Pencils	Assessment of skills • Observation • Making inferences and drawing conclusions
	The image formed in the eye is real and inverted.	Construction and use of a pin-hole camera to demonstrate formation of real inverted images.	cardboard box, translucent paper, black construction paper, scissors, glue,	Assessment of model of eye for functionality and creativity

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: OPTICS

TOPIC: **LENSES & OPTICAL EQUIPMENT**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr>
<td>• Describe the focusing of the lens in the eye to see near & distant objects. (accommodation)</td>
<td>The ciliary muscles allow the lens to adjust their focal length to enable it to focus both far and near objects, by changing shape. This process is called accommodation.
<table>
<tr><th>Viewing Distant Objects</th><th>Viewing Near Objects</th></tr>
<tr><td>ciliary muscles relaxes</td><td>ciliary muscles relaxes</td></tr>
<tr><td>Lens flatten, becoming long and thin</td><td>Lens widen, becoming short and fat</td></tr>
<tr><td>Focal length increases</td><td>Focal length decreases</td></tr>
</table></td>
<td>Practical Demonstration
Use of a ray box and converging lens of different thickness to demonstrate focal length is smaller for fatter lens and greater for thinner lens.

Drawing diagrams to show the refraction of light rays through converging lens of varying thickness.</td>
<td>Ray box
Convex lens of different thickness</td>
<td>Assessment of skills
• Observation
• Communication
• Recognizing Relationships

Written Assessment
• Worksheet
• Quiz</td>
</tr>
<tr>
<td>• Draw diagrams to show eye defects associated with the lens and the use of additional lenses to correct these defects (long & short sightedness)</td>
<td>Defects in vision may be eliminated by using spectacles, whose lenses refract light before it enters the eye.
<u>Hypermetropia (long or farsightedness)</u> occurs when near objects cannot be focused because the diverging rays of light are focused behind the retina. Only far objects are clearly seen. This may be caused by a short eyeball or weak lens. It may occur in older people since the refractive power of the lens decreases with age.
Correction: use of a convex lens</td>
<td>Discussion

Simulations:
http://www.s-cool.co.uk/
http://www.physicsclassroom.com

Drawing diagrams of eye defects associated with the lens and the use of additional lenses to correct these defects</td>
<td>Internet

Physics text

Paper
pencil
ruler</td>
<td>Written/ Oral Questions

Written Assessment
• Worksheet
• Quiz
• Illustration of Eye Defects and their corrections</td>
</tr>
</table>

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: OPTICS

TOPIC: **LENSES & OPTICAL EQUIPMENT**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Make models of the eye to show defects and their corrections by use of additional lenses.	**Myopia (short or near sightedness)** occurs when distant objects appear blurred because parallel light rays are refracted too much and become focused in front of the retina. Only near objects can be seen very clearly. It may be caused by a long eyeball, poor nutrition or genetic reasons. **Correction:** use of a concave or diverging lens	Discussion Practical activity: Construction of model of eye defects and their corrections	Suitable materials such as plasticine, Styrofoam, cardboard, lenses, marbles	Assessment of model for functionality and creativity

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: OPTICS

TOPIC: **LENSES & OPTICAL EQUIPMENT**

LEARNER OUTCOMES	CONTENT			ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Eye	**Camera**	**Pinhole Camera**			
• Compare & contrast the operation of the human eye, simple lens camera and the pin-hole camera	Convex lens form real inverted image on the retina	Convex lens form real inverted image on the film	No lens Real inverted image formed on screen	Research Comparison of concrete models Concept maps Graphic organizers	Model of eye Camera Pinhole camera Paper Pencil	Written Assessment • Worksheet • Quiz
	Iris controls the amount of light entering the eye	The diaphragm controls the amount of light entering the camera	Light enters through pinhole			
	Black choroid layer absorbs stray light	Inside camera is black which absorbs stray light	Inside camera is airtight to prevent light escaping			

PHYSICS CURRICULUM
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UNIT: OPTICS

TOPIC: **LENSES & OPTICAL EQUIPMENT**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr><td></td><td>
<table>
<tr><th>Eye</th><th>Camera</th><th>Pinhole Camera</th></tr>
<tr><td>Focusing is achieved by altering the shape (focal length) of the lens</td><td>Focusing is achieved by altering the distance between the lens and the film</td><td>Focusing is achieved by altering distance between pinhole camera and object</td></tr>
<tr><td>Image does not have a lasting record on the retina</td><td>Permanent record is possible when film is developed</td><td>Permanent record only possible if light sensitive photographic paper placed is developed after long exposure</td></tr>
<tr><td>Eyelids protect the cornea and lens from dust</td><td>Lens cap used to protect the lens</td><td>Not applicable</td></tr>
</table>
</td><td></td><td></td><td></td></tr>
</table>

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: OPTICS

TOPIC: **LENSES & OPTICAL EQUIPMENT**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Design & construct optical devices (single lens camera, projector, a compound microscope, a simple refracting telescope.	The camera consists of a light proof box containing: • An opening … which contains the convex lens. This gathers incoming light and focuses it on the film. • A light proof shutter … behind the lens, which when closed prevents light from reaching the film. • A diaphragm … located just behind the lens and is adjustable in size to control the amount of light passing through the shutter when it is opened. • A light sensitive film … which records the image and is later developed to give a permanent picture. (1) The Projector … uses several lenses and a concave mirror which produces on screen a real magnified and inverted image on the screen (for the image to be the right way up, the object (slide or film) must be upside down.	Research Use of Optical devices • Camera • Projector • Microscope • Simple refracting telescope Construction of simple optical instrument	Resource materials • Textbooks • Internet Cameras Projectors Microscopes Telescopes	Written Assessment • Worksheet • Quiz

TOPIC: **LENSES & OPTICAL EQUIPMENT**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	(2) The Microscope: the objective lens, which is a powerful converging lens of short focal length, is used to produce a real inverted image and magnified image. The eyepiece lens is the lens that is nearest to the eye. It has a short focal length and is used to magnify the first image (acts as a magnifying glass). The combination of the two lenses produces a final image (I2), which is inverted compared to the object, virtual, and magnified. (3) The Telescope … uses two converging lens to produce an inverted virtual image. The objective lens is a wide aperture converging lens of long focal length. The aperture allows it to collect a lot of light from weak distant sources and forms a weak inverted diminished image (I1). The eyepiece lens is a short focal length convex lens, which is to magnify the first image. The final image is inverted.	Students and teachers can access the worldwide telescope® online on www.microsoft.com		

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: OPTICS

TOPIC: **LIGHT & COLOUR** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
To identify the colours of the spectrum produced when white light passes through a prism.	White light is a mixture of several colours (red, orange, yellow, green, blue, indigo, violet), which may be separated by refraction. The band of colours formed is called a spectrum and the process is called dispersion. Refraction of light through a prism, or diamond and rainbows are examples of dispersion,	• Practical Activity – Forming a spectrum with a prism Using a raybox, shine a ray of white light through a glass prism and onto a white screen • Repeat using a convex lens to focus the rays to form a pure spectrum (GCSE Physics; page 27) (Physics for You, page 206)	Raybox Prisms Convex Lenses Screens	Practical demonstrations, cooperative group activities, presentations,
To describe how a spectrum can be recombined to produce white light	White light can be recombined to produce white light by: (i) arranging a second prism so that light is deviated in an opposite direction and (ii) spinning a disc at high speeds with the colours of the spectrum painted on its sectors	• Practical Activity – Recombining spectrum to produce White light • Using two prisms opposite arranged • Constructing a colour wheel and spinning it at high speeds using an electric motor	Raybox Prisms Colour wheel Electric motor	Practical demonstrations, cooperative group activities,
To describe the relationship between the colours of the spectrum and their wavelength	The colours of the spectrum vary in their wavelength. In transparent materials, such as glass, the colours of the spectrum travel at different speeds based on their wavelength. The greater the wavelength, the slower the speed and the greater the angle of refraction. Violet has the shortest wavelength and is refracted through the greatest angle since its speed decreases the most. Red has the longest wavelength and is refracted least since its speed decreases the least.	Research Drawing and labeling colours of the spectrum and their relative wavelengths after refraction through a prism.	Raybox Prisms	Practical demonstrations, cooperative group activities,

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: OPTICS

TOPIC: **LIGHT & COLOUR**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
To describe the factors that affect colour of an object	The colour of an object depends on the colour of light falling on it and the colour it transmits or reflects. The primary colours of light are red, green and blue. Secondary colours of light are yellow, magenta and cyan. A filter only allows light to pass through of certain colours only e.g a green filter only transmits mostly green light and absorbs other colours. Opaque objects are seen as reflected light. In general, white reflects all light falling on it, coloured objects reflect the colour they contain and absorb other colours e.g. a red object appears red in white light because it reflect red only and absorbs the other colours of the spectrum. It also appears red in red light, but black(the absence of colour) in green light since no light is reflected. Duncan, Tom (2001) GCSE Physics. 4th Ed. Pgs.27 -29	Practical Activity • Mixing coloured lights … primary colours can be mixed by shining beams of red, green and blue light unto a white screen allowing them to partially overlap. • Using coloured filters to investigate the transmission of light through them	Ray box Light box & accessory kit Colour filters Screen	Practical demonstrations, cooperative group activities, presentations, quizzes,

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: ELECTROSTATICS

TOPIC: **STATIC ELECTRICITY** **DURATION: 3 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
Describe the importance of safety practices and procedures when handling electrical and electronic circuits (wiring in wet surroundings, etc.)	The rate at which current flows through an individual depends on how well the body conducts electricity. • With dry hands on a non-conductive surface such as a rubber mat, it is possible not to feel a shock. However, if one is perspiring and is standing in water, this may result in death. • The length of time the current flows through the body. The longer the electric contact, the greater the current flow and the greater the shock. • The path the current takes through the body. The most dangerous path is through vital organs. **Your actions can protect your safety:** • Read and follow instructions before handling anything electrical. • Plugs should only be inserted in receptacle outlets with the same slot or blade pattern, unless proper adapters are used. • Water conducts electricity. Keep wet hands from touching electrical equipment or switches. • Firmly grip the plug, not the cord, when disconnecting equipment. • Unplug equipment, appliances and extension cords when not in use and before inspecting, cleaning, or fixing them. • Recognize signs of overloaded circuits including flickering lights, blown fuses, warm wall plates or extension cords, and tripped circuit breakers	Design a poster highlighting the importance of electrical safety.	Physics text Internet	In class discussions Assessment of poster for accuracy, content and creativity Worksheets

PHYSICS CURRICULUM
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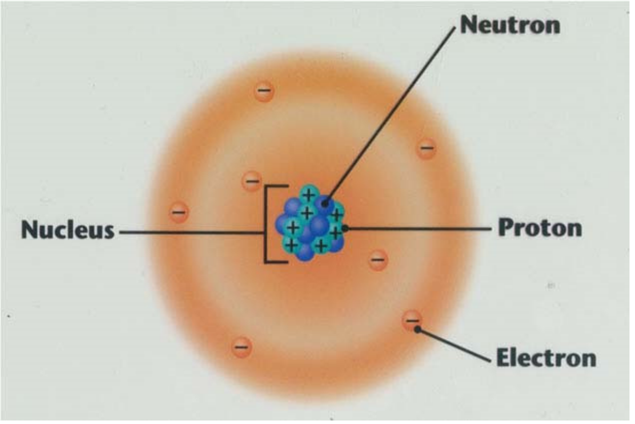
UNIT: ELECTROSTATICS

TOPIC: **STATIC ELECTRICITY**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr><td>Define the term atom</td><td>The atom is the smallest object that retains properties of an element.</td><td></td><td>Physics Textbook</td><td></td></tr>
<tr><td>List the subatomic particles in an atom and describe their relative charges and masses</td><td>The atom is composed of electrons and a nucleus (containing protons and neutrons).
<table>
<tr><th>Particle</th><th>Relative Mass</th><th>Relative Charge</th></tr>
<tr><td>Proton</td><td>1</td><td>+1</td></tr>
<tr><td>Neutron</td><td>1</td><td>0</td></tr>
<tr><td>Electron</td><td>0.0005</td><td>-1</td></tr>
</table></td><td>Draw the structure of simple atoms</td><td>Physics Textbook
Internet
http://www.s-cool.co.uk/gcse/physics</td><td>Drawing of Atoms
Worksheet</td></tr>
<tr><td>Construct models of simple atoms</td><td>
</td><td>- Students can build models of an atom</td><td>Suitable materials such as Styrofoam, modeling clay (plasticine), cardboard, markers, marbles</td><td>Assessment of model of atom for accuracy and creativity</td></tr>
</table>

PHYSICS CURRICULUM
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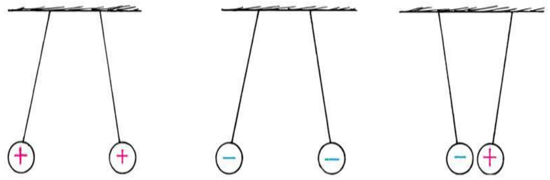
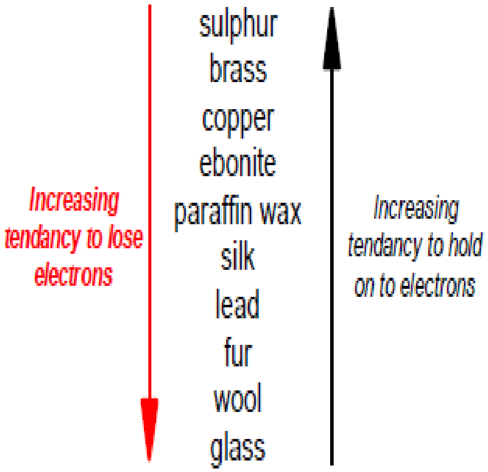
UNIT: ELECTROSTATICS

TOPIC: **STATIC ELECTRICITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
✓ Describe static electricity as stationary positive or negative charges	Static electricity is the accumulation of electrical charges on the surface of a material, usually an insulator or non-conductor of electricity. It is called "static" because there is no current flowing. It is usually caused when certain materials are rubbed against each other—like wool on plastic or the soles of your shoes on the carpet. It is also caused when materials are pressed against each other and pulled apart.	Class discussions Demonstrations of simple examples of static electricity	Physics Textbook	
• Describe charging as a result of the movement of electrons.	Both +ve and –ve electrostatic charges are produced by the movement of electrons. The +ve charge is caused by electrons moving away from the object whilst the –ve charge is caused by electrons moving onto the object. For example if a polyethene rod is rubbed with a cloth it becomes negatively charged because electrons move from the cloth to the polyethene rod. If an acetate rod is rubbed with a cloth, it becomes positively charged because electrons move from the acetate rod to the cloth.	Students can charge polythene and acetate rods (which are charged negatively and positively charged respectively) and then investigate their attraction to neutral tiny strips of paper.	Polythene rod acetate rod Soft cloth	Practical lab assessment Worksheet
✓ State and demonstrate the law of charges	• Like charges repel one another and unlike charges attract one another.  **Opposite charges attract. Like charges repel**	• Students can suspend Explain how the cathode ray oscilloscope works and state common uses. • Recognize the advantages and disadvantages of space exploration. polyethene and acetate rods to investigate the law of charges.	Polythene rod acetate rod Soft cloth	Practical lab assessment Worksheet

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: ELECTROSTATICS

TOPIC: **STATIC ELECTRICITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe and demonstrate charging by friction e.g. balloons, ebonite rod, polythene,	• It is possible to charge an object positively or negatively. One way to do this is by rubbing two different materials together, a process known as charging by friction. Since the two objects are made of different materials, their atoms will hold onto their electrons with different strengths. The strengths with which materials hold onto electrons is shown by the Electrostatic series below: • 	**<u>Activity 1:</u>** Rub a piece of ebonite (very hard, black rubber) across a piece of animal fur. Explain what happens. The fur does not hold on to its electrons as strongly as the ebonite. At least some of the electrons will be ripped off of the fur and stay on the ebonite. The fur now has a slightly positive charge (it lost some electrons) and the ebonite is slightly negative (it gained some electrons).The net charge is still zero between the two… due to the conservation of charge. No charges have been created or destroyed, just moved around. **<u>Activity 2</u>**: Rub a glass rod with a piece of silk. Explain what happens. This is the same sort of situation as the one above. In this case the silk holds onto the electrons more strongly than the glass. Electrons are ripped off of the glass and go on to the silk. The glass is now positive and the silk is negative.	An ebonite rod, a piece of animal fur, a glass rod and a piece of silk	In class discussions Worksheets

PHYSICS CURRICULUM
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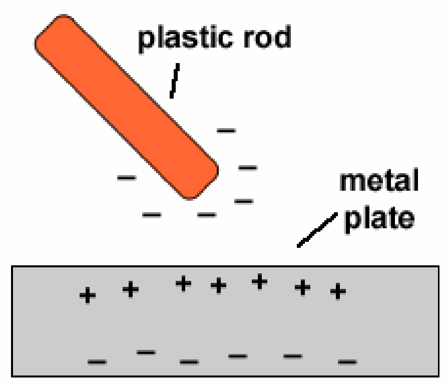
UNIT: ELECTROSTATICS

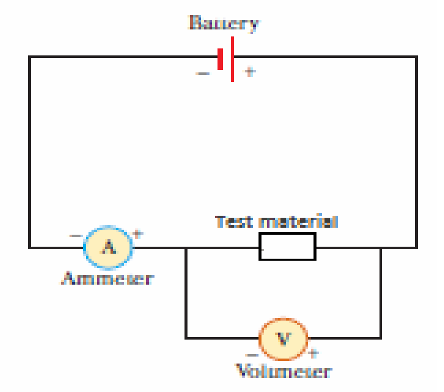
TOPIC: **STATIC ELECTRICITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
✓ explain how a charged object can attract objects having net zero charge.	• A charged object attracts a neutral object by electrostatic induction. This is the redistribution of electric charge on one material under the influence of an electric charge on a nearby object. ✓ When a negatively charged object is brought near a neutral object, it induces a positive charge on the near side of the object and a negative charge on the far side. This causes the negatively charged object to attract the neutral one.  • When a positively charged object is brought near a neutral object, it induces a negative charge on the near side of the object and a positive charge on the far side. This causes the positively charged object to attract the neutral one.	Charge a plastic rod with the fur. Run a small continuous trickle of water from the tap. Hold the rod near the stream of water and observe. Blow up a balloon. Charge the balloon by rubbing. Hold the balloon up to the wall and observe. Repeat, using other materials such as pith balls, chopped hair and bits of paper.	glass rod, polythene rod, acetate rod duster, bits of paper, pith balls	Worksheet Practical assessment

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: ELECTROSTATICS

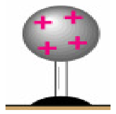
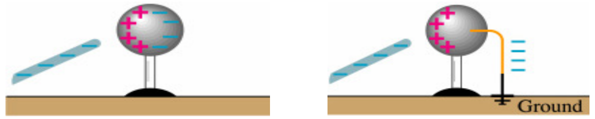
TOPIC: STATIC ELECTRICITY

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Distinguish between insulators and conductors in terms of movement of electrons	• Insulators are materials do not allow the movement of electrons readily through the material e.g rubber, glass. It is easy to place an electrostatic charge on an insulator because the charge does not move easily. • Conductors are materials that allow the movement readily through the material e.g copper, silver. In order to charge a conductor, that conductor should be isolated by an insulator.	Students can test various materials to see whether they are insulators or conductors by using the circuit diagram below:  • If the ammeter registers a reading then the material is a conductor. • If the ammeter does not registers a reading then the material is an insulator.	ammeter, voltmeter, connecting wires, battery / power supply, and several insulators and conductors.	Practical assessment Lab report

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: ELECTROSTATICS

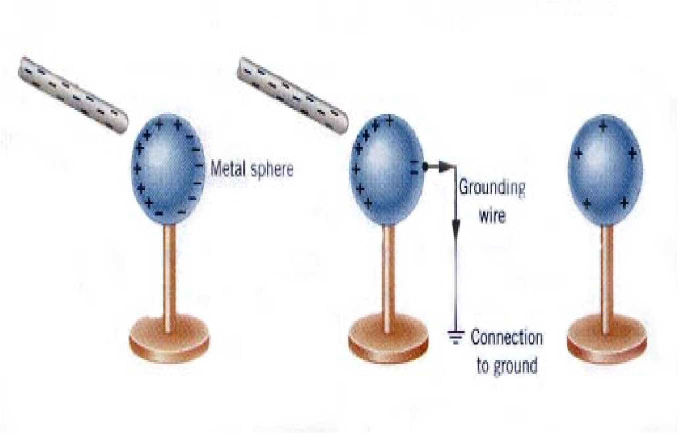
TOPIC: **STATIC ELECTRICITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe the discharging of positive and negative charges by earthing (grounding)	 ⏚ Symbol for earth: The build-up of static charge on an object can be eliminated by grounding (or earthing). This is accomplished by connecting the object via a conductor to the ground. The diagram illustrates how a negative charge can be grounded:  • If a negatively charged object is grounded, electrons flow from that object to earth. • If a positively charged object is grounded, electrons flow from earth to that object. • The negatively charged rod is brought near the sphere. It pushes electrons to the back side of the sphere. • The ground wire is then connected to the sphere (or you can touch the sphere) resulting in the electrons moving to ground. • The ground wire is disconnected to prevent the return of the electrons from ground, and then the rod is removed. • The sphere is now positively charged	Design a poster showing how positive and negative charges may be discharged by ear thing.	Physics Textbooks	Class discussion

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: ELECTROSTATICS

TOPIC: STATIC ELECTRICITY

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
- Describe the charging of objects and electroscopes by electrostatic induction and by contact.	**Charging by induction:** Charging an object positively, by induction is shown in the series of diagrams below:  Induction can similarly be used to charge an object negatively by using a positively charged rod.	Students can practice charging an object positively or negatively by induction or by contact using an electroscope (or a metal sphere connected to an insulator). During the charging by induction grounding can be demonstrated. Students can demonstrate the detection of charges using the appropriate materials.	Polythene rod, acetate rod duster cloth and an electroscope	Practical Assessment
	Charging by contact: Rub an insulator to charge it up. Then stroke it across the top plate of the electroscope. This will transfer charge from the insulator to the electroscope. The charge left on the electroscope will not always leave it fully deflected. An electroscope can be used to detect the presence of a charge. If a positive or negative charge is brought near an uncharged electroscope the leaf will deflect.	- Students can practice charging an electroscope (or a balloon attached to string) positively using a negatively charged rod. - Students can practice charging an electroscope (or a balloon attached to string) negatively using a positively charged rod.	Electroscopes Balloons	Practical Assessment

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: ELECTROSTATICS

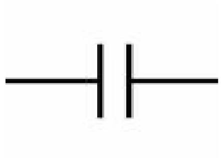
TOPIC: **STATIC ELECTRICITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe the force between charged bodies and the qualitative relationship of size of charge and distance between charge bodies (inverse square law: product of charged of bodies /distance squared)	There is a force between the charges and the bigger the charges the greater the force and the shorter the distance between the charges the bigger the force. This is called Coulomb's Law of charges which states: The force between two charged objects is directly proportional to the product of their charges and inversely proportional to the square of the distance between them. The magnitude of the electrostatic force (F) on a point charge (q_1) due to the presence of a second point charge (q_2), is given by $F = k_e \frac{q_1 q_2}{r^2}$ where r is the distance between the two point charges and k_e a proportionality constant. A positive force implies a repulsive interaction, while a negative force implies an attractive interaction.	• Students can charge a polythene and an acetate rod (which are charged negative and positive respectively) then suspend them on a string. Coulomb's Law can then be investigated qualitatively • Solving quantitative and qualitative questions involving Coulomb's Law.	Polythene rods, acetate rods, string	Practical Assessment Worksheet

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: ELECTROSTATICS

TOPIC: **STATIC ELECTRICITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe the use the electroscope to detect the presence of a charge and the sign of charge on objects	• If a charged object is brought near an electroscope of the same charge, the deflection of the leaf will increase. This increase in deflection is the only sure way of testing a charge because both an uncharged object and one of the same charge will cause a decrease in deflection. • See the above section on Coulomb's Law.	Students can practice charging an electroscope (or a balloon attached to string) positively using a negatively charged rod. Students can practice charging an electroscope (or a balloon attached to string) negatively using a positively charged rod. Students can practice grounding when charging an electroscope	Electroscopes, polythene rods, acetate rods and duster cloth.	Practical Assessment
• Describe the capacitor as a device used to store charges (energy).	• A capacitor is a device that stores electrical energy. Inside the capacitor, the terminals connect to two metal **plates** separated by **a non-conducting substance,** or **dielectric**. Symbol: 			

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

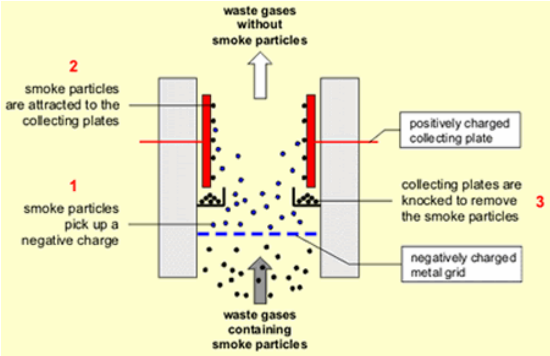
UNIT: ELECTROSTATICS

TOPIC: **STATIC ELECTRICITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe the construction of a simple capacitor.	• A simple capacitor can be built from two pieces of aluminium foil and a piece of paper. It won't be a particularly good capacitor in terms of its storage capacity, but it will work.	Students can build a simple capacitor using the materials listed on the left. ✓ Cut two 1" square pieces of aluminum foil. ✓ Cut about five 1" square pieces of paper. ✓ Place the sheets of paper between the two sheets of aluminum foil. In the centre of the two sheets of aluminum foil, via the wires, connect to the battery.	Sheets of aluminum foil, paper, connecting wire and a 12V battery A polythene rod, an acetate rod, a duster rod and tiny bits of paper (care must be exercised when handling 12 V)	Students write up report Solving numerical problems involving capacitance, charge and potential differences.
• relate capacitance to the quantity of charge (energy) stored and Identify the Farad as the unit for capacitance (qualitative only)	• A capacitor's storage potential, or **capacitance**, is measured in units called **farads**. A 1-farad capacitor can store one coulomb of charge at 1 volt. An ideal capacitor is characterized by a constant capacitance *C*, defined as the ratio of charge ±*Q* on each conductor to the voltage *V* between them: $C = \frac{Q}{V}$	• Numerical problem solving. Discuss problems of the following types: ✓ Determining capacitance given charge and potential difference. ✓ Determining charge given capacitance and potential difference. ✓ Determining potential difference given charge and capacitance.		Numerical problem solving. Worksheet

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11
UNIT: ELECTROSTATICS

TOPIC: **STATIC ELECTRICITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe applications; hazards, and their associated safety procedures of electrostatics, e.g. capacitors, spark plugs, lightning and lightning conductors, gas lighters, photocopying devices, painting of automobiles, electrostatic precipitation.	***Practical Uses of Static Charges*** The ability of opposite charges to attract each other (or for a charged object to attract an uncharged object) in static electricity is commonly used when designing electrostatic applications. A few examples are listed below: **Dust removal:** Some appliances can eliminate dust from the air, like air purifiers. They use static electricity to alter the charges in the dust particles so that they stick to a plate or filter of the purifier that has an opposite charge as that of the dust (opposite charges attract each other). This effect is also used in industrial smokestacks to reduce the pollution that they generate, although they work in a very large scale, the effect is similar to that of a ier.  From BBC - Electrostatic Precipitators	Students can demonstrate the applications of static electricity by using a charged rod to attract uncharged bits of paper, and using a charged polythene rod and a charged acetate rod to show the attraction between oppositely charged objects constructing simple static electricity models (or simulation of models)	Polythene rods, cellulose acetate rods	Assessment of project for creativity, relevance and appropriateness

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 11

UNIT: ELECTROSTATICS

TOPIC: **STATIC ELECTRICITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	✓ **Photocopy:** The photocopier or Xerox machine uses static electricity to copy print to a page. This is done through the science of xerography. One version of this device electrically charges ink so that it will stick to the paper in the designated areas. Another version of a photocopier uses charges to stick the ink to a drum, which then transfers it to the paper. ✓ **Car painting:** To make sure a car's paint is uniform and that it will resist the high speeds and weather to protect the car's metal interior, it is applied with a static charge. The metal body of the car is submerged in a substance that charges it positively, and the paint is charged negatively with the paint sprayer. This process ensures a uniform layer of paint. • **Hazards of Static Electricity** The main hazards of static electricity are: ✓ the creation of sparks in an explosive or flammable atmosphere. These sparks can set off an explosion or fire. The danger is greatest when flammable liquids are being poured or transferred. ✓ the risk of electric shock. If the static charge build up is high, it can be discharge (dissipate) via a spark. This can be dangerous or lethal.	Design a poster showing applications of static electricity Design a poster showing hazards of static electricity		Assessment of poster – safety Assessment of poster – applications of static electricity

UNIT: ELECTROSTATICS

TOPIC: **STATIC ELECTRICITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Most static electricity control measures provide ways for the static charges to discharge (dissipate) harmlessly before sparks occur. Some ways to prevent static charges from accumulating on materials are: ✓ grounding ✓ humidification ✓ static collectors ✓ Additives			

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: CURRENT ELECTRICITY

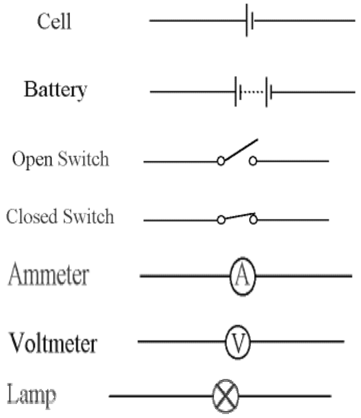
TOPIC: **CURRENT** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• **Current electricity** • Define current as the rate of electron flow (charge) measured in coulombs per second and use $I = \frac{Q}{t}$ to solve Problems	Current is defined as the rate of flow of electrons (the quantity of charge) around an electric circuit. $I = \frac{Q}{t}$ It is measured in Amperes or Coulombs per second.	Laboratory Practical Students construct circuit and measure the amount of current using an ammeter. Worksheet: Students complete worksheet: calculations involving Q = It Simulations http://www.s-cool.co.uk/gcse/physics/static-and-current-electricity/basic-circuits.html#current-voltage-and-resistances	Textbook Worksheets Internet LCD projector Laptop Student electricity apparatus sets (circuit boards, connecting wire, bulb, switch, ammeter) Worksheet: Calculations involving Q = It	Practical Assessment Worksheet
• Distinguish between alternating (a.c.) and direct current (d. c.)	In a direct current (d.c.), electrons flow in one direction only, from one side of the cell through all circuit components and return to the other side of cell. Alternating current (a.c.) refers to an electric current whose direction of flow is reversed in periodic cycles.	**Simulation** http://www.s-cool.co.uk/gcse/physics/static-and-current-electricity/electricity-at-home.html#mains-supply-ac-and-dc Demonstration Using the cathode-ray oscilloscope, a.c.- d.c. power supply and function generator to observe d.c and a.c displays. Sketching graphs of current against time and voltage against time for a.c and d.c.	Internet Projector Laptop a.c- d.c. Power supply function generator Cathode Ray Oscilloscope	Oral questions Written assessment

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: CURRENT ELECTRICITY

TOPIC: **CIRCUIT SYMBOLS, POTENTIAL DIFFERENCE & RESISTANCE** **DURATION: 1½ WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Use circuit symbols and describe circuit components, symbols, and functions (including switches, fuses, resistors, variable resistors, filament lamps)	A circuit refers to the arrangement of electrical components. Each component in a circuit may be represented by symbols e.g.  	Matching Game: Students participate in a game of matching, in order to correctly link the symbol to the component using concrete objects or pictures	Worksheet Matching Circuit Symbols Construction paper Markers Concrete objects PowerPoint	Written Assessment Oral questions
• define potential difference as the work done or energy transferred per unit charge passed between any two points ($V = \frac{W}{Q}$)	The potential difference measures the amount of work done or the energy converted per unit charge passed between two points. $$V = \frac{W}{Q}$$ Voltage, also called potential difference, or p.d. is measured using a voltmeter. The unit of potential difference is the volt (V).	Laboratory Practical Students construct circuit and measure the amount of voltage across components using the voltmeter.	Student electricity apparatus sets (circuit boards, connecting wire, bulb, switch, ammeter)	Practical Assessment

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: CURRENT ELECTRICITY

TOPIC: **CIRCUIT SYMBOLS, POTENTIAL DIFFERENCE & RESISTANCE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Define resistance as the opposition to the flow of electrons through a conductor. • State and investigate factors which affect resistance of a conductor. (cross-sectional area, length, type of material, temperature)	Resistance is the opposition to the flow of electrons through a conductor. Resistance is dependent on several factors such as: thickness (cross-sectional area), length, the nature (material) of the conductor and temperature.	**Laboratory Practical** Students investigate the effect of (i) Length (ii) Thickness (iii) Type/ nature of conducting material on resistance Note: All other variables are held constant , except variable being investigated	Wires of different thickness Wires of different types Wires of different lengths Power pack Ammeter Voltmeter 1 meter ruler 110cm of wire Crocodile clips	Practical Assessment
• State Ohm's law (R = $\frac{v}{I}$) and apply it to solve problems (including graphical problems).	Resistance (R) is measured in Ohms (Ω) and may be calculated by the equation R = $\frac{V}{I}$ (Ohm's Law) where V= voltage and I = current. Ohm's law states the current is proportional to potential difference applied, provided that the temperature of the conductor remains constant.	**Laboratory Practical** Students design and construct a test circuit with a voltmeter connected parallel, an ammeter in series and a rheostat to determine resistance of a given circuit component Worksheet: Students apply Ohm's Law to solve calculations	Student electricity apparatus sets (circuit boards, connecting wire, bulb, switch, ammeter)	Practical Assessment Written Assessment • Quiz • Worksheet
• Use instruments to accurately measure current and voltage. • Describe why (a) an ammeter should have a very low resistance and positioned in series (b) a voltmeter should have a very high resistance and positioned in parallel circuitry.	Current is measured by an ammeter. Ammeters have low resistance so that they could measure circuit current without affecting its value. The voltmeter measures voltage across two points. It has very high resistance ad is always connected in parallel with the component so that minimum current flows through it.	Practical Assessment Students construct circuit and measure the current at different points and the voltage across components using the voltmeter.	Student electricity apparatus sets (circuit boards, connecting wire, bulb, switch, ammeter, power pack. battery)	Practical Assessment Oral questions

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: CURRENT ELECTRICITY

TOPIC: **OHMIC & NON- OHMIC CONDUCTORS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Design and construct test circuits to determine the resistance of a given circuit component, through the application of Ohm's Law.	A test circuit may be used to determine a range of voltages and currents for a given component.	Students design and construct test circuit to determine the resistance of a given circuit component by measuring the voltage across component and current in circuit as resistance is varied, then apply Ohm's Law to determine the resistance. Problem solving Worksheet: Students apply Ohm's Law to solve calculations	Student electricity apparatus sets (circuit boards, connecting wire, bulb, switch, rheostat, d.c. ammeter, d. c. voltmeter, power supply/ battery pack) Worksheet	Practical Assessment Worksheet
• Deduce how resistance varies from current versus voltage graphs (bulb, thermistors, LDR's) and explain their applications	Non-Ohmic conductors include: • **Filament lamp** ... as temperature increases, the resistance of the filament wire increases and hence less current flows • **Thermistor** ... as temperature increases, the resistance of the thermistor decreases so more current flows. Thermistors are useful in circuits sensitive to temperature changes such as thermostats. • **Light dependent resistor (LDR)** ... as light increases, the resistance of the LDR decreases so more current flows. LDRs act as a light sensitive switches and are useful in light sensitive circuits such as burglar alarms, photographic equipment and automatic lighting and burglar alarms.	Construction of simple electronic circuits Drawing and interpreting graphs of V-I / I=V graphs for non-Ohnic conductors Drawing and interpreting resiatnce against temperature grsphs for bulbs and thermistors Research and present applications of thermistors and LDR's	Junior electronic circuit kits http://www.electronickits.com/kit/complete/science/sc300.htm	Practical Assessment Students' research, presentations and simple electronic circuits assessed for accuracy, creativity.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: CURRENT ELECTRICITY

TOPIC: **PARALLEL & SERIES CIRCUITS** **DURATION: 1½ WEEKS**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr>
<td>• Distinguish between parallel and series circuits (with reference to current, voltage and resistance), through construction of circuits
• Apply formulae to solve problems involving series, parallel and combination resistors.
○ $V_T = V_1 + V_2$ (series)
○ $I_T = I_1 + I_2$ (parallel)
○ $R_T = R_1 + R_2$ (series)
○ $1/R_T = 1/R_1 + 1/R_2 + 1/R_3$ (parallel)</td>
<td>A series circuit is one that provides one complete conducting pathway, while parallel circuits provide alternative pathways for circuit current.
<table>
<tr><th>SERIES CIRCUIT</th><th>PARALLEL CIRCUITS</th></tr>
<tr><td>Supply voltage is shared between components. ($V_T = V_1 + V_2$…). The bigger the resistance of a component, the bigger its share of voltage.</td><td>Voltage across all components is same and equal to the supply voltage. ($V_T = V_1 = V_2$ …)</td></tr>
<tr><td>Total resistance is the sum of all the resistances.
($R_T = R_1 + R_2$ …)</td><td>The reciprocal of the total resistance is the sum of the reciprocals of all the resistances.
($1/R_T = 1/R_1 + 1/R_2 + 1/R_3$ …)</td></tr>
<tr><td>Current is same in all parts of the circuit. ($I_1 = I_2$ …)</td><td>Total current in the circuit is split into its separate branches, based on the resistance of each branch. ($I_T = I_1 + I_2$ …) The lower the resistance, the greater the current. Total current going into and leaving alternative branches is same.</td></tr>
</table>
</td>
<td>Laboratory Practical:
Students construct series circuit and parallel circuits and measure current in different parts of circuits and voltage across components.
simulations
http://www.physicsclassroom.com/Class/circuits/u9l4b.cfm
Problem Solving
Students apply formula to solve problems involving series, parallel and combination circuits.</td>
<td>Student electricity apparatus sets (circuit boards, connecting wire, bulb, switch, ammeter, voltmeter, battery pack/ power supply)
Worksheets
Text</td>
<td>Practical Assessment
Written Assessment</td>
</tr>
</table>

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: CURRENT ELECTRICITY

TOPIC: **PARALLEL & SERIES CIRCUITS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Justify the use of parallel circuitry for wiring buildings	Components in separate branches of parallel branches are unaffected if components in one branch is disconnected, whether blown or switched off. Components in Parallel circuits get full supply voltage; have lower combined resistance and therefore more current when compared to series circuitry.	Wiring a model house using parallel circuitry. Debate Poster Jingle	Resources will vary	Student portfolio Students' research, presentations and models assessed for accuracy, creativity.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: CURRENT ELECTRICITY

TOPIC: **ELECTRICAL SAFETY** **DURATION: ½ WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• **Electrical safety** • Explain the importance of electrical safety in buildings and describe how fuses and circuit breakers are used to protect from circuit overloads and short circuits	• A **circuit breaker** is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and, by interrupting continuity, to immediately discontinue electrical flow. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city. • A **fuse** (from the Latin "fusus" meaning to melt) is a type of sacrificial overcurrent protection device. Its essential component is a metal wire or strip that melts when too much current flows, which interrupts the circuit in which it is connected. Short circuit, overload or device failure is often the reason for excessive current.	• Student can use actual circuit breakers and fuses to demonstrate how they protect from circuit overload.	A circuit breaker, a 5 A fuse	Student write up demonstration
• Justify why fuses, circuit breakers, cables must have a suitable current rating for a given use.				• In class discussions

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: CURRENT ELECTRICITY

TOPIC: **ELECTRICAL SAFETY** **DURATION: ½ WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Explain the use of earthing (grounding), insulation, double insulation and correct wires as safety measures	Sources: ✓ http://en.wikipedia.org/wiki/Circuit_breaker ✓ http://en.wikipedia.org/wiki/Fuse_%28electrical%29 • Fuses, circuit breakers and cables should always have amperage rating a little higher than the appliance that they are connected to. As a general multiply the amperage of the appliance by 1.25 to calculate the rating of the fuse, circuit breaker or cable to use, eg if an appliance requires 20 amp use a 25 ampere fuse. • Some electrical safety measures: ✓ The grounding of an appliance is a means to protect that appliance from the build-up of hazardous voltages. ✓ Insulation on current-carrying wires is protect the user from coming into direct contact with electric current, thus avoiding harm. ✓ To avoid overheating and possibly fires, the correct wiring should always be used.			

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: CURRENT ELECTRICITY

TOPIC: **ELECTRICAL POWER, ENERGY AND DOMESTIC APPLICATIONS** **DURATION: 1½ WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
Electricity in the home • Explain the importance of the use of standard colour codes in electrical wiring. • State the colour codes used for electrical wiring in the Bahamas and research colour codes used in other parts of the world.	Here are the colour coding for wiring in homes: UK • Live Brown • Neutral Blue • Earth Green and Yellow Bahamas • Live Black or red • Neutral White • Earth Green	Student can conduct research on: ✓ the importance of the use of standard colour codes in electrical wiring. ✓ the colour codes used in other parts of the world	Internet access	Student write up
• Describe with the aid of diagrams or suitable models a domestic wiring system, justifying the use of ring circuits, two way switches for lightning, the relative positioning of switches, fuses, circuit breakers and earth		• Student can conduct research on domestic wiring systems, especially in the Bahamas.	• Internet access	• Student write up

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: CURRENT ELECTRICITY

TOPIC: **ELECTRICAL POWER, ENERGY AND DOMESTIC APPLICATIONS** **DURATION: 1½ WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Compare energy consumption of various appliances in the home, e.g. light bulbs, cooker, air conditioner, toaster oven, water heaters etc.	The greater the wattage a appliance has, the more energy it consumes in a given time period. Here are the power consumption for some household appliances: • 60W Incandescent light bulb (Light equivalent to a 16W Compact Fluorescent): 60W • 100W Incandescent light bulb (Light equivalent to a 30W Compact Fluorescent): 100W • Toaster : 800-1500W • Microwave : 600-1500W • Dishwasher : 1200-1500W • Washing Machine : 500W • Vacuum Cleaner : 200-700W • Iron : 1000W • Clothes dryer : 4000W • Ceiling Fan : 10-50W • Table Fan : 10-25W • Hair Blow dryer : 1000W • Electric Shaver : 15W • Laptop Computer : 20-50W • Desktop Computer : 80-150W • TV (19" colour) : 70W • TV (25" colour) : 150W • Clock radio : 1W • Fridge / Freezer : 500W • Electric Kettle : 2000W	• Students can conduct research on the energy consumption of various electrical appliances.	• Internet access.	• Student write up.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: CURRENT ELECTRICITY

TOPIC: **ELECTRICAL POWER, ENERGY AND DOMESTIC APPLICATIONS** **DURATION: 1½ WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Recognise that the current drawn by each appliance at a given instance is dependent on its' power rating and supply voltage, provided other factors remain constant and apply concept in solving numeric problems (I = P/V) • Interpret electricity bills and perform calculations of the cost of electrical energy in joules and kilowatt-hours [Energy consumption = Power (kilowatt) x time (h) Cost = kWh x cost per unit (i.e. cost per kWh)]	• Students should be able to solve problems involving the formula Current = Power/Voltage(I = P/V) • The energy consumed by an appliance (in kilowatt-hour) is given by the formula Energy = Power(kilowatt-hour) x time(h) For example: If a 500 W freezer is left on continuously for 3 weeks then the energy it consumes during that time is: Energy = (500W/1000W/kW) x (3 weeks x 2352h/week) = 3528 kWh Note if a freezer is on for 3 weeks, it will not be using 1000W of power for the full 3 weeks. • 1kWh = (1kW x 1000W/kW) x (1h x 3600s/h) = 3 600 000 Ws = 3 600 000J This conversion factor of 1kWh/ 3 600 000J can be used to interconvert between Kilowatt-hour and Joule	Numerical problem solving Discussion and practice in solving problems involving the use of the formula: P = IV Numerical problem solving Discussion and practice in solving problems involving the use of the formula: E = Pt	Internet access	Worksheets involving numerical problem solving Worksheets involving numerical problem solving

TOPIC: **ELECTRICAL POWER, ENERGY AND DOMESTIC APPLICATIONS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Discuss ways of conserving electrical energy in homes (reducing wastage).	• In the above example if a utility company charges 10¢ per kilowatt-hour the cost of running the freezer for 3 weeks would be: Cost = 10¢/kilowatt-hour x 3528 kWh = 3 528¢ = $35.28¢ Here are a few energy saving tips for homes: ✓ **Computer**: Keep the monitor and the computer switched off when you are not using them. Start doing this even when at work. ✓ **Light bulbs**: As a power-saving measure, begin using the compact fluorescent light bulbs as often as you can. If you are conceiving they are more pricey than the standard bulbs, the gains of the CFL bulbs will prove lots more economic in the long turn by the amount of power they will save. ✓ **Air Conditioning**: Put the temperature at the minimum or maximum strongest you are comfortable with, depending on the season. Try not to put it at too high or too low temperatures. Setting the air conditioner at fair temperatures helps oneself preserve lots of power.	Numerical problem solving Discussion and practice involving the interconversion between kilowatt-hour and joules using the fact that:: 1 kWh = 3 600 000J • Numerical problem solving Discussion and practice in solving problems involving the use of the formula: Cost = # of kWh x cost per kWh • Students can conduct research on energy conservation methods both in the home and in the office.		Worksheets involving numerical problem solving Worksheets involving numerical problem solving Student write up

TOPIC: **ELECTRICAL POWER, ENERGY AND DOMESTIC APPLICATIONS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	✓ **Washers**: Do you use your washing machine as frequently as you wish? Do you use your laundry machine even when there are not plenty garments to wash? Minimize the amount of washings by cleaning a full load of garments every time. ✓ **Television**: Unplug the power plug of your television set when not using it. This may not sound like a big deal but this little step will help oneself save power. ✓ **Water Heater**: Keep the thermostat at the minimal heat. You do not need to heat the water at a very high temperature or for very long. ✓ **Refrigerator**: Bring cooked food to room temperatures before placing it into the refrigerator. You can also spare power by bringing cold or frozen food out of the freezer a great deal ahead of the mealtime, thereby conserving energy in heating it. Source: http://www.squidoo.com/save_energy_now			

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

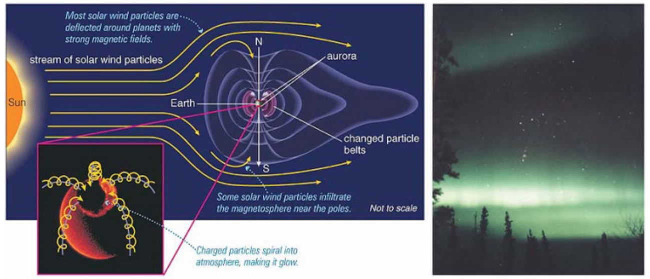
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **MAGNETISM – MAGNETIC FIELDS AND THEORY** **DURATION: 2 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Identify the poles of a magnetic dipole by suspending it freely in the earth's magnetic field	All magnets have two poles: a **'north-seeking'** or **'N'** pole, and a **'south-seeking'** or **'S'** pole. When a magnet is allowed to move freely by being suspended, it always comes to rest roughly in a north–south direction. The north-seeking (N) pole points towards the northern end of the Earth while the south-seeking (S) pole points to the southern end of the Earth.	Practical Activity Suspend bar magnet using a wooden clamp stand or wooden table and allow t to come to rest.	Bar magnet Thread Wooden Clamp stand	Practical Assessment Written Assessment Oral questions
• Classify materials as magnetic and non- magnetic.	Magnets only attract strongly certain materials (ferromagnetics) such as iron, steel, nickel and cobalt, and their alloys	Use magnets to test and classify materials as magnetic or non-magnetic.	Magnets, Assorted materials (iron, brass, copper, lead, steel, gold, silver, nickel, aluminium, nickel, cobalt)	Practical Assessment Written Assessment • Quiz • Worksheet
• Describe the domain theory	Magnets are made up of groups of atoms called **domains**, which behave like magnets within magnets. A magnetic domain is a region in a ferromagnetic material where each atom acts as a small magnet called a dipole. They are grouped together in domains. Domains in an un-magnetised ferromagnetic material are arranged in random directions (haphazardly) and their effects cancel each other out. There is no overall effect. When the ferromagnetic material is exposed to a magnetic field, the domains line up in the magnetic field. All the north poles point in the same direction.	Making Models simulating domain theory using matchsticks or toothpicks Drawing magnetic domains in un-magnetized and magnetized ferro-magnetic materials	Match Sticks/ Toothpicks Paper, markers, pens	Simulation model assessed for accuracy and creativity. Written Assessment • Quiz • Worksheet

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: MAGNETISM & ELECTROMAGNETISM

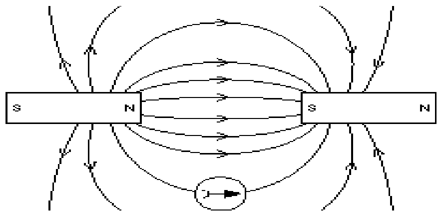
TOPIC: **MAGNETISM –APPLICATIONS OF EARTH'S MAGNETIC FIELD**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
Describe the importance of the earth's magnetic field to life on earth (bird navigation, deflection of charged particles from the sun)	The Earth's strong magnetic field creates a **magnetosphere** that acts like a protective bubble surrounding our planet (see part **a** in figure below). The magnetosphere deflects most of the charged particles from the Sun around our planet. Charged particles trapped in the magnetosphere also create the beautiful spectacle of light we call the **aurora** (see part **b** in figure below).  **a** This diagram shows how Earth's magnetosphere deflects solar wind particles. Some particles accumulate in charged particle belts encircling our planet. The inset is a photo of a ring of auroras around the North Pole; the bright crescent at its left is part of the day side of Earth. **b** This photograph shows the aurora near Yellowknife, Northwest Territories, Canada. In a video, you would see these lights dancing about in the sky. Source: *Cosmic Perspective* by Bennett, Donahue The magnetosphere still allows a few solar wind particles to get through, especially near the magnetic poles. Once inside the magnetosphere, these particles move along magnetic field lines, collecting in **charged particle belts** that encircle our planet. (These belts are often called the Van Allen belts after their discoverer.) The high energies of the particles in charged particle belts can be hazardous to spacecraft and astronauts passing through them	Conducting research on the importance of the earth's magnetic field (magnetosphere) Making models simulating the earth's magnetic field	Source: *Cosmic Perspective* by Bennett, Donahue	Research Project Model depicting simulation of earth's magnetic field

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

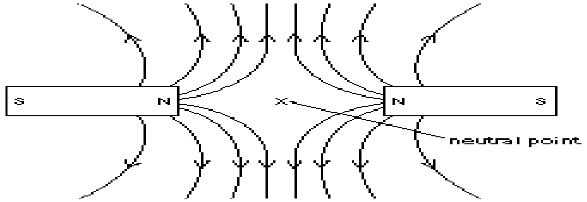
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **MAGNETISM – MAGNETIC FIELDS AND THEORY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Explain the factors determining field strength (closeness of poles, alignment of domains).	Magnetic field refers to the space around a magnet, which produces a magnetic force. (i.e. the area where magnetism acts). The strength of a magnet is determined by how well the domains are lined up. When all the domains are lined up, is termed a saturated magnet and therefore cannot get any stronger. The closer the poles the stronger the magnetic field strength.	Simulation http://www.s-cool.co.uk/gcse/physics/magnetism-and-electromagnetism/magnetism.html Practical demonstrations	Internet Projector Computer	Practical Assessment Written Assessment Oral questions
• Illustrate magnetic lines of force for a bar magnet and between poles of two bar magnets.	Iron fillings may be used to determine the shape of the magnetic field. The magnetic field is represented by field lines or lines of force. When two bar magnets with unlike poles face each other, attraction occurs. North and south poles attract. The field lines go from the N pole of one magnet to the S pole of the other. 	Plotting magnetic fields around magnets (bar, disc, horseshoe) to determine shape and strength of magnetic field Identify the north pole and south poles of magnets. Alternatively bring poles together to observe when attraction or repulsion occurs. Plot field lines between opposite poles. Use plotting compass to determine direction of field lines. Draw magnetic field patterns between magnets with opposite poles facing each other.	Magnets (bar, disc, horseshoe) Iron fillings Paper Bar magnets Plotting compasses Iron fillings paper	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **MAGNETISM – MAGNETIC FIELDS AND THEORY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	When similar poles of two magnets face each, (N pole to N pole) or (S pole to S pole), repulsion occurs. The single point in the centre, in between the two similar poles is a neutral point. At this point, the field due to one magnet cancels out that due to the other and there are no lines of force.  	Plot field lines between similar poles. Use plotting compass to determine direction of field lines Draw magnetic field patterns between magnets with similar and opposite poles facing each other	Bar magnets Plotting compasses Iron fillings paper	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

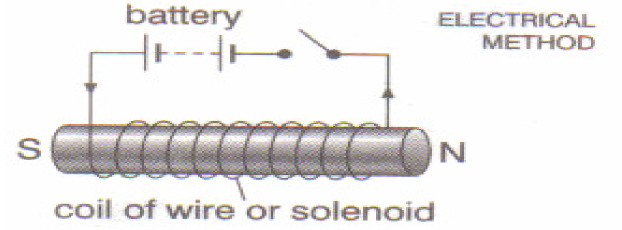
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: MAGNETISM – MAGNETIC FIELDS AND THEORY

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
- Describe and explain the different methods of magnetization.	**Magnets may be made in the following ways:** 1. **By Stroking** … The act of stroking an un-magnetised material in one direction only, with a magnet, lines up each domain, so that they are all 'pointing' in the same direction.	Stoke a piece of un-magnetised steel or iron with the north pole of a bar magnet. Test it to see whether it attracts magnetic materials and use a plotting compass to determine the polarity.	Un-magnetised steel or iron bar, bar magnets, iron fillings, plotting compasses	Practical Assessment Written Assessment Oral questions
	2. **By Magnetic Induction** … In magnetic induction, a magnetic pole induces an unlike pole near to it and a similar pole away from it. When the ferromagnetic material is held close to a magnet, magnetism is induced into the material, allowing it to become a magnet. This induced magnetism is temporary if a magnetically soft material is used and permanent if a magnetically hard material is used.	Attract a paper clip with a bar magnet, then use paper clip with induced magnetism to attract other paper clips.	Bar magnets, paper clips	
- Construct an electromagnet and investigate the factors affecting its strength. - Predict the polarity of electromagnets.	3. **By Electrical Method: using a Solenoid (long coil of wire (to make an electromagnet)** An electromagnet (temporary) magnet is activated by an electric current. When a current is passed through the solenoid, it obtains a magnetic field (which is strongest inside the solenoid). If a bar of magnetically soft iron, called the **core**, is placed inside it, a much stronger magnetic field is attained, enabling the core to become an **electromagnet.**	Wind about 1 metre of insulated copper wire and round a large iron nail. Construct a simple circuit using suitable d.c. power supply (battery), ammeter, connecting wire and switch. Use electromagnet to attract magnetic materials such as iron fillings, paper clips or staples.	Iron nail, insulated copper wire, connecting wires, ammeter, switches Magnetic materials (paper clips, staples, iron fillings)	Assessment of electromagnet for functionality and creativity Written Assessment • Quiz • Worksheet

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **MAGNETISM – MAGNETIC FIELDS AND THEORY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	 The shape of the magnetic field is similar to that of a bar magnet and the polarity obtained by the electromagnet can be found by applying the (1) <u>Right Hand Grip Rule or (2) the</u> <u>Right hand Screw Rule</u> applied to a short length of one turn of the solenoid.	Students determine the polarity of electromagnet		

PHYSICS CURRICULUM
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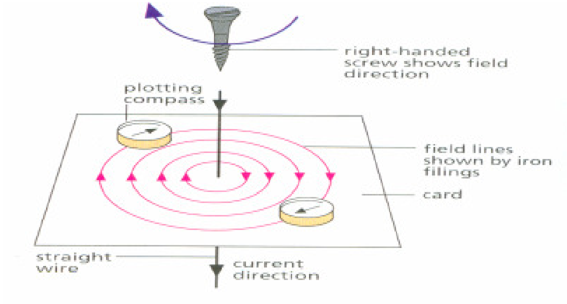
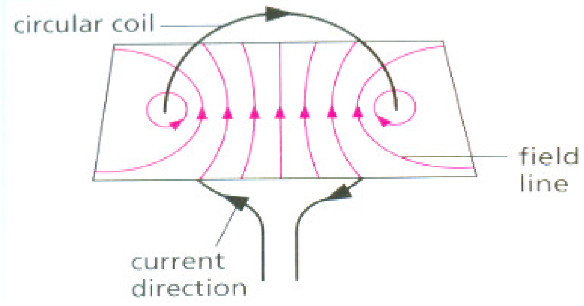
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **MAGNETISM – MAGNETIC FIELDS AND THEORY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe and explain the different methods of demagnetization.	Methods of demagnetizing permanent magnets include: 1. Heating 2. Banging or hitting 3. Alternating Current Heating and hitting makes the particles move vigorously upsetting the alignment of the domains. Using an alternating current slowly breaks up the arrangement of the domains, as the current, and the direction of the magnetic field, are constantly changing direction. Domains arranged haphazardly have no overall magnetic effect.	Magnetize a piece of steel strongly then hammer it and test to see whether it can attract magnetic materials Repeat procedure with magnetized steel using heat and alternating current from a power supply	Magnetized steel bar Hammer, Bunsen burner, a.c. power supply Magnetic materials (iron fillings, paper clips, staples)	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions

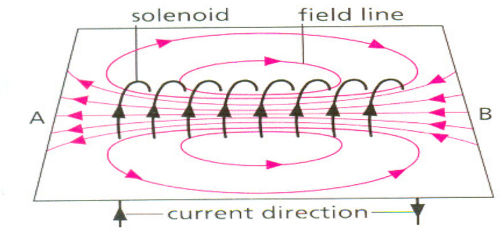
PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **ELECTROMAGNETISM – CURRENT AND MAGNETISM** **DURATION: 2 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
- Describe the magnetic flux pattern for a straight wire, a circular coil and a solenoid each carrying a direct current.	The magnetic field pattern around a straight vertical wire is one of concentric circles. The direction of the magnetic field may be determined by compasses or the Right Hand Screw Rule, which states that if a right-handed screw moves forward in the direction of conventional current, the direction of rotation of the screw gives the direction of the field.  GCSE physics pg. 234 The magnetic field pattern due to a circular coil is shown below:  GCSE physics pg. 235	Pass a large current through a vertical wire with iron fillings sprinkled on a horizontal cardboard. Tap the card lightly and observe magnetic field pattern. Place a small compass on the card to find the direction of the magnetic field Apply the right hand grip rule to confirm the direction of the magnetic field Reverse current direction and repeat Sprinkle iron fillings on a horizontal cardboard into which a coil carrying current has been placed. Tap the card lightly and observe magnetic field pattern. Place a small compass on the card to find the direction of the magnetic field	Power source (d.c. power source/ battery) Straight vertical wire Cardboard Compasses Power source (d.c. power source/ battery) Circular coil Cardboard Compasses Power source (d.c. power source/ battery) Straight vertical wire	Practical Assessment Written Assessment • Quiz • Worksheet - Drawing magnetic fields around straight wires coils or solenoids that carrying current - Predicting the direction of the magnetic field Oral questions

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **ELECTROMAGNETISM – CURRENT AND MAGNETISM**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	A solenoid is a long cylindrical coil of wire. The field pattern is similar to a bar magnet as shown below:  GCSE Physics pg. 235	Sprinkle iron fillings on a horizontal cardboard into which a solenoid has been placed. Tap the card lightly and observe magnetic field pattern. Place a small compass on the card to find the direction of the magnetic field	Cardboard compasses	
• Describe and construct electromagnetic devices e.g. relays, electric bells, circuit breakers, scrap iron lifts.	Electromagnets (usually made of a soft iron core) become magnetised when a current flows through it, causing the soft-iron armature to be attracted to the pole of the electro-magnet. In the case of • an electric bell ... this action causes the hammer to strike the gong. • a relay ... this action completes a secondary circuit. (A relay is a magnetic switch, used so that a small current can switch on a large current).	Practical Activity Construction of simple electromagnetic devices such as relays and electric bells. Research and Present on electromagnetic devices	power supply or batteries, iron rod, connecting wires, ammeters, bell	Students' research, presentations and simple electronic circuits assessed for accuracy, creativity.
• Distinguish between magnetically hard and soft materials.	**A Magnetically Hard** material is one that is difficult to magnetize, but retains its magnetism permanently, once magnetized e.g. steel. **A Magnetically Soft** material is one that is easy to magnetize, but loses its magnetism easily. The magnetism is temporary e.g. iron.	Practical Activity Construction of electromagnets using (soft) iron cores and (hard) steel cores	Iron nail, steel nails, insulated copper wire, connecting wires, ammeter, switches Magnetic materials (paper clips, staples, iron fillings)	Practical Assessment Worksheet

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: MAGNETISM & ELECTROMAGNETISM

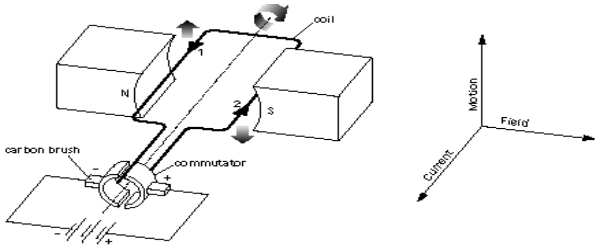
TOPIC: **ELECTROMAGNETISM – CURRENT AND MAGNETISM** **DURATION: 2 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Explain why a rectangular, current carrying coil experiences a couple in a uniform magnetic field.	When a wire carrying a current is placed in a magnetic field, at right angles to the direction of the field, it experiences a force, at right angles to the direction of the current and the direction of the magnetic field. (the motor effect). When a coil carries current in a magnetic field, the current in the coil flows in different directions. A couple (pair of forces, equal in size but opposite in direction) is experienced which pushes one side of the coil upwards and the other side of the coil downwards, causing the coil to rotate.	Practical Activity Place a straight wire carrying a current between the opposite poles of a C-shaped magnet and observe movement Place a coil carrying current between the curved opposite poles of a magnet and observe movement	C –shaped magnet Straight wire Rectangular coil Power supply/ battery pack	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **THE MOTOR EFFECT, ELECTRIC MOTORS & METERS** **DURATION: 2 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe the operation of a d.c. electric motor. • State and describe ways of increasing efficiency of electrical motors (increase current, # of coils, strength of magnet field).	A motor is a rotating device, which converts electrical energy into mechanical/ kinetic energy. Electric motors create motion from an electric current.  A simple direct current (d.c.) motor consists of a rectangular coil of wire mounted on an axle allowing it to rotate between the poles of a c-shaped magnet. Two carbon brushes are connected to an electrical supply. The two ends of the coil are soldered to the two halves of a copper split ring commutator, which reverses the current direction in the coil on each half cycle, ensuring that the motion of the coil is continuous. A couple is formed on each side of the coil which causes the coil to rotate. The momentum of the coil keeps it moving round, even when the coil is in the vertical position and brushes in space between the commutator halves. The two commutator halves automatically change contact from one brush to the other, which reverses the direction of the forces on the sides of the coil.	Simulation http://www.s-cool.co.uk/gcse/physics/magnetism-and-electromagnetism/uses-of-electromagnetism.html Construction of simple d. c. motors using inexpensive materials Construction of fans	Knitting needle Cork Insulated copper wire Bar magnets Power supply/ battery pack Play dough 2 pairs of long pins (New Physics for You, page 293)	Practical Assessment Practical Assessment Assessment of model for functionality and creativity

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: MAGNETISM & ELECTROMAGNETISM

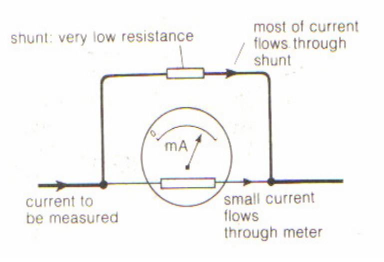
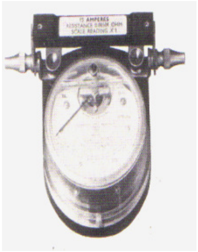
TOPIC: **THE MOTOR EFFECT, ELECTRIC MOTORS & METERS** **DURATION: 2 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• State and describe ways of increasing efficiency of electrical motors (increase current, # of coils, strength of magnet field)	1. Increase the number of turns or loops of wire to make a coil 2. Increase the strength of the magnetic field (use stronger magnets) 3. Increase the current flowing through the loop of wire	Construction of a simple d.c. motor, varying • Magnetic field strengths • number of turns • current • type of core (use of soft iron instead of cork)	Knitting needle Cork, ammeter Insulated copper wire Bar magnets Power supply/ battery pack Play dough 2 pairs of long pins (New Physics for You, page 293)	Assessment of model of electric motors for functionality and creativity
• Apply the motor effect to the operation of the moving coil loudspeaker	The moving coil loudspeaker uses the motor effect to change electrical energy into sound energy. It converts electrical energy to mechanical energy, which vibrates air molecules producing sound. When a current is passed through the coil, it experiences a force, according to Fleming's Left hand rule which makes it and the attached paper cone move in and out, vibrating air molecules.	Simulation http://www.s-cool.co.uk/gcse/physics/magnetism-and-electromagnetism/uses-of-electromagnetism.html Demonstration using Moving Coil loudspeaker	Moving coil loudspeaker	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions
• Describe the operation of the moving coil galvanometer	Electric meters are based on the motor principle that a turning effect can be produced by a passing current through a coil which is in a magnetic field. ➢ Current enters and leaves the coil which is pivoted on jeweled bearings between the poles of a permanent magnet by hairsprings above and below it. This action causes the coil to turn in the magnetic field and the attached pointer to move across the scale.	Correct use of electric meters • Ammeters • Voltmeters • Milliammeters (galvanometers) including centre zero galvanometers	Ammeters Voltmeters Milliammeters (galvanometers including centre zero galvanometers) Simple electrical kits	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **THE MOTOR EFFECT, ELECTRIC MOTORS & METERS** **DURATION: 2 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	• The rotation of the coil is resisted by two spiral springs (called hairsprings) and the coil comes to rest when the couple turning it is balanced by an opposing couple from the springs. • The higher the current the greater the deflection of the coil (the angle turned) and the further the pointer moves on the scale.			
• Explain how a moving coil galvanometer can be modified for use as an ammeter (with the use of shunts)	A galvanometer can be modified for use as an ammeter (in order to measure higher currents), by connecting a resistor called a shunt across its terminals. Shunts usually have very low resistance. Since the shunt has significantly lower resistance than the meter, nearly all of the current entering the combination bypasses the meter and flows through the shunt instead   Explaining Physics (page 285) An ammeter is placed in series in a circuit and has a low resistance compared with the rest of the circuit, otherwise, it changes the current to be measured.	Drawing diagrams showing how galvanometers could be converted into ammeters using shunts placed parallel to it	GCSE Physics, page 243 - 244	Written Assessment Oral questions

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: MAGNETISM & ELECTROMAGNETISM

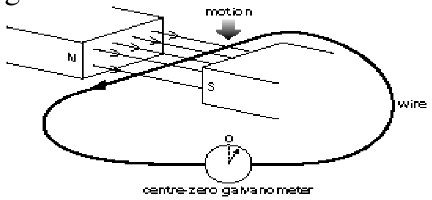
TOPIC: **THE MOTOR EFFECT, ELECTRIC MOTORS & METERS** **DURATION: 2 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Perform calculations to determine the resistance of shunt or multiplier required, given current and voltage of galvanometer and the total current or voltage of the ammeter or voltmeter, respectively.	If the resistance of a galvanometer and its full scale deflection current are known, it is possible to calculate the shunt resistance required to produce an ammeter measuring up to any given current value. 1. Current through shunt = total current meter and shunt – current through meter 2. p.d. across meter = current through meter x resistance of meter (using V = IR) 3. Resistance of the shunt = $\frac{p.d.}{current}$ (using R= V/I) If the resistance of the combination, and the resistance of the galvanometer alone are known, the resistance of the meter can be found. 1. Resistance of combination = p.d across combination / current (using R = V/I) 2. Resistance of multiplier = resistance of combination – resistance of meter	Problem - solving using worksheets to calculate: • Shunt resistance required to make ammeters measuring up to a specified current • Multiplier resistance required to make voltmeters measuring up to a specified voltage	Worksheets	Written Assessment • Quiz • Worksheet

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **ELECTROMAGNETIC INDUCTION & GENERATORS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	**CONTENT**	**ACTIVITIES**	**RESOURCES**	**METHOD OF ASSESSMENT**
Electromagnetic induction • Explain electromagnetic induction as an energy transfer process	Electromagnetic induction is an energy transfer process whereby mechanical/ kinetic energy is converted to electrical energy. Electro-magnetic induction is the process whereby an electromotive force (e.m.f.) or voltage is induced when a conductor moves relative (at right angle) to a magnetic field. If the circuit is a complete one, then a current is also induced.	Simulation http://www.s-cool.co.uk/gcse/physics/magnetism-and-electromagnetism/generating-electricity.html Practical Activity • moving a conductor through the jaws of a horseshoe magnet, • dipping a bar magnet into and out of a solenoid connected to a galvanometer (milli-ammeter)	Internet Computer LCD Projector Straight wire Connecting wires U shaped magnets milliammeter Solenoid Bar magnet	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions
• Describe and demonstrate the induction of an e.m.f. (and hence current in a complete circuit) based on the relative motion of a conductor perpendicular to a magnetic field (& motion of magnet in solenoid)	An electromotive force (e.m.f.) or voltage is induced when a conductor moves at right angles to a magnetic field. The changing magnetic field causes the electrons to start moving.  A voltage can be induced if a magnet is dipped into a coil or solenoid. As a magnet is moved into the coil, the coil cuts field lines all around the magnet, and a current is induced	**Practical Activity** Connect a straight piece of wire to a sensitive milli-ammeter and move the wire vertically in a strong magnetic field **Practical Activity** Connect a solenoid to a centre zero ammeter (milliammeter) and move bar magnet into coil.	Straight wire Connecting wires U shaped magnets milliammeter Solenoid Connecting wires milliammeter Bar magnet	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions

PHYSICS CURRICULUM
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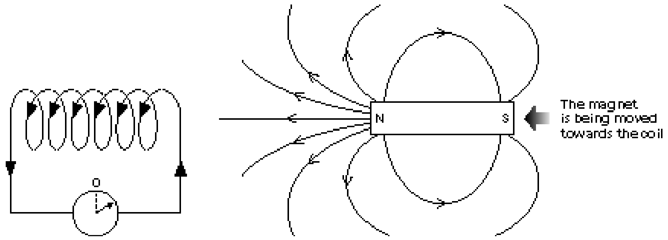
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **ELECTROMAGNETIC INDUCTION & GENERATORS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
				
• State Faraday's Law	Faraday's Law: The magnitude of the induced e.m.f. (voltage) is proportional to the rate at which the wire cuts magnetic field lines (magnetic lines of flux).	**Practical Activity** Connect a solenoid to a centre zero ammeter (milliammeter) and move bar magnet into coil. Observe effect on deflection of pointer of meter when the speed of motion of the bar magnet increases	Solenoid Connecting wires milliammeter Bar magnet	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions
• Use Fleming's right hand rule to determine direction of induced voltage (current) in a conductor moving in a magnetic field.	The direction of the induced current for a straight conductor can be predicted using Fleming's Right Hand Rule. Fleming's Right-hand Rule (for the Dynamo Effect) states that if the thumb, the first finger, and the second finger of the right hand are held at right angles to each other, then; the first finger points in the direction of the Field (N to S), the second finger points in the direction of conventional Current (+ve to –ve), the thumb points in the direction of the Motion of the conductor.	Use Fleming's right hand rule to predict the direction of induced current.		

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UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **ELECTROMAGNETIC INDUCTION & GENERATORS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• State and explain Lenz's Law. (predicting direction of induced current)	Lenz's Law: The direction of an induced current in a circuit is always such as to oppose the change that caused it.	**Practical Activity** Connect a solenoid to a centre zero ammeter (milliammeter) and move bar magnet quickly into coil. Observe effect on deflection of pointer of meter when bar magnet: • Is pushed into solenoid • Is stationary • Is pulled out or removed from solenoid	Solenoid Connecting wires milliammeter Bar magnet	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions
• State and demonstrate factors that affect the magnitude of induced e.m.f. and current in a complete circuit (strength of magnetic field, # of turns on solenoid, speed of motion, cross sectional area of the conductor)	The induced voltage, and therefore the induced current in a circuit, increases if: • The strength of the magnetic field (the stronger the magnetic field, the bigger the induced e.m.f.) • The number of turns of coil for solenoids (the greater the number of coils, the bigger the e.m.f.). • The speed at which wire cuts through the conductor or solenoid (the greater the speed, the greater the induced e.m.f.) • The type of core (a soft iron core increases the value of the e.m.f. since soft iron concentrates field lines and makes an electro-magnet.	Practical Activity Discussion	Solenoid Connecting wires milliammeter Bar magnet Straight wire U shaped magnets	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions

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UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **ELECTROMAGNETIC INDUCTION & GENERATORS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe and demonstrate applications of electromagnetic induction in alternators (a.c. generators) and (d.c generators/dynamos, Eddy-heating stoves, furnaces)	A generator is a machine which converts rotational (mechanical) energy into electrical energy. A generator consists of loops or coils of wire, which rotates in a magnetic field. As the coil(s) rotates, it cuts the magnetic field and a voltage is induced across it. This voltage causes a current to flow. • In a.c. generators, slip rings are connected to carbon brushes. The reason the slip rings are used is so that the wire does not get tangled when it rotates. • In d.c. generators or dynamos, the slip ring is segmented (i.e. split ring commutator is used like the electric motor).	Practical Demonstration Construction of simple d. c. and a. c. generators Connecting a bicycle dynamo to a lamp Students research the applications of electromagnetic induction in: ✓ a.c generators ✓ d.c generators ✓ eddy-heating stoves and furnaces	Dynamo Lamps Magnets Coils of wire Connecting wire Carbon brushes Slip rings Lamps	Assessment of model of electromagnet for functionality and creativity

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UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **ELECTROMAGNETIC INDUCTION & GENERATORS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT		ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	d.c.	**a.c.**			
• State the advantages and disadvantages of alternating and direct current.	Fixed direction	Reverses direction	Simulation http://www.s-cool.co.uk/gcse/physics/static-and-current-electricity/electricity-at-home.html Demonstration of electrolysis using d.c. Construction of simple electronic circuits using diodes in simple circuits	Internet LCD projector Electrolysis kit Junior electronic circuit kits http://www.electronickits.com/kit/complete/science/sc300.htm	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions
	May be steady in magnitude from a given source	Varies between reversals of polarity			
	Its value cannot be stepped up (increased) or stepped down (decreased) by a transformer	Its value can be stepped up (increased) or stepped down (decreased) by a transformer			
	Has an associated lighting, heating and magnetic effect	Has an associated lighting, heating and magnetic effect			
	Has an associated chemical effect (can be used in electrolysis, electroplating and battery charging)	Does not have an associated chemical effect (cannot be used in electrolysis, electroplating and battery charging)			
		Can be converted to d.c using rectifiers			

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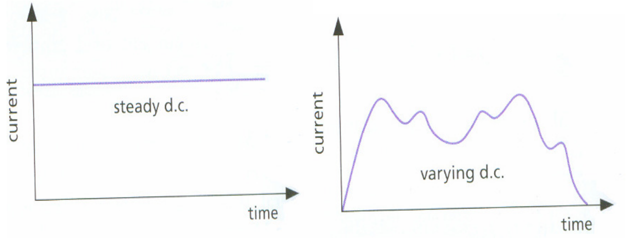
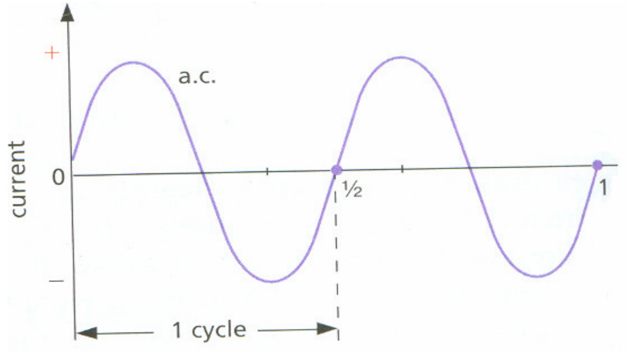
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **ELECTROMAGNETIC INDUCTION & GENERATORS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Represent both d.c. and a.c. on current-time & voltage -time graphs and deduce peak values and frequencies from a.c.	In a direct current, electrons flow in one direction only. **Direct current** may be steady or fluctuate (vary).  **GCSE physics pg. 200** **Alternating current (a.c)** is an electric current which reverses its direction of flow in periodic cycles. Electrons first start to flow in one direction until the current reaches a maximum value, then the current slows down and stops. The electrons then start to flow in the opposite direction until the current reaches the same maximum value.  **GCSE physics pg. 200**	Use of the Cathode Ray Tube/ Oscilloscope to observe the of output of • Direct current (d.c) • Alternating current (a.c.) Plotting current against time and voltage against time for d.c and a.c. Worksheet Calculating: • period (T) and frequency (f) of an a.c. • peak voltage of a.c.	Cathode ray oscilloscope Power supply Signal generator Connecting wire Dynamo	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions

PHYSICS CURRICULUM
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UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **ELECTROMAGNETIC INDUCTION & GENERATORS** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	The peak voltage of an alternating current is the value of the crest/ peak or trough of its alternating waveform The number of cycles in one second (called the frequency) is given in a unit called Hertz (symbol Hz) where 1 Hz = 1 cycle per second.			
• Describe local methods of power production (wind, fossil fuels).	Solar … energy received directly from the sun mainly in the form of light, infrared and ultraviolet radiation, may be converted into electrical energy photovoltaic panels and solar thermal collectors. Wind … windmills can be used to convert wind energy into electrical energy. Hydro-electric …water stored in dams can be used to generate electricity Bio-fuels refer to fuels derived from plant and animal materials or their waste, due to the chemical energy stored in their tissues.	Construction of Models utilizing alternative energy sources in the generating of electrical energy Debates Presentations Designing of posters and pamphlets	Resources and materials are student generated and will therefore vary	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions
• Research and compare mains voltage & frequencies used in homes. (mainly 110 V and 60 Hz in the Bahamas).	Mains electricity in The Bahamas is mainly supplied at 110 V and 60 Hz (60 cycles per second), whereas in the UK, it is supplied as 240 and 50 Hz (50 cycles per second).	Research Visit to BEC's power plant		Written Assessment • Quiz • Worksheet Field Trip Report

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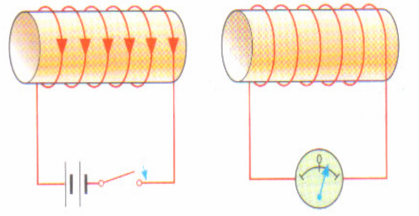
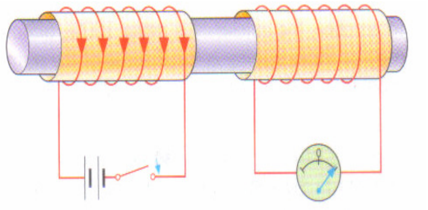
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **TRANSFORMERS & OTHER APPLICATIONS OF ELECTROMAGNETIC INDUCTION** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Explain the principle of operation of transformers. (mutual induction)	A transformer changes the voltage of an alternating current without changing the frequency of the supply. Transformers operate on the principle of electromagnetic induction. When an alternating p.d. is applied to the primary coils, the resulting current produces a large alternating magnetic field or flux which reaches the secondary coils and induces an e.m.f. in it. The magnitude of the induced e.m.f. depends on: (1) the p.d. applied to the primary and (2) the relative number of turns Np and Ns, comprising the primary and secondary coils, respectively.	Construction of a simple transformer by placing two coils side by side.  New Physics for you (page 301) Repeat placing a soft-iron core through coils  New Physics for you (page 301) Demonstration of the action of transformers (demonstration only due to the danger associated with high voltages) New Physics for you (page 302)	Solenoid Insulated copper wire Centre-zero galvanometer a.c./ d.c power supply	Practical Assessment Written Assessment • Quiz • Worksheet Oral questions

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: _**TRANSFORMERS & OTHER APPLICATIONS OF ELECTROMAGNETIC INDUCTION**

LEARNER OUTCOMES	CONTENT		ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	SOME CAUSES OF POWER LOSS IN TRANSFORMERS	**DESIGN FEATURES TO REDUCE POWER LOSS (INCREASE EFFICIENCY)**			
• Describe the sources of power losses in real transformers and ways of minimizing these losses.	Heating effect of the current in the wires of the coils. (power loss in each coil = I^2R where R is the resistance of the wire in each loop)	Thick copper wire of low resistance	Research Presentation Graphic Organisers Concept maps Examination of concrete models	- Resources will vary -	Practical Assessment Written Assessment • Quiz • Worksheet Students' research, presentations and portfolios assessed for accuracy, creativity
	Heating effect of "eddy" currents (swirling, circular current) induced in the iron core. (power loss in each coil = I^2R where R is the resistance of a closed loop in the iron core where eddy currents flow)	The iron core is laminated, cutting across the path of any eddy current. The high resistance between the laminations greatly reduces the eddy currents and the heat they would produce.			
	Energy is used in the process of magnetizing the iron core and reversing the magnetization every time the current reverses. This energy appears as heat.	The core is made of soft iron which is very easily magnetised and demagnetized by the magnetic field of the primary coil.			
	Some of the magnetic field lines produced by the primary coil do not link with the secondary coil, reducing the e.m.f. in the secondary coil.	The core is designed for maximum linkage between the primary and secondary coils. The common method is to wind the secondary coil over the primary coil. The iron core must always be in the form of a closed loop.			

PHYSICS CURRICULUM
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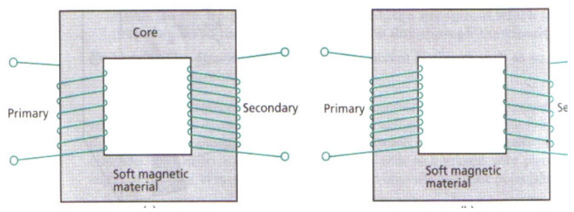
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: _**TRANSFORMERS & OTHER APPLICATIONS OF ELECTROMAGNETIC INDUCTION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
- Distinguish between real and ideal transformers	An ideal transformer is defined as one for which the input and output powers are equal. i.e. $P_{out} = P_{in}$ ∴ $P_s = P_p$ (since the secondary circuit is the output circuit and the primary circuit is the input circuit) **[Since P= IV]** $I_sV_s = I_pV_p$	Worksheet Finding power, current and/or voltage on primary or secondary coil, assuming transformers are ideal.	Worksheet	Practical Assessment Written Assessment - Quiz - Worksheet Oral questions
- Distinguish between step up and step down transformers	 **Step Up Transformer** **Step Down Transformer** **Lett's Revise GCSE Physics Review pg. 116** The transformer is said to be a **step-up** one if n_s is greater than n_p. The voltage in the secondary coil exceeds that on the primary if there are more turns on the secondary coil, the current in the secondary is less than in the primary since power is same. The transformer is said to be a **step-down** one if n_s is less than $n_{p.}$ The voltage in the secondary coil is less than in the primary if there are fewer turns on the secondary coil, but the current in the secondary is greater than in the primary.	Use and examination of step-up and step down transformers Drawing of step-up and step-down transformers	Assortment of step –up and step-down transformers	Practical Assessment Written Assessment - Quiz - Worksheet Oral questions

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **TRANSFORMERS & OTHER APPLICATIONS OF ELECTROMAGNETIC INDUCTION** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Apply the relationship $\frac{Vs}{Vp}=\frac{Ns}{Np}$ to solve turns ratio & voltage problems	$\frac{Vs}{Vp}=\frac{Ns}{Np}$ where V_s - voltage across secondary coil V_p - voltage across primary coil N_s - number of turns on secondary coil N_p - number of turns on primary coil	Problem solving using $\frac{Vs}{Vp}=\frac{Ns}{Np}$ to solve turns ratio and voltage problems	Worksheet	Written Assessment • Quiz • Worksheet
• Express electrical power, (rate of energy transferred) as a product of voltage and current (P = VI) and apply relationship in solving numeric problems	(Electrical) power refers the amount of (electrical) energy that is transferred every second. P = Power is measured in watts (W) or joules/ second (J/s). The power of an appliance is related to the potential difference (v) across it and the current (I) flowing through it, by the equation: Power, P (in watts) = Current, I (in Amperes) x Potential difference, V (in volts) **P =IV**	Problem solving using $P = \frac{E}{t}$ and P =IV to solve problems related to power, energy and time Problem solving using P = IV to solve problems related to power, current and voltage	Worksheet Worksheet	Written Assessment • Quiz • Worksheet
• Apply the relationship $V_p I_p = V_s I_s$ to perform current/ voltage calculations for an ideal transformer	An ideal transformer is defined as on for which the input and output powers are equal**. i.e.** $\mathbf{P_{out} = P_{in}}$ $\therefore$ $\mathbf{P_s = P_p}$ (since the secondary circuit is the output circuit and the primary circuit is the input circuit) [**Since P= IV**] $\mathbf{I_sV_s = I_pV_p}$	Solve problems assuming transformers are ideal	Worksheet	Written Assessment • Quiz • Worksheet

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

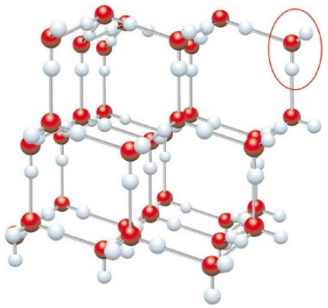
UNIT: MAGNETISM & ELECTROMAGNETISM

TOPIC: **TRANSFORMERS & OTHER APPLICATIONS OF ELECTROMAGNETIC INDUCTION** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe common uses of transformers (in the home, long distance transmission of power-national grid).	- Transformers are used for long distance transmission of electrical power. The National Grid system uses high voltages in power cables to save on energy losses. The high voltages are produced using step-up transformers, and at the end of the line, step-down transformers in substations are used to bring the voltage down to 110V. - To get low voltages from the mains 110V a.c., e.g. for radios. - To get high voltages from the mains, e.g. for TV. • Other uses of transformers include: ✓ Computer network interface cards, ✓ Modems, ✓ Power amplifiers ✓ Microwave ovens, ✓ Car and marine ignition systems, ✓ Tesla coils and moving coil	Student based research on use of transformers Making models of the National Grid System (GCSE Physics page 253)	Power supply Retort stand and clamps Transformers Lamps	Written Assessment • Quiz • Worksheet

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: THE ATOM & NUCLEAR PHYSICS

TOPIC: **THE ATOM** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
1 THE ATOMIC THEORY • State the Atomic Theory	**The Atomic Theory:** According to the Atomic Theory - Matter is made up of tiny particles. - The particles cannot be destroyed by chemical means. - Atoms of the same element are alike; atoms of different elements are different. **Definition of an element** An element is a substance that is made up of one kind of matter only (e.g. aluminium and sulphur are elements because the former consists of aluminium only and the latter sulphur only; water is not an element since it consists of two different kinds of substances, hydrogen and oxygen). **Definition of atom** An atom is the smallest particle of an element that retains the chemical properties of the element.	**1. Making and displaying models** (What the Atomic Theory puts forward is a particle model of matter. There are other models (e.g. wave-probability model). Using polystyrene balls you (or students) can make and display models of - elements (similar balls stuck together) and - substances that are not elements but combinations of elements e.g. ice (the building block water molecule model should also be pointed out) **2 Looking at "photographs" of atoms** (note that these are not photographs taken with light, so they do not represent what atoms look like; the "pictures", taken with special devices only provide evidence to support the particle model of matter).	**Models depicting matter being made up of atoms** These could be made ahead of time or during class time, using polystyrene balls of at least two different sizes and some method of attaching polystyrene balls together.  Model of ice (made up of H_2O molecules) http://www.oup.co.uk/oxed/children/oise/pictures/atoms/ice/ **"Photographs" of atoms** "Picture" of atoms (e.g.) http://www.physik.uni-augsburg.de/exp6/imagegallery/afmimages/atoms.jpg Background for Teacher: *Physics for CSEC*, by Farley and Trotz, ch. 35	Statement of Atomic Theory Definition of element Definition of atom Identifying atoms in pictures and models Making of atomic models of matter

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: THE ATOM & NUCLEAR PHYSICS

TOPIC: **THE ATOM**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
2 STRUCTURE OF THE ATOM • Describe the importance of alpha particle scattering experiments with regard to the structure of the atom • Describe the structure of an atom (review: nucleus, proton, neutron, electron, orbits)	**The Geiger-Marsden Experiment (Geiger and Marsden were Rutherford's research assistants)** In this experiment, positively charged alpha (α) particles (helium nuclei) were aimed at very thin sheets of gold foil. - The fact that most of the particles went straight through the foil suggested that most of the atom was an empty space. - Since and only a few alpha particles were scattered, this suggested that: an atom has a very heavy, but very tiny, positively charged part (which is now called the nucleus). The experiment confirmed that the atom contained a positively charged, but heavy and tiny nucleus. The experiment showed that an existing "plum pudding" model of the atom, where positive charge in the atom was assumed spread out as a cloud within the atom, could not be correct.	**1 Simulation of α particle scattering** Show students how to operate the simulation. There are two models being simulated – paths taken by alpha particles according to a nuclear (Rutherford) model, and also according to a "plum pudding" model - Most of the alpha particles show straight, or nearly straight, paths. Very few are deflected backwards, confirming the Rutherford model. - All the alpha particles go straight through in the plum pudding model. This shows that there are no heavy, positive scattering centres.	**Alpha-particle scattering simulation** Click on the link below. **http://phet.colorado.edu/simulations/** Then type 'Rutherford scattering' in the search bar and click on the simulations link that shows up. Run both simulations for the Rutherford atom and the plum-pudding atom models. *Physics for CSEC*, by Farley and Trotz, ch. 35	Inferring location of nuclei from paths taken by alpha particles Predicting paths of alpha particles, given location of heavy nuclei Drawing and labeling the Geiger-Marsden apparatus

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: THE ATOM & NUCLEAR PHYSICS

TOPIC: **THE ATOM**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe the properties of sub-atomic particles	**Structure of the atom** In 1932, James Chadwick discovered the neutron in the nucleus. The neutron had almost the same mass as a proton, but had no charge. It is believed that neutrons help to keep the protons together in the nucleus (protons are positively charged and would have repelled each other, causing the nucleus to break up). The atom was now believed to be made up of a tiny, but heavy, nucleus, consisting of positively charged protons and zero charged neutrons; negatively charged electrons orbited the nucleus. Since atoms are neutral, the number of positive charges (protons) are equal to the number of negative charges (electrons).	**2 Making / displaying polystyrene models of the atom** **3 Discussing diagrams of the simple atom from textbook** **4 Drawing diagrams of simple atoms** (showing: nucleus, protons, neutrons, orbits and electrons)	**Models depicting structure of the atom** These could be made ahead of time or during class time, using polystyrene balls and wire 'orbits' containing 'electrons'. *Physics for CSEC*, by Farley and Trotz, ch. 35 and ch. 36, p 505	Drawing an atom and labeling the parts
	Properties of sub-atomic particles Charge Electron (-*e*) Proton (+*e*) Neutron (0) where $e = 1.6 \times 10^{-19}$ C Mass units/u Mass/kg Mass Electron 9.11×10^{-31} 0 Proton 1.67×10^{-27} 1 Neutron _1.67×10^{-27} 1	**5 Discussion** Point out that - the proton and the neutron each has a mass that is about 2000 times that the mass of an electron - the mass unit, u, is 1/12 the mass of a carbon-12 atom and that 1 u = 1.66×10^{-27} kg. However, the values of these masses in kg do not need to be memorized.	**Properties of sub-atomic particles** See, for example, *Physics for CSEC*, by Farley and Trotz, ch. 36, p 503-504	Stating properties of sub-atomic particles on terms of *e* and u.

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: THE ATOM & NUCLEAR PHYSICS

TOPIC: **THE ATOM**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
3. DESCRIBING THE NUCLEUS - Define the terms: atomic number (Z), mass number (A), neutron number (X)	**Numbers describing the nucleus** - Atomic number (Z); the number of protons in the nucleus (this will also be the same as the number of electrons orbiting a neutral atom, and it is this number of electrons that determines the chemical character of each element). - Mass number (A): the total number of particles (protons + neutrons) in the nucleus. The mass number gives an idea of the total mass of an atom, since the electrons have negligible mass. - Neutron number (X): the number of neutrons within a nucleus. A simple reasoning shows that $\mathbf{A = Z + X}$ **Nuclear symbols** Nuclear symbols are written by placing the mass number as a superscript and the atomic number as a subscript on the left of the chemical symbol of the element. Thus, the carbon-12 nucleus is written as $^{12}_{6}$C, since the carbon-12 nucleus has 6 protons and 6 neutrons.	**1 Building/displaying models of simple nuclei** (e.g He, C, N) **2 Writing nuclear symbols** (using atomic number and mass number information from Periodic Table). **3 Using the equation** $\mathbf{A = Z + X}$	**Models of nuclei** These could be made ahead of time or during class time, using polystyrene balls and some method of gluing them together. **Periodic Table** *Physics for CSEC*, by Farley and Trotz, ch. 36, p 509	**Defining atomic number, mass number and neutron number** **Using the equation** $\mathbf{A = Z + X}$ **Writing nuclear symbols** (using atomic number and mass number information from Periodic Table).
- Define isotopes, noting that isotopes of the same element have identical chemical properties, and give examples of isotopes including radioisotopes	**Isotope** Isotopes of an element have atoms that have the same number of protons but different numbers of neutrons. Thus isotopes of an element have the same atomic number (hence the same chemical properties) but different mass numbers. Some isotopes are radioactive (more on this later).	**4 Building/drawing models of isotopes** (e.g. C-12 and C-14)		**Defining isotope** **Identifying isotopes** (from Periodic Table)

PHYSICS CURRICULUM
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UNIT: THE ATOM & NUCLEAR PHYSICS

TOPIC: **RADIOACTIVITY** **DURATION: 2 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
4 RADIOACTIVITY • Design and perform investigations on naturally occurring radioactivity in the environment	**Discovery of naturally occurring radioactivity** Natural radioactivity was discovered quite by chance in 1896 by the French scientist, Henri Becquerel. Shortly after, Ernest Rutherford, experimenting in Canada, and Marie and Pierre Curie, experimenting in France, investigated	**Investigations** In all investigations, we must pay attention to controlling variables. We suggest using only materials common to our environment as other radioactive materials are too dangerous for high school demonstrations or experiments.	**Geiger-Muller tube attached to ratemeter or counter and metre rule** **Foodstuffs to be investigated** - e.g. tea bags	**Laboratory investigation designs and reports**
• Account for the presence of background radiation. (cosmic rays, earth-minerals, foods, etc)	**Sources of naturally occurring radioactivity** These include - cosmic rays (charged particles e.g. protons that reach the Earth from space; one source of cosmic rays is the Sun) - minerals that make up the Earth (especially, but not restricted to, those with large mass numbers e.g uranium-235) - foods, objects and living organisms (since these are made from minerals that come from the Earth)	**1 Measuring background radiation** - using a Geiger-Muller tube connected to a counter or ratemeter, you can measure the background radiation in places such as the lab or outdoors. **2 Other investigations** It is said that the food we eat does emit radiation. One such investigation is described in *Physics for CSEC*, by Farley and Trotz, p 575.	*Physics for CSEC*, by Farley and Trotz, ch. 37	
• Describe the detection of radioactive emissions using GM tube, ratemeter/counter and cloud chamber	**Detection of radioactivity** First detected (by Becquerel) by fogging that the emissions produced on photographic film. Later, other detectors were developed such as: - the Geiger-Muller tube that could assist in determining the number of emissions detected, and	**3 Discussions** - how the GM tube works - how cloud chambers work	**Geiger-Muller tube attached to ratemeter or counter** **Pictures of cloud chambers**	**Drawing labeled diagrams of GM tube and cloud chambers** **Outlining the functioning of the GM tube and ratemeter, and cloud chambers**

PHYSICS CURRICULUM
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UNIT: THE ATOM & NUCLEAR PHYSICS

TOPIC: **_RADIOACTIVITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	- cloud chambers that could show the tracks of these emissions (through no fields or through electric or magnetic fields).			
• Describe and compare alpha, beta, gamma radiation in terms **of** their nature, penetration ability, ionization effects, deflection by electric & magnetic fields, speeds	**Nature of radioactive emissions** Rutherford's investigations identified three types of emissions radiated from the nucleus: - alpha particles (helium nuclei) - beta particles (high speed electrons coming from the nucleus) - gamma rays (high energy electromagnetic waves emitted by the nucleus. **Harm caused by radioactivity**	**4 Discussion** Using the textbook, lead discussions on comparing the three types of radiations in terms of - nature - penetrating ability (ranges in different materials) - ionization effects - deflection by electric fields - deflection by magnetic fields		**Inferring the signs of charges given the paths they take as they enter** **- electric fields** **- magnetic fields** **Predicting the paths of charges given the direction of fields they enter** **- electric fields** **- magnetic fields**
• Describe safety precautions to protect from harmful radiation	Radioactivity is extremely dangerous. What makes it so dangerous is that its effects are not usually felt at the time of contact but manifests later. - on entering living matter, alpha particles ionize matter, disrupting cell functioning; when they come to a stop, they also give up their energy and cause cells to overheat. Since alpha particles have short range, most of the damage is to the outer layer of the skin. - beta particles penetrate deeper into living tissue and also disrupt ionic reactions within cells - gamma rays are not only the most penetrating of the three, but also damage chromosomes, affecting cell functions, including reproduction	**5 Discussion** Harm caused by radioactivity **6 Discussion** Protective measures when handling radioactive materials	**Pictures from internet or books** (showing harm caused to humans and other life forms by radioactivity) **Pictures from internet or books** (showing protective procedures and/or wear during handling of radioactive materials)	**Describing harm caused by radiation** **Describing protective actions and wear when handling radioactive materials.**

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UNIT: THE ATOM & NUCLEAR PHYSICS

TOPIC: **_RADIOACTIVITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Symptoms of radiation sickness include: loss of body hair, nausea, a feeling of exhaustion, drop in white blood-cell count and sterility after overexposure **Protection from harmful radioactivity** Clearly, only trained persons should be handling radioactive materials. Materials should be handled with tools - never with bare hands, lead aprons should be worn, sources should never be pointed toward users or other living organisms, monitoring devices and alarms should be present, there should be no eating or drinking, and radioactive materials must be locked away in lead containers when not in use.			
5 RADIOACTIVE DECAY EQUATIONS • Write and balance equations for alpha, beta and gamma decay • Account for the changes if any in atomic number or mass number for alpha and beta and gamma decay	**About radioactive decay equations** Two simple rules to follow when writing decay equations are: - the total mass number on the left-hand-side must be equal to the total mass number on the right-hand side (i.e. mass number must be conserved) - the total atomic number on the left-hand-side must be equal to the total atomic number on the right-hand side (i.e. charge must be conserved)	**1 Balancing radioactive decay equations e.g.** - alpha decay of americium-241 (americium 241 is used in smoke-detector alarms) - beta decay of sodium-24 (a weak source of sodium-24 is used as a radioactive tracer to monitor blood flow) - gamma decay of cobalt-60 (cobalt-60 is used to "see through" baggage at airports and through the body the way x-rays work)	**Periodic Table Chart** (to help students identify elements from their atomic numbers)	**Writing and balancing radioactive decay equations** **Predicting daughter elements produced from alpha, beta and gamma decay of given elements** **Inferring parent elements given nature of emission and daughter elements**

TOPIC: **_RADIOACTIVITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Alpha decay example ${}^{226}_{88}\text{Ra} \longrightarrow {}^{222}_{86}\text{Rn} + {}^{4}_{2}\text{He}$ **radium-226 radon-222 helium-4 (α particle)** Mass number check: 226 = 222 + 4 Atomic number check: 88 = 86 + 2 **Beta decay example** ${}^{14}_{6}\text{C} \longrightarrow {}^{14}_{7}\text{N} + {}^{0}_{-1}\text{e}$ **carbon-14 nitrogen-14 beta particle (β)** Mass number check: 14 = 14 + 0 Atomic number check: 6 = 7 + (-i) **Gamma decay example** ${}^{222}_{86}\text{Rn} \longrightarrow {}^{222}_{86}\text{Rn} + {}^{0}_{0}\gamma$ **radon-222 radon-222 gamma ray photon** Mass number check: 222 = 222 + 0 Atomic number check: 86 = 86 + 0 (gamma rays are electromagnetic waves and have no mass or charge)	**2 Simulation** Run the alpha particle decay simulation of polonium-211	**Beta decay simulation** Click on the link below. **http://phet.colorado.edu/simulations/** Then type 'alpha decay' in the search bar to find the alpha decay of polonium-211 *Physics for CSEC*, by Farley and Trotz, ch. 37	

TOPIC: **_RADIOACTIVITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
6 HALF-LIFE - Define half-life	**Why half life?** Radioactive decay is a random process. This means that we cannot tell exactly when a particular atom will decay (i.e. its 'life'). An atom might decay in 5 minutes; its neighbour might decay in 5 million years. However, for a large sample of atoms of a given element, the time taken for half the sample to decay is constant. This time is called the half-life of the sample. It has also been found that the rate of decay is proportional to the quantity of undecayed atoms in a sample. Therefore half-life can be determined practically by measuring the time taken for the rate of decay of a sample to drop by half. We measure rate of decay in becquerels (Bq), where 1 Bq = 1 decay per second. Decay rate is also called 'activity'. Another unit of decay rate is the curie (Ci) where 1 Ci = 3.7 x 10^{10} decays per second.	**1 Simulation of beta decay** (showing random nature of decay) Run the simulation on 'beta decay' to show the random nature of radioactive decay. **2 Determining half-life from simulation** The simulation in 1 above will give the half-life of the element (see the red line). Pause the simulation when half of the sample has decayed. Read the time taken and compare it with the given half-life. Do this several times using 10 atoms and find the average. Repeat with 100 atoms and find the average. Do we get more consistent results of half-life if the sample size is large or small?		
- Solve radioactive decay problems based on numerical data of half-life	**Solving decay problems based on numerical data** To find the half-life, we must divide the total time of decay by the number of half-lives that occurred during the decay. (See example on right.)			

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UNIT: THE ATOM & NUCLEAR PHYSICS

TOPIC: _**RADIOACTIVITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Determine half-life of a radioactive isotope from a decay graph • Distinguish between observed and corrected count rate (subtracting background radiation) • Explain dating methods using carbon-14 and calculate age of dead organic materials	**Experimental determination of half-life** This could be done by plotting a graph of corrected activity vs. time for a sample. (Corrected activity is observed activity minus background activity.) See graphs in textbook. **Radioactive dating** Knowing the present activity per gram of a sample and the graph of activity per gram vs. time for the material, we can determine the age of the sample.	**3 Solving decay problems based on numerical data** The initial activity of a sample is 80 Bq. After 500 minutes, the activity drops to 20 Bq. Determine the half-life of the sample. Solution From 80 Bq to 40 Bq to 20 Bq represents 2 half-lives. Hence one half-life = 500 mins ÷ 2 = 250 mins. **4 Experimental determination of half-life** (not to be done experimentally at high-school level on account of dangers present) **5 Determining half-life graphically** **6 Determining age of a piece of ancient wood** An example of archaeological dating, using an activity per gram vs. time graph, is discussed in *Physics for CSEC*, by Farley and Trotz, pp 529-530. **7 Radioactive dating game simulation** Play the radioactive dating game.		

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TOPIC: **RADIOACTIVITY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
			Simulation of beta decay Click on the link below. **http://phet.colorado.edu/simulations/** Then type ‘beta decay’ in the search bar to find the beta decay simulation. *Physics for CSEC*, by Farley and Trotz, ch. 38 *Physics for CSEC*, by Farley and Trotz, ch. 38 **Radioactive dating game simulation** Click on the link below. **http://phet.colorado.edu/simulations/** Then type ‘radioactive dating game’ in the search bar to find the games and simulations.	**Defining ‘half-life’.** **Determining half-life from a simulation which shows decays** **Solving problems based on half life using numerical data** **Defining ‘corrected count rate’** **Interpreting activity vs. time graphs** - determining half life - predicting activity for a future time **Using activity vs. time graphs to determine ages of samples**

PHYSICS CURRICULUM
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UNIT: THE ATOM & NUCLEAR PHYSICS

TOPIC: **NUCLEAR ENERGY** DURATION: **1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
7 ENERGY FROM THE NUCLEUS • Distinguish between nuclear fission and nuclear fusion (with the use of equations) • Recognize that energy released from fission or fusion is obtained from mass being converted to energy according to $E = mc^2$. • Explain how nuclear chain reactions occur.(including criteria for sustained chain reactions-purity of radioactive fuel, critical mass- the minimum amount of substance required for a sustained chain reaction)	**Albert Einstein and $E = mc^2$** In 1905, Einstein proposed the mass-energy equivalence equation, $E = mc^2$ **Energy by nuclear fission** Otto Hahn, Lise Meitner and Fritz Straussmann demonstrated that a large nucleus (e.g. $^{235}_{92}U$), when bobbarded with a slow-moving neutron, broke into two large pieces (i.e. underwent fission) and released, not only other neutrons, but also large amounts of energy. The equation for this reaction is shown below: $^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{144}_{56}Ba + {}^{90}_{36}U + 2\,{}^{1}_{0}n$ + energy **Chain reaction** The 2 neutrons liberated in the above reaction could produce fission in other uranium-235 nuclei present, resulting in a chain reaction, since these nuclei would also be liberating neutrons during fission. However, the fuel ore is a mixture of uranium-235 (which undergoes fission) and uranium-238 (which does not). To sustain a chain reaction, there must be enough of uranium-235 atoms i.e. a critical mass of uranium-235 present. That is why the ore must be purified (using centrifuges) so as to	**1 Calculation of energy from mass** Calculations of energies obtained from given masses **2 Discussing pictures showing fission** **3 Viewing and discussing simulation of nuclear reaction** **4 Calculating energy released from a nuclear reaction** By inserting atomic masses in the fission equation shown in column 2, it can be shown that the total mass on the right is less than the total mass on the left. The mass that has 'disappeared' has been converted into energy which can be calculated using $E = mc^2$.	**Pictures showing nuclear fission** Taken from textbooks or internet **Nuclear fission simulation** Click on the link below. **http://phet.colorado.edu/simulations/** Then type 'nuclear fission' in the search bar to find the simulation. The following can be done: - fission of one nucleus - chain reaction (you can manipulate the 'purity' of the sample by mixing $^{235}_{92}U$ and $^{238}_{92}U$ in different ratios to demonstrate the concept of 'critical mass'	**Defining terms** fission, fusion, chain-reaction and critical mass **Calculating nuclear energy** - using $E = mc^2$ - from nuclear fission equations - from nuclear fusion equations

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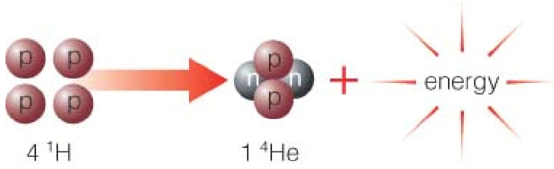
UNIT: THE ATOM & NUCLEAR PHYSICS

TOPIC: **NUCLEAR ENERGY** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
- Describe the main design features of a fission nuclear power plant	increase the percentage of uranium-235 present in the fuel such that a critical mass of uranium-235 is present. **Energy by nuclear fusion** In nuclear fusion, two light nuclei (e.g. hydrogen-2, also called 'deuterium') are made to collide and fuse. Energy is released, as the equation shows below: $^{2}_{1}H + ^{2}_{1}H \longrightarrow ^{3}_{2}He + ^{1}_{0}n$ + energy It has not yet been possible to control nuclear fusion so that energy can be obtained at a safe rate. The sun produces energy through a process called nuclear fusion. This is the process of combining nuclei to make a nucleus with a greater number of protons or neutrons. The nuclear fusion in the sun is summarized below 	**5 Viewing / manipulating a nuclear power plant simulation**	**Nuclear power plant simulation** Click on the link below. **http://phet.colorado.edu/simulations/** Then type 'nuclear fission' in the search bar to find the simulation. Then click on the tab 'nuclear reactor' when the simulation appears. - nuclear reactor (you actually get to raise or lower the control rods and see the effect on the reaction rate and power output) *Physics for CSEC*, by Farley and Trotz, ch. 39	**Describing how a nuclear power plant works** - drawing and labeling of structure - describing features of the design (including safety features)

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TOPIC: **NUCLEAR ENERGY** **DURATION: 1 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	Nuclear power plant The main design features are described in *Physics for CSEC*, by Farley and Trotz, pp 538-539 as follows: - The r**eactor** (fuel rods are used rather than one block of ore so as to be able to reduce the chance of an uncontrolled nuclear reaction; the moderator slows down the neutrons so that they can be captured by the uranium-235 nuclei; the control rods are raised or lowered to control the number of neutrons reaching the fuel, and hence the rate of the reaction rate; the coolant carries heat generated in the core to the heat exchanger; the pressure vessel is made of steel to withstand pressures built up in the reactor; the concrete casing is there in case pressure builds up in the reactor and also serves a shield preventing radiation from escaping to the environment). - The **heat exchanger** receives heat from the reactor via the coolant and uses this heat energy to convert water into steam at high pressure - The steam from the exchanger causes the **steam turbine** to spin. - The spinning turbine is connected to a **generator** which converts the rotational kinetic energy of the turbine into electrical energy			

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TOPIC: **NUCLEAR ENERGY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
8 THE NUCLEAR ENERGY DEBATE - Critically analyse the use of nuclear energy as an alternative source of energy	**World's current dependence on fossil fuel energy** - The world is currently heavily dependent (approximately 90%) on fossil fuels for its energy. - With more countries undergoing development, with world population growing and therefore with more demands for energy, the fossil fuel supplies are expected to run out soon (oil, for example, in about 100 years' time) - Fossil fuels also produce severe pollution when used (and even when spilled during transportation) The nations of the world are therefore stepping up development of other sources of energy. One such source is <u>nuclear energy</u> **Nuclear energy as a source** It is estimated that the known reserves of nuclear fissionable material will last for a few hundred years. This time could be extended to about a thousand years using 'breeder' reactors. However, dangers are involved in every stage of obtaining this energy: mining the ore, transporting the ore, refining the ore, using the ore in the reactor and getting rid of nuclear waste.	**1** Identifying major producers of - Oil - Coal - Natural gas 2 Describing pollution effects due to fossil fuel use 3 Identifying nations using nuclear energy as a source 4 Identifying nations now developing their nuclear energy technology or adding to their number of nuclear reactors 5 Discussing disasters associated with using nuclear power plants	**Map of the world** Show places where oil, coal and gas are produced. **Map of the world** Show countries - currently using nuclear energy and the number and location of nuclear power plants each has **Pictures of nuclear power plant disasters** e.g. Chernobyl, Three Mile Island	**Presenting / sharing of current information gathered from various sites** (e.g. on the internet from news sites, National Geographic sites, energy sites, environmental sites, government sites, United Nations sites, search engines like Google) **Presenting / sharing of current information gathered from various sites** (e.g. on the internet from news sites, National Geographic sites, energy sites, environmental sites, government sites, United Nations sites, search engines like Google)

PHYSICS CURRICULUM
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UNIT: THE ATOM & NUCLEAR PHYSICS

TOPIC: **APPLICATIONS OF NUCLEAR ENERGY** **DURATION: ½ WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
9 APPLICATIONS OF NUCLEAR PHYSICS • Evaluate the use of radioactive isotopes in medicine, archaeology, industry and food processing etc. • Outline useful and harmful effects of radioactive isotopes in terms of their half-lives and radiation emitted	**How to evaluate an application** - What is physical property of the radiation is being used (e.g. range, half-life, penetrating ability, energy) in the given application? - What are some of the dangers associated with the application (especially in terms of half-life, penetrating ability, energy) - How effective is the application? Is there a better way of producing the same desired results? - What are some of the symptoms produced in living things associated with the use of the application - What safety precautions are being used and how effective these are; what other safety precautions should be used The following applications could be considered: **Uses of radioisotopes in medicine** **Uses of radioisotopes in archaeology** **Uses of radioisotopes in industry** **Uses of radioisotopes in food processing** **Other uses of radioisotopes**	1. Gathering and critically discussing information on applications of nuclear physics. 2 Students could be urged to present their findings in class. Students could vote on the most interesting finding.	**Internet sites** **Textbooks** e.g. *Physics for CSEC*, by Farley and Trotz, ch. 39 **Magazine articles**	**Presenting / sharing of current information gathered from various sites** (e.g. on the internet from news sites, National Geographic sites, energy sites, environmental sites, government sites, United Nations sites, search engines like Google)

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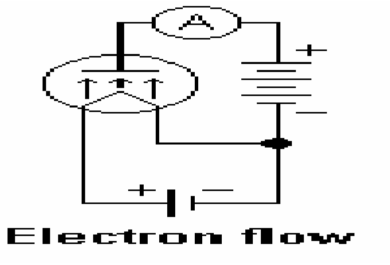
UNIT: ELECTRONICS

TOPIC: **THERMIONIC EMISSION** **DURATION: 2 WEEK**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Define and explain thermionic emission.	• Thermionic emission is the emission of **electrons** **or** **ions** by substances that are highly heated, the charged particles being called thermions. The number of thermions emitted increases rapidly as the temperature of the substance rises. The heated material may be in the form of a metal filament or of some compound that coats and is heated by the filament. 	• Teachers can demonstrate thermionic emission using the apparatus given.	• Induction coil and a cathode-ray tube (with maltese cross)	• Worksheet

PHYSICS CURRICULUM
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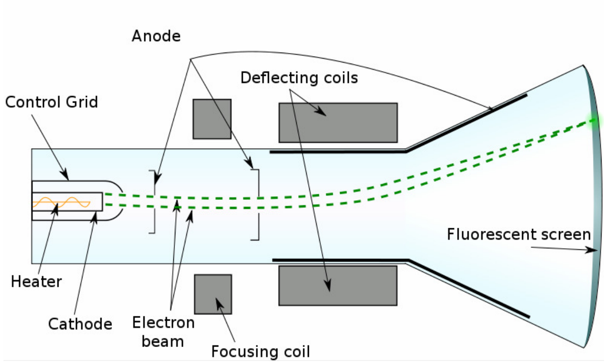
TOPIC: **THE CATHOSE RAY OSCILLOSCOPE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Draw a diagram of a cathode ray tube and explain how it works.	Diagram of a CRT  	• Teachers can describe and explain how the CRO works using the apparatus provided	• A digital CRO	• Worksheets • This website has some great questions on the CRO: http://www.allaboutcircuits.com/worksheets/scope1.html
• Describe and explain how the cathode ray oscilloscope works and state common uses.	In a cathode ray tube, the "cathode" is a heated filament. The heated filament is in a vacuum created inside a glass "tube." The "ray" is a stream of electrons that naturally pour off a heated cathode into the vacuum. Electrons are negative. The anode is positive, so it attracts the electrons pouring off the cathode. In a TV's cathode ray tube, the stream of electrons is focused by a focusing anode into a tight beam and then accelerated by an accelerating anode. This tight, high-speed beam of electrons flies through the vacuum in the tube and hits the flat screen at the other end of the tube. This screen is coated with phosphor, which glows when struck by the beam. The image formed on this screen can be used in oscilloscopes, televisions, computer monitors and radars.	Research the operation, common uses and applications of the cathode ray oscilloscope Constructing models simulating the use of Cathode Ray Oscilloscopes Teacher demonstration of the use of the Cathode Ray Oscilloscope Students use output on screen of Cathode ray oscilloscope to determine peak voltage and frequency of a.c. and to distinguish between direct and alternating current	Internet Physics Texts	Research project Presentation Simulations Worksheet: • Determining peak voltage and frequency of alternating current waveforms generated by a CRO • Distinguishing between direct and alternating current

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TOPIC**: THE CATHOSE RAY OSCILLOSCOPE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	A cathode ray oscilloscope is an electronic measuring instrument that creates a visible two-dimensional graph of one or more electrical potential differences. The horizontal axis of the display normally represents time, making the instrument useful for displaying periodic signals. The vertical axis usually shows voltage. The display is caused by the electron beam hitting the phosphor and periodically sweeping the screen from left to right. Oscilloscopes are used in the sciences, medicine, engineering, telecommunications, and industry. General-purpose instruments are used for maintenance of electronic equipment and laboratory work. Special-purpose oscilloscopes may be used for such purposes as analyzing an automotive ignition system, or to display the waveform of the heartbeat as an electrocardiogram.			

PHYSICS CURRICULUM
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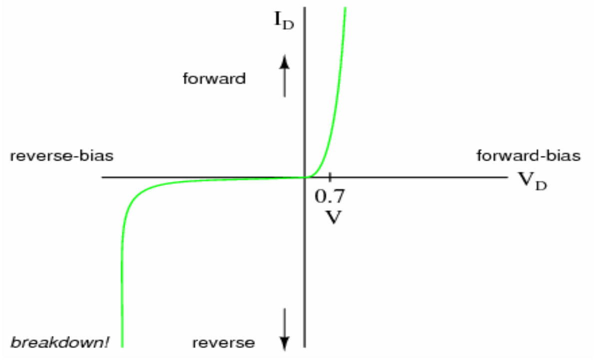
TOPIC: **THE SEMI-CONDUCTOR DIODE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe the structure of a semiconductor diode (p-type, n-type semiconductors). • Perform experiments to show that current passes basically in one direction through a semiconductor diode.	A diode is a device that blocks current in one direction while letting current flow in another direction. Diodes can be used in a number of ways. For example, a device that uses batteries often contains a diode that protects the device if you insert the batteries backward. Semi-conducting diodes are semiconductors of the of the p-type or n-type, typically made silicon mixed with small amounts of impurities. Silicon is a nonmetal because all four of its outer electrons are involved in **perfect covalent bonds**, so they can't move around. A pure silicon crystal is nearly an **insulator** -- very little electricity will flow through it. The behaviour of silicon can be changed into a conductor by doping it, In doping, a small amount of an impurity is mixed into the silicon crystal. There are two types of impurities: • **N-type** - In N-type doping, phosphorus or arsenic is added to the silicon in small quantities. Phosphorus and arsenic each have five outer electrons, so they're out of place when they get into the silicon lattice. The fifth electron has nothing to bond to, so it's free to move around. It takes only a very small quantity of the impurity to create enough free electrons to allow an electric current to flow through the silicon. N-type silicon is a good conductor. Electrons have a negative charge, hence the name N-type.	• Teachers can demonstrate the action of semiconducting diodes using kits that can be ordered from: www.elenco.com • Teachers can use the Snap Circuits ® to demonstrate a diode only allows current to flow in one direction	• A semiconducting diode • Snap Circuits kits ® can be ordered from : www.elenco.com	• Classroom discussions/ Worksheets • Classroom discussion/ Worksheets

TOPIC: **THE SEMI-CONDUCTOR DIODE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
	• **P-type** - In P-type doping, boron or gallium is the dopant. Boron and gallium each have only three outer electrons. When mixed into the silicon lattice, they form "holes" in the lattice where a silicon electron has nothing to bond to. The absence of an electron creates the effect of a positive charge, hence the name P-type. Holes can conduct current. P-type silicon is a good conductor. When the N-type and P-type are put together, interesting behavior at the junction occurs, which represents what happens in a diode.			

TOPIC: THE SEMI-CONDUCTOR DIODE

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Draw and interpret current vs. voltage graphs for a semiconductor diode.	A diode blocks current in one direction while letting current flow in another direction.  			
• State and explain the limitations of the semiconductor diode with respect to reverse p.d. and forward current.	✓ When voltage is applied across a diode in such a way that the diode allows current, the diode is said to be *forward-biased.* The voltage dropped across a conducting, forward-biased diode is called the *forward voltage*. Silicon diodes have a forward voltage of approximately 0.7 volts. • When voltage is applied across a diode in such a way that the diode prohibits current, the diode is said to be *reverse-biased*. The ability of a diode to withstand reverse-bias. Voltage is limited, as it is for any insulator. If the applied reverse-bias voltage becomes too great, the diode will experience a condition known as *breakdown* (Figure above), which is usually destructive.			

PHYSICS CURRICULUM
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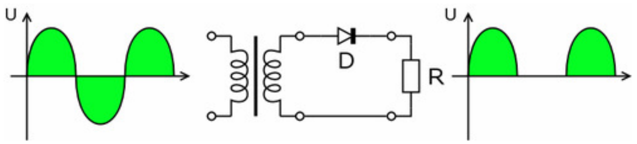
UNIT: ELECTRONICS

TOPIC: **HALF-WAVE RECTIFICATION OF AN AC CURRENT**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe the use of a single diode in half wave rectification of a.c and draw graphs to illustrate.	•  Source: http://en.wikipedia.org/wiki/Rectifier ✓ Diode symbol:  ✓ During the first half cycle of the waveform shown in the left hand diagram (AC), the diode is forward biased and current flows around the circuit formed by the diode, the transformer winding and the load ✓ Since the current through the load, and the voltage across the load are in the same proportions, then the voltage across the load is as shown in the right hand diagram, during the first half cycle. ✓ During the second half cycle, the diode is reverse biased and no current flows. This is indicated by the horizontal line in the right hand diagram. ✓ The diode only conducts on every other half cycle. Hence the name half-wave rectification. ✓ The rectified voltage is DC (it is always positive in value). However, it is not a steady DC but PULSATING DC. It needs to be smoothed before it becomes useful.	Half-wave rectification can be demonstrated using an AC source, a diode and an oscilloscope	A diode and an oscilloscope	Worksheets on Half-Wave Rectification

PHYSICS CURRICULUM
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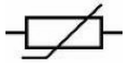
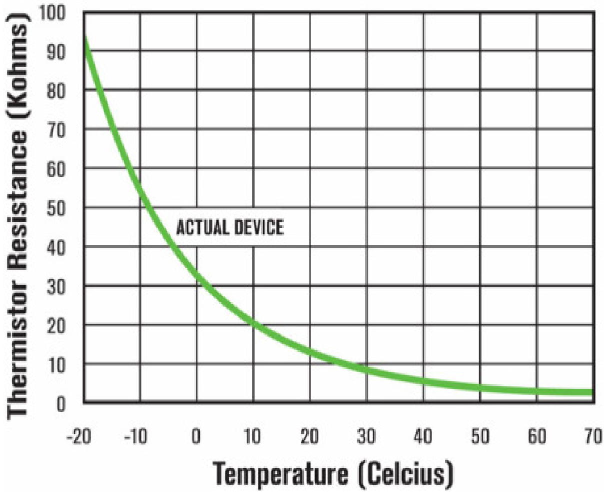
UNIT: ELECTRONICS

TOPIC: **LIGHT EMITTING DIODE**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Describe how the light-emitting diode (LED) works.	✓ LED symbol:  LED lights work very similarly to standard light bulbs except for the fact that LEDs are much smaller and contain no filament. Instead of a filament, an LED creates light using nothing but the movement of electricity along the path of its semiconductor. As the electrons stream across the semiconductor, they create electromagnetic radiation. This can be of infrared, ultraviolet or in the form of visible light, which humans can perceive. LEDs have may uses, which include: they form the numbers on digital clocks, transmit information from remote controls, light up watches and tell you when your appliances are turned on. Collected together, they can form images on a jumbo television screen or illuminate a traffic light.	• Demonstration using Snap Circuits®	• Snap Circuits® .	• Worksheets • Students should list appliances where LED are found

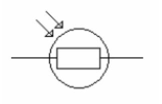
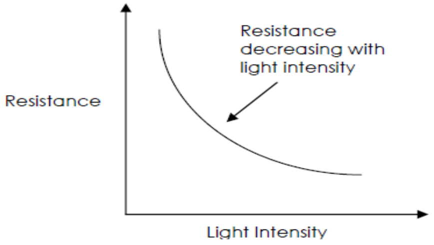
PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: ELECTRONICS

TOPIC: **THERMISTORS**

LEARNER OUTCOMES	**CONTENT**	**ACTIVITIES**	**RESOURCES**	**METHOD OF ASSESSMENT**
• Describe the variation of resistance of the thermistor with temperature and represent on graphs.	• Thermistor symbol:  • Thermistors are temperature sensitive resistors Thermistors are constructed of semiconductor material. However, unlike most other resistive devices, the resistance of a thermistor decreases with increasing temperature • Below is a graph of a thermistor showing variation of resistance with temperature: 	• Demonstration using Snap Circuits® • Teacher design activity. Here is a link to thermsitor activity: http://www.technologystudent.com/elec1/therm1.htm	• Snap Circuits® • Thermistors, thermometers, ammeters, voltmeters, wires	• Worksheets • Discussion on uses/applications of thermistors. Some questions can be found on the link to the left.

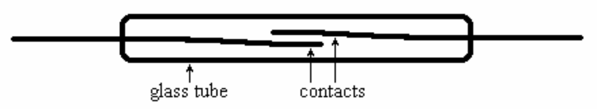
PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: ELECTRONICS

TOPIC: **LIGHT DEPENDENT RESISTORS**

LEARNER OUTCOMES	**CONTENT**	**ACTIVITIES**	**RESOURCES**	**METHOD OF ASSESSMENT**
• Describe the variation of resistance of the light-dependent resistor with light intensity and represent on graphs.	Light Dependent Resistor (LDR) symbol:  • A light dependent resistor or a photoresistor is a resistor whose resistance decreases with increasing incident light intensity. Light dependent resistors are a vital component in any electric circuit which is to be turned on and off automatically according to the level of incident light - for example, solar powered garden lights, and night security lighting. • Below of a graph of a LDR showing variation of resistance with light intensity:  	• Link to a LDR activity: http://www.technologystudent.com/elec1/ldr1.htm	• Snap Circuits® • LDR, variable light source, ammeter, voltmeter, wires, power source (battery).	• Worksheets • Discussion on uses/ applications of LDRs. Some questions can be found on the link to the left.

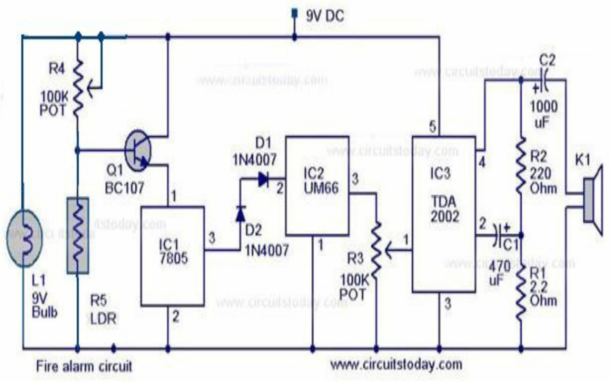
UNIT: ELECTRONICS

TOPIC: **THE REED SWITCH**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
✓ Describe the operation of the reed switch and simple applications	A reed switch consists of two magnetic contacts in a glass tube filled with protective gas:  When a magnet comes close to a reed switch the two contacts become magnetized and attracted to each other allowing an electrical current to pass through. When the magnet is moved away from the reed switch the contacts demagnetize, separate, and move to their original position. Reed switches commonly used in door and window sensors in burglar alarm systems and in modern laptops which puts the laptop on sleep/hibernation mode when the lid is closed.	• Students can examine the operation of a reed switch on their school campus	• Reed switch • Snap Circuits®	

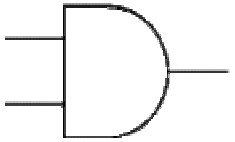
PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: ELECTRONICS

TOPIC: **SIMPLE ELECTRONIC CIRCUITS & LOGIC GATES**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
✓ Design and construct simple electronic circuits such as motor control, light-operated switches, fire alarms and burglar alarms.	A simple fire alarm circuit based on a LDR and lamp pair could be used for sensing the fire. The alarm works by sensing the smoke produced during fire. The circuit produces an audible alarm when the fire breaks out with smoke. When there is no smoke the light from the bulb will be directly falling on the LDR. The LDR resistance will be low and so the voltage across it (below .6V).The transistor will be OFF and nothing happens. When there is sufficient smoke to mask the light from falling on LDR, the LDR resistance increases and so do the voltage across it. Now the transistor will switch to ON. This gives power to the IC1 and it outputs 5V.This powers the tone generator IC UM66 (IC2) to play a music. This music will be amplified by IC3 (TDA 2002) to drive the speaker. Read more: http://www.circuitstoday.com/fire-alarm-circuit#ixzz0qMtR1Eu1 Here is a circuit diagram of the above fire alarm system:  Source: http://www.circuitstoday.com/fire-alarm-circuit	Student activities can include designing and testing these monitoring systems Students can design simple electronic circuits using readily available materials.	Snap Circuits® Internet access	- Students can draw circuit diagrams for types of electronic circuits and then construct them. - Worksheets. Exercises can be found on: http://www.scribd.com/doc/5370651/9-4-Logic-Gates-doc

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: ELECTRONICS

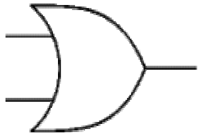
TOPIC: **SIMPLE ELECTRONIC CIRCUITS & LOGIC GATES**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr><td>✓ Draw circuit symbols for LDR, LED, thermistors, diodes, reed switches, AND and OR gates.</td><td>• Circuits symbols are in their respective sections</td><td></td><td></td><td></td></tr>
<tr><td>✓ Construct a mechanical switching model of AND and OR gates and corresponding truth tables (using 2 inputs only).
✓ Design and use simple control and monitoring systems with electronic AND and OR gates</td><td>• AND Gate
The output Q is true if input A AND input B are both true: Q = A AND B. An AND gate can have two or more inputs, its output is true if all inputs are true.

Symbol
<table><tr><th>Input A</th><th>Input B</th><th>Output Q</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>Truth Table</td><td>Student activities can include designing and testing these monitoring systems
Students can design simple electronic circuits using readily available materials.</td><td>Snap Circuits®
Internet access</td><td>• Students can draw circuit diagrams for types of electronic circuits and then construct them.
• Worksheets.
Exercises can be found on: http://www.scribd.com/doc/5370651/9-4-Logic-Gates-doc</td></tr>
</table>

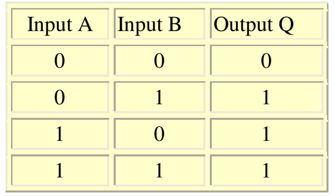
TOPIC: **THERMIONIC EMISSION & ELECTRONICS**

<table>
<tr><th>LEARNER OUTCOMES</th><th>CONTENT</th><th>ACTIVITIES</th><th>RESOURCES</th><th>METHOD OF ASSESSMENT</th></tr>
<tr><td>✓</td><td>

- OR Gate
  The output Q is true if input A OR input B is true (or both of them are true): **Q = A OR B.** An OR gate can have two or more inputs, its output is true if at least one input is true.



Symbol

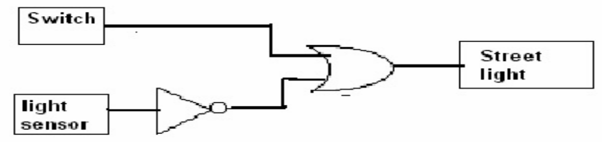


Input A	Input B	Output Q
0	0	0
0	1	1
1	0	1
1	1	1

Truth Table

The diagram below shows a simple electronic control system that is used as an automatic and manual switch to switch on the street lights when it is dark. The control system allows the street lights either to switch on manually by a switch at any time, or automatically by a light sensor when it is dark.

Light sensor: daytime = 1 Dark /night = 0



Source: http://www.scribd.com/doc/5370651/9-4-Logic-Gates-doc
</td><td></td><td></td><td></td></tr>
</table>

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: ASTROPHYSICS

TOPIC: **HISTORY & GREAT ASTRONOMERS** **DURATION: 2 WEEKS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Understand a historical approach from the geocentric model of our solar system to the heliocentric model. • Name great astronomers and describe their contribution to astronomy (Bruno, Copernicus, Galileo, Kepler, Hubble, Friedman, Hoyle, etc.)	• The development of astronomy has been deeply intertwined with the development of civilization. Revolutions in astronomy have gone hand in hand with the revolutions in science and technology. • In 1543, the Copernican revolution, revealed that the earth is not the center of the universe, but a planet orbiting the sun. Three later figures–Tycho Brahe, Johannes Kepler, and Galileo–provided the key evidence that eventually led to wide acceptance of the Copernican idea. The revolution culminated with Isaac Newton's uncovering of the laws of motion and gravity.	• In class discussions/Internet research Students can be asked to research the sciences of astronomy, astrophysics and cosmology	*Cosmic Perspective* by Bennett, Donahue Internet access	Student presentations to class

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: ASTROPHYSICS

TOPIC: **TERMS ASSOCIATED WITH ASTRONOMY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Define the terms: astronomical unit, light year, galaxy, star, planet, asteroid, moon, comet, meteor, meteorites	• An astronomical unit (abbreviated as **AU** or **au**) is a unit of length equal to approximately 149.60 million kilometres (93 million miles). It is defined by the International Astronomical Union, and is the mean (average) distance between the Earth and the Sun over one Earth orbit. • A light year is a unit of length, and it is the distance that light travels in one year. It is a little less than 10^{13} kilometres. • A galaxy is a numerous large-scale aggregates of stars, gas, and dust that constitute the universe, containing an average of 100 billion (10^{11}) stars and ranging in diameter from 1,500 to 300,000 light-years. • A star is a self-luminous celestial body consisting of a mass of gas held together by its own gravity in which the energy is generated by nuclear fusion in the interior • A planet is a celestial body that orbits the sun, has sufficient mass to assume nearly a round shape, clears out dust and debris from the neighborhood around its orbit. • An asteroid is any of the numerous small, often irregularly shaped rocky bodies that orbit the Sun primarily in the **asteroid belt**, a region between the orbits of Mars and Jupiter.	Make a vocabulary list or scrap book of terms.		Worksheets

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

UNIT: ASTROPHYSICS

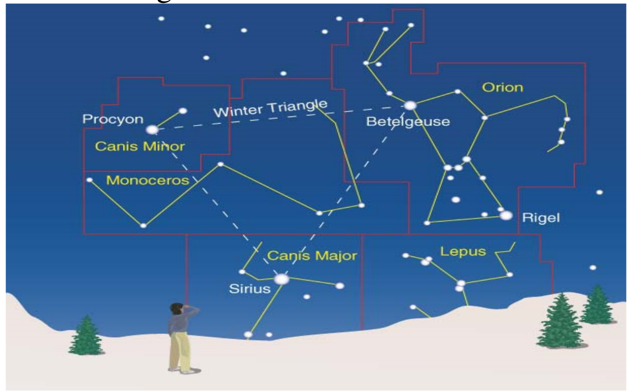
TOPIC: **TERMS ASSOCIATED WITH ASTRONOMY**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Define the terms: astronomical unit, light year, galaxy, star, planet, asteroid, moon, comet, meteor, meteorites	• A moon is a natural satellite revolving around a planet. • A comet is a relatively small extraterrestrial body consisting of a frozen mass that travels around the sun in a highly elliptical orbit • A meteor is a very small meteoroid that has entered the earth's atmosphere. Such objects have speeds approaching 70 kilometres per second. The friction with the air causes the meteor to glow with heat. Also called *shooting star*. • A stony or metallic mass of matter that has fallen to the earth's surface from outer space.	Make a vocabulary list or scrap book of terms.		Worksheets

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12

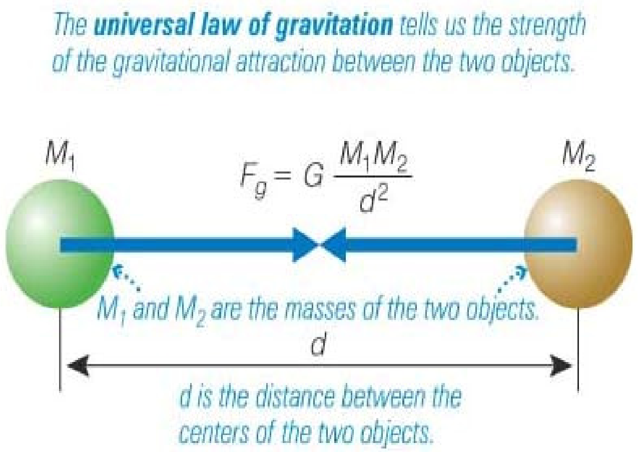
UNIT: ASTROPHYSICS

TOPIC: **CONSTELLATIONS**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Identify some constellations such as: Orion, Ursa Minor, Ursa Major and Canis Major.	• A constellation is an area of the celestial sphere defined by exact boundaries. It can also be used loosely to refer to the more prominent, visible stars that seem to form a pattern in that area. The most recognized constellation is Orion.  	• Constellations can be shown to students by downloading a free software " Stellarium®" from www.stellarium.com • Nighttime observations • Observe and draw 2-3 constellations eg. Orion and classify stars according to the observation.	*Cosmic Perspective* by Bennett, Donahue • Free Stellarium® software	The Cosmic Perspective has teachers resources with lots of worksheets • Worksheets

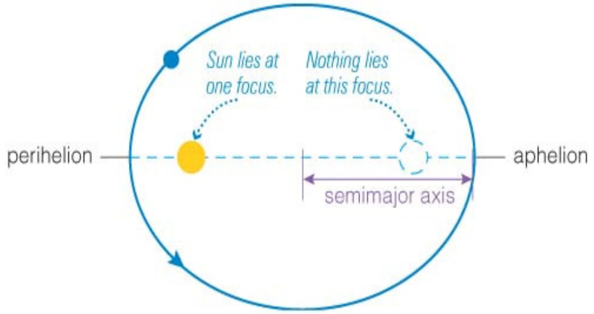
PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: ASTROPHYSICS

TOPIC: **NEWTON’S LAW OF UNIVERSAL GRAVITATION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• State Newton's law of universal gravitation (inverse square law) and describe the qualitative relationship between force, mass, distance.	$F_g = G\frac{M_1 M_2}{d^2}$ ✓ where F_g is the force of gravitational attraction, M_1 and M_2 are the masses of the two objects, and d is the distance between their centers. The symbol G is a constant called the gravitational constant, and its numerical value has been measured to be $G = 6.67 \times 10^{-11}$ $m^3/(kg \times s^2)$  Source: *Cosmic Perspective* by Bennett, Donahue			Worksheets

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: ASTROPHYSICS

TOPIC: **KEPLER'S FIRST LAW OF PLANETARY MOTION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• State Kepler's first law of planetary motion.	Kepler's first law tells us that the orbit of each planet around the Sun is an ellipse with the Sun at one focus. (Nothing is at the other focus.) In essence, this law tells us that a planet's distance from the Sun varies during its orbit. It is closest at the point called **perihelion** (from the Greek for "near the Sun") and farthest at the point called **aphelion** (from the Greek for • "away from the Sun").  Source: *Cosmic Perspective* by Bennett, Donahue	• Use pictures/slide presentations to depict/communicate Kepler's First law of planetary motion		

PHYSICS CURRICULUM
SCOPE OF WORK
GRADE: 12
UNIT: ASTROPHYSICS

TOPIC: **SPACE EXPLORATION**

LEARNER OUTCOMES	CONTENT	ACTIVITIES	RESOURCES	METHOD OF ASSESSMENT
• Name 2 main types of telescopes (reflecting, refracting) used in astrophysics.	A reflecting telescope uses a precisely curved primary mirror to gather light, which is reflected to a secondary mirror which lies in front of it and further reflects the light to a focus at the place where the eye or instruments can observe it. Refracting telescopes use transparent glass lenses to focus light from distant objects. The Hubble space telescope is the most famous observatory in space.	Using a concave mirror and a sheet of white paper, students can form a real image of a distant object. This simple demonstration illustrates how a reflecting telescope works. Using a biconvex lens and a sheet of white paper, students can form a real image of a distant object. This simple demonstration illustrates how a refracting telescope works.	A concave mirror, a biconvex lens and a sheet of white paper.	
• Classify stars based on colour.	Astronomers classify stars according to surface temperature by assigning a **spectral type** determined from the spectral lines present in a star's spectrum. The hottest stars, with the bluest colors and coolest stars appear reddish in colour. Source: *Cosmic Perspective* by Bennett, Donahue	Students can use the naked eye or a telescope to observe stars of different colours, For example the star Betelgeuse in the Orion constellation appears red to the naked eye.	telescope	Worksheets
Discuss/debate the pros & cons of space exploration.		Research and debate pros and cons of space exploration.		Judge debate

APPENDIX I
RUBRIC FOR ASSESSMENT

What is Rubric?

Rubric – a set of guidelines for assessment which states the characteristics and/or dimensions being assessed with clear performance criteria and a rating scale. – *Policy on Assessment and Evaluation published by the Scarborough Board of Education, 1977.*

A scoring rubric consists of:
- A fixed scale
- A list of characteristics/criteria describing performance for each of the points on a scale.
- Clear performance targets for students.

How to design a Rubric
- Select a result/results based on a learner outcome that will be assessed.
- Describe a superior performance.
- Describe a low-level performance.
- Set different level performances between the high and low level performances described.
- Explain the scoring criteria to students.
- Use examples to assist students in using the rubric as a means of demonstrating their understanding.

Examples of Rubric are included in this document to assist teachers in effectively using alternative methods of assessment. However, the use of Rubric for assessment is not limited to the categories shown. Teachers are encouraged to develop similar Rubric to assess learner outcomes or student activities that are not included. Additionally, teachers are expected to develop score sheets based on the criteria. An example is shown.

RUBRIC SCORE SHEET FOR ASSESSING VISUAL AIDS

Students' Names or Groups	Visual appeal	Use of space	Comprehension of assignment	Content – information	English	Effectiveness in making a point	Creativity	TOTAL	Percentage

GENERAL RUBRIC FOR VISUAL AIDS

(posters, pamphlets/brochures, fliers, PowerPoint presentations)

Criteria	Exemplary **4**	Proficient **3**	Satisfactory **2**	Incomplete/ Below standard **1**	Unsatisfactory **U**
Visual appeal	Very attractive colour scheme, bold, easily-read writing, very attractive and appropriate graphics.	Attractive colour scheme, legible writing, attractive and appropriate graphics.	More than one colour font, legible writing, a graphic used.	One colour font, legible writing.	One colour font, font is not easily read.
Use of space	Visual display effectively covers at least 90% of the space available.	Visual display effectively covers approximately 75% of the space available.	Visual display covers approximately 67% of the space available.	Visual display covers 50 – 66% of the space available.	Visual display covers less than 50% of the space available.
Comprehension of assignment	Display shows an excellent understanding of the intent and focus of the assignment.	Display shows an good understanding of the intent and focus of the assignment.	Display shows some understanding of the assignment.	Display is related to the topic but does not satisfy the focus of the assignment.	Apparent misunderstanding of the assignment.
Content – information	Includes the necessary information, avoids unnecessary information, information is correct and current.	Includes the necessary information, information is correct, also includes unnecessary information.	Information included is correct. However, only some of that needed is included along with some unnecessary information.	Less than 50% of the required information is included.	Insufficient information, some information included is incorrect.
English	Vocabulary ideally suited for target group, correct grammar and spelling.	Vocabulary appropriate for target group, correct grammar and spelling.	Correct grammar and spelling.	Grammatical or spelling errors.	Grammatical and spelling errors.
Effectiveness in making a point	Display is very effective in marketing its message.	Display makes a point strongly.	Display makes a point (covers its theme).	Information does not show connection.	No evidence of structure or sequence.
Creativity	A very high level of creativity shown in visual appearance as well as in the message.	A good standard of creativity shown in visual appearance as well as in the message.	Some creativity shown in visual appearance as well as in the message.	Creativity shown in visual appearance or in the message.	Little or no evidence of creativity.
Grade	A 86 – 100	B 71 – 85	C 56 – 70	D 41 – 55	F 40 and lower

GENERAL RUBRIC FOR ORAL PRESENTATIONS

(rap, song, poem, speech)

Criteria	Exemplary **4**	Proficient **3**	Satisfactory **2**	Incomplete/ Below standard **1**	Unsatisfactory **U**
Preparedness	Completely prepared and had obviously rehearsed.	Seemed well-prepared but could have spent more time rehearsing.	Somewhat prepared, but seems not to have rehearsed.	Did not seem prepared to present.	Appeared to have made no effort to prepare.
Sound appeal	Very attractive beat or rhythm used with outstanding variations of voice intonation and volume.	Attractive beat or rhythm used with good variations of voice intonation and volume.	Consistent beat or rhythm used with variations of voice intonation or volume.	Consistent beat or rhythm used with no variations in voice intonation and volume.	Lyrics were presented with no accompanying sounds.
Time/length	Duration was for the required time.	Duration was longer or shorter than the time allotted by 0 – 20% of duration.	Duration was longer or shorter than the time allotted by 21 – 30% of duration.	Duration was longer or shorter than the time allotted by 31 – 40% of duration.	Duration was longer or shorter than the time allotted by 41 – 67% of duration.
Enthusiasm	Facial expressions and body language evoked a strong interest in and enthusiasm from the audience.	Facial expressions and body language sometimes evoked a strong interest in and enthusiasm from the audience.	Facial expressions and body language were used to spark interest and enthusiasm from the audience but the expressions seemed faked.	Very little use of facial expressions and body language. Did not evoke interest or enthusiasm from the audience.	Little enthusiasm was shown by the presenter(s).
Content – information	Included the necessary information which was correct and current. Unnecessary information was not included.	Included the necessary information which was correct. Unnecessary information was not included.	Information included was correct. However, it included necessary as well as some unnecessary information.	Less than 50% of the required information was included.	Insufficient information was given, some of which was incorrect.
English	Speaks clearly and distinctly throughout the presentation, does not mispronounce words.	Speaks clearly and distinctly throughout the presentation, mispronounced one and two words.	Speaks clearly and distinctly for most of the presentation, mispronounces key vocabulary or makes one or two grammatical errors.	Mumbles at one or two points, more than two grammatical errors.	Mumbles most of the presentation, mispronunciation and grammatical errors.
Effectiveness in making a point	Song etc. was very effective in marketing its message.	Song etc. made a point strongly.	Song etc. made a point related to the topic.	Information in the song etc. was disjointed.	Lyrics did not portray a theme.
Creativity	A very high level of creativity shown in sound appeal as well as in the message.	A good standard of creativity shown in sound appeal as well as in the message.	Some creativity shown in sound appeal as well as in the message.	Creativity shown in sound appeal or in the message.	Little or no evidence of creativity shown.
Grade	A 86 – 100	B 71 – 85	C 56 – 70	D 41 – 55	F 40 and lower

GENERAL RUBRIC FOR RESEARCH PROJECTS

(surveys, research information)

Criteria	Exemplary **4**	Proficient **3**	Satisfactory **2**	Incomplete/ Below standard **1**	Unsatisfactory **U**
Information sources	Used a variety of relevant sources (three or more different types and several of each type of source). Cited all sources.	Used many sources of two types. Cited all sources.	Used many sources of one type (e.g. textbooks, Internet, journals, magazines, questionnaires). Sources were referenced.	Two or three sources were used.	One source used and referenced.
Sources had data to support claims	All sources (but one) had data to support claims.	Most sources had data to support claims.	Some sources had data to support claims.	One source had data to support claims.	No source had data to support claims.
Extracted relevant information	All information extracted was relevant to the topic.	All information extracted was relevant to the topic. However, no information was given for one aspect.	Some relevant and some irrelevant information was extracted.	Little relevant information was extracted.	Little information was extracted; it was mainly irrelevant.
Paraphrased information	All information extracted was paraphrased and well-written.	Most information was paraphrased and well-written.	Some information was paraphrased. However, copied portions were not indicated.	Most information was copied from sources.	All information was copied from sources.
Organized information	Information was very clearly and sequentially organized. The position was logically stated with supporting data. Alternative points of view were included.	Information is clearly and sequentially organized. Logically stated position with supporting data.	Information was clearly and sequentially organized.	Information was sequentially organized.	Information was written haphazardly.
Synthesized	Project clearly and articulately showed: problem, hypothesis, method of research, literature reviewed, findings, analysis of findings, position.	Project showed: problem, hypothesis, method of research, literature reviewed, findings, analysis of findings, position.	Project showed problem, hypothesis, method of research, literature reviewed, findings, analysis of findings, position (one missing).	Project showed problem, hypothesis, method of research, findings.	Notes shown on aspects of the project.
Grade	A 86 – 100	B 71 – 85	C 56 – 70	D 41 – 55	F 40 and lower

GENERAL RUBRIC FOR INVESTIGATIONS
(experiments, experimental report)

Criteria	Exemplary **4**	Proficient **3**	Satisfactory **2**	Incomplete/ Below Standard **1**	Unsatisfactory **U**
Hypothesis	Correct purpose and explanation of purpose were clearly stated.	Correct purpose was clearly stated.	Stated a purpose that was correct.	States a purpose that is incorrect.	States a purpose that is incorrect and irrelevant.
Sequence	Aim, Apparatus, Materials, Procedure, Observations, Results, Conclusion (given in sequence).	One (sub-heading) missing or out of sequence.	Two (sub-headings) missing or out of sequence.	One missing and two out of sequence.	More than two missing or out of sequence.
Procedure/ Method	Clear step-by-step description of experimental procedures; labeled diagrams used.	Step-by-step description written description with one step missing, labeled diagrams included.	Two steps missing or diagrams not labeled.	An account written which includes most steps but not clearly and sequentially recorded.	A few steps are recorded.
Observations	All observations made and recorded in a clear format.	All obvious observations made and recorded in a clear format.	One obvious observation missing, clear format for recording.	Two observations missing or format for recording is not clear.	More than two observations missing.
Results	All data clearly recorded with units to the highest level of accuracy.	One reading missing; data clearly recorded with units to the highest level of accuracy.	Readings not to highest level of accuracy but all recorded with units in a clear format.	Readings not to highest level of accuracy and not recorded clearly.	A few readings recorded with no units.
Conclusion	Conclusion is logically drawn from data and stated as a relationship – in general terms.	Logical conclusion drawn, general reference to data, stated as a summary conclusion.	Logical conclusion but not connected to data. Written as a series of statements.	Obvious conclusion drawn, not connected to data, hypothesis or aim.	Results stated as a conclusion.
Handles apparatus and materials	Handles apparatus correctly, handles materials appropriately and safely, no help needed.	Handles apparatus correctly, handles materials appropriately and safely, one or two reminders given.	Handles apparatus correctly, handles materials appropriately, one or two reminders given.	Handles apparatus or materials correctly, two or three reminders given.	Uses apparatus and materials with much assistance given.
Error	Identifies all main sources of error and explains effect on results.	Identifies all but one main sources of error and explains effect on results.	Identifies sources of error.	Suggests possibility of error but identifies no sources.	Does not address Possibility of error.
Grade	A 86 – 100	B 71 – 85	C 56 – 70	D 41 – 55	F 40 and lower

Reference: www.accessexcellence.org

GENERAL RUBRIC FOR FIELD WORK

(field trips)

Criteria	Exemplary **4**	Proficient **3**	Satisfactory **2**	Incomplete/ Below standard **1**	Unsatisfactory **U**
Organization/ systematic investigation	Read and comprehended instructions first. Gathered the necessary equipment. Organized functions/tasks for group members. Worked systematically.	Read and comprehended instructions first. Gathered the necessary equipment. Organize functions/tasks for group members.	Read instructions first. Gathered the necessary equipment. Group worked together.	Read instructions, gathered equipment. Members of the group performed tasks but not in sequence.	Did not participate or individuals in the group performed tasks randomly/haphazardly.
Following instructions	Followed all instructions. Made adaptations when necessary.	Followed all instructions except one.	Followed most instructions.	Followed some instructions.	Failed to follow most instructions.
Use of equipment	Used equipment safely and correctly without additional assistance.	Used equipment safely and correctly with some assistance (reminders).	Used equipment safely but with much assistance needed.	Used equipment correctly but unsafely.	Did not use all equipment correctly and no evidence of safety techniques used.
Collection of data	Required number of readings taken – additional done to verify anomalies. Readings all taken at required time/place etc.	Required number of readings taken. Readings all taken at required time/place etc.	Most of the required number of readings taken Readings all taken at required time/place etc.	Some of the number of readings taken. Readings for some intervals missing.	Few readings were taken. Readings were not at regular intervals.
Observations	All possible observations made and described in detail.	Most observations made in detail and the others as obvious observations.	Some observations made in detail.	Most observations made as general or obvious observations.	Few, obvious observations made.
Teamwork	Performed all assigned duties efficiently. Supported other group members. Readily provided additional assistance as was needed.	Performed all assigned duties efficiently. Supported other group members.	Performed all assigned duties.	Performed most assigned duties. Worked independently.	Performed few duties. Did not support other group members. Refused to perform additional tasks.
Safety	Adhered to all rules of conduct. Reminded others to keep the rules.	Adhered to all rules of conduct.	Adhered to most rules of conduct.	Caused another student to break a rule.	Action(s) responsible for jeopardizing the safety of another participant.
Sensitivity to the environment	Demonstrated sensitivity to the environment at all times and reminded others to do so.	Demonstrated sensitivity to the environment at all times.	Demonstrated sensitivity to the environment most times.	Required frequent reminders to avoid negatively impacting the environment.	Actions caused a negative reaction or damage to the environment.
Grade	A 86 – 100	B 71 – 85	C 56 – 70	D 41 – 55	F 40 and lower

GENERAL RUBRIC FOR MODELS

Criteria	Exemplary **4**	Proficient **3**	Satisfactory **2**	Incomplete/ Below standard **1**	Unsatisfactory **U**
Representation of Components	Included all the necessary components, no unnecessary or unrelated parts were included. Components accurately represented (appearance) object.	Included all the necessary components, no unnecessary or unrelated parts were included. Components did not accurately represent the object.	Included some of the necessary components, no unnecessary or unrelated parts were included. Components accurately represented the object.	Included few of the necessary components, or unnecessary or unrelated parts were included. Components did not accurately represent the object.	Incomplete model or model did not accurately represent the object.
Proportions of Components	All components made in correct (proportional) dimensions. All components made in correct proportion to each other and the overall model.	All components made in correct (proportional) dimensions. Some components made in correct proportion to each other and the overall model.	Some components made in correct (proportional) dimensions. Some components made in correct proportion to each other and the overall model.	Few components made in correct (proportional) dimensions. Components were not in correct proportion to each other or to the overall model.	Components did not made in correct proportions.
Materials Used.	All materials used were appropriate, non-hazardous, inexpensive and easily available.	All materials used were appropriate, non-hazardous and inexpensive.	Some materials used were appropriate.	Few materials used were appropriate	Some materials used were inappropriate and at least one was unsafe.
Construction	Much care taken in the construction process. The model was neat, durable and well-fitted.	Much care taken in the construction process. The model was neat and well-fitted but not durable.	The structure was fairly well-fitted and neat.	The structure was fairly well-fitted.	The structure was falling apart and untidy.
Overall Appearance	Very attractive colour scheme used. Bold, easily-read writing used. Structure was appropriate size.	Attractive colour scheme used. Structure was appropriate size.	More than one colour used. Font used was legible. Structure was appropriate size.	One colour used. Structure was very small or too large.	No attempt to make the structure attractive.
Creativity	A very high level of creativity shown in visual appearance as well as in the message.	A good standard of creativity shown in visual appearance as well as in the message.	Some creativity shown in visual appearance as well as in the message.	Creativity shown in visual appearance or in the message.	Little or no evidence of creativity.
Information Displayed	Includes the necessary information, avoids unnecessary information, information is correct and current.	Includes the necessary information, information is correct, also includes unnecessary information.	Information included is correct. However, only some of that needed is included along with some unnecessary information.	Less than 50% of the required information is included.	Insufficient information, some information included is incorrect.
Grade	A 84 – 100	B 71 – 85	C 56 – 70	D 41 – 55	F 40 and lower

APPENDIX II

BIBLIOGRAPHY

Avison, J. (1998). The World of Physics (5th Ed.). UK: Thomson Learning.

Bennett, J.O., Donahue, M., Schneider, N. & Voit, M. (2008) Cosmic Perspective (5th Ed.) *USA:* Addison-Wesley/ Prentice Hall

Duncan, T. & Kennett, H. (2001). GCSE Physics (4th Ed.). London, UK: John Murray Publishers Ltd.

Farley, A. & Trotz, C. (2009). *Physics for CSEC (2nd Ed.). London, UK: Macmillan Publishers Ltd.*

Hewitt, P. G. (2006). Conceptual Physics (10th Ed.). USA: Addison-Wesley/ Prentice Hall

Jackson B. & Whiteley P. (2007). Longman Physics for CSEC (3rd Ed.) London, UK: Longman Publishers.

Johnson, K. (2006). New Physics for You (6th Ed.). London, UK: Nelson Thornes Publishers.

Lambert, N., Lewis dos Santos, N., & Samuel, T.A. (2000) Physics for CXC. Oxford, UK: Heinemann educational Publishers.

Shepherd M., & Lovat, I. (1997). Lett's Revise GCSE Physics (2nd ed.) London, UK: Lett's Educational.

Wysession, M., Frank, D. & Yancopoulos, S. (2006) Prentice Hall Physical Science: Concepts in Action Teachers' Edition USA: Pearson Prentice Hall.

http://en.wikipedia.org/wiki/Binocular_vision

http://en.wikipedia.org/wiki/Circuit_breaker

http://en.wikipedia.org/wiki/Fuse_%28electrical%29

http://en.wikipedia.org/wiki/Rectifier

http://faculty.washington.edu/chudler/chvision.html

http://phet.colorado.edu/simulations

http://spaceplace.nasa.gov/en/kids/goes/hurricanes/

http://starryskies.com/try_this/baro1.html

http://www.acoustics.salford.ac.uk/feschools/waves/super.htm#phase

http://www.allaboutcircuits.com/worksheets/scope1.html

http://www.bbc.co.uk/schools/gcsebitesize/physics

http://www.britannica.com/

http://www.circuitstoday.com/fire-alarm-circuit

http://www.circuitstoday.com/fire-alarm-circuit#ixzz0qMtR1Eu1

http://www.electronickits.com/kit/complete/science/sc300.htm

http://www.euwfd.com/html/hydrological_cycle.html

http://www.musicwithmelissa.com/index_files/Page892.html

http://www.ohaus.com/products/education/weblab/TBBentry.html

http://www.oup.co.uk/oxed/children/oise/pictures/atoms/ice/

http://www.phschool.com/webcodes10/index.cfm?wcprefix=cch&wcsuffix=2173&fuseaction=home.gotoWebCode&x=16&y=12

http://www.physicsclassroom.com/Class/circuits/u9l4b.cfm

http://www.physicsclassroom.com/Class/waves/u10l1a.cfm

http://www.physik.uni-augsburg.de/exp6/imagegallery/afmimages/atoms.jpg

http://www.sam.usace.army.mil/en/wra/Bahamas/BAHAMASWRA.pdf

http://www.s-cool.co.uk/gcse/physics/magnetism-and-electromagnetism/generating-electricity.html

http://www.scribd.com/doc/5370651/9-4-Logic-Gates-doc

http://www.scribd.com/doc/5370651/9-4-Logic-Gates-doc http://www.squidoo.com/save_energy_now

http://www.studyphysics.ca/30/charging.pdf

http://www.technologystudent.com/elec1/ldr1.htm

http://www.technologystudent.com/elec1/therm1.htm

http://www.wsc.com.bs/waterandsewerage.asp

www.elenco.com

www.microsoft.com

www.nationalgeographic.com

www.stellarium.com

APPENDIX III
INSTRUCTIONAL SUPPLIES – PHYSICS

A.C. / D.C. power supply
Aluminum wire
Ammeters
Assorted magnets (bar, disc, horseshoe, U -shaped)
Assorted materials (iron, brass, copper, lead, steel, gold, silver, nickel, aluminium, nickel, cobalt)
Ball and ring apparatus
Ball bearings
Bar magnets (strong magnetic field) 4 ½” size
Battery
Battery holders
Beakers (various sizes)
Bell jar apparatus with vacuum pump
Bi-metallic strips
Boiling tubes
Boyle’s Law apparatus
Brownian motion smoke-cell apparatus
Bulbs
Bunsen burners
Burettes
Burette Clamp and Boss Head
Calorimeters
Candles
Car screw jack
Cathode ray oscilloscope
Charles’ Law apparatus
Circuit boards
Circuit breaker
Circular coil
Coiled glass tubes
Colour wheel
Compasses
Concave lenses
Concave mirrors
Conduction spike
Conical flasks
Connecting wires - Copper (PVC covered/ insulated)
Convection box
Convex Lenses
Convex mirrors
Convex-Concave lens
Crocodile clips (with insulation - red and black)
Diodes
Displacement Cans
Dynamics Trolley/Cart
Electric heaters (hot plates)
Electric immersion heaters
Electric kettles
Electroscopes
Fibre optic cables
Fixed resistors
Free fall apparatus
Fuses (assortment)
Galvanometers (including centre –zero galvanometers)
Gas syringes (assortment)
Geiger-Muller tube (attached to ratemeter or counter)
Glass beakers
Glass rods
Gold Leaf Electroscope
Graduated cylinders (various sizes 5 ml, 10 ml, 20 ml, 50ml, 100 ml, 500 ml, 1000 ml)
Hooke Law Apparatus
Inclined plane and roller with accessories
Indelible ink markers

INSTRUCTIONAL SUPPLIES – PHYSICS

Insulated copper wire
Iron fillings
Iron nails
Junior Electronic Circuit kits (ordered from www.elenco.com)
Laboratory Barometer (simple aneroid barometer)
Laboratory hydraulic demonstration system
Laboratory Pulleys (single fixed, single moveable, block & tackle)
Large protractor
Lens & mirror holders
Light boxes and accessory kits
Light Dependent Resistors
Light emitting diodes
Lodestone
Low friction carts and balls
Low-voltage d.c. motors
Machine screws
Magnets (assorted shapes and sizes – U shaped, C- shaped, disc and bar magnets)
Magnetic compasses
Manometer
Mass balances (Triple beam balances, Top pan balances, Bathroom scales)
Mass hangers
Measuring cylinders
Metre Rule
Micrometer
Microscopes
Milliammeters
Model d.c. motor
Model of simple a.c. and d.c. generators
Ohmic resistors
Optical bench apparatus and accessories
Pascal' Vases
Pendulum balls
Pinhole Camera
Pins
Pipettes
Plane mirrors
Plotting compasses
Power pack
Pressure Law Apparatus
Prisms (Acrylic Prism set)
Pulleys
Radiation cans (black and silver)
Raybox
Rectangular glass blocks
Reed switches
Refraction tanks
Resistance wires (such as Nichrome)
Resistors box
Retort stands and clamps
Rheostats (variable resistors)
Solar cell
Ripple tank apparatus fitted with small motor and power supply
Rubber bands
Screens
Screwdriver
Semi-circular glass blocks
Semi-conducting diodes
Simple pendulum apparatus (drilled metal ball, strong length of thread, clamp (retort) stand
Slides and coverslips
Slinkies
Slotted masses (1g, 5 g, 10g, 50 g, 100 g 200 g)
Small bottles
Small electric motors

INSTRUCTIONAL SUPPLIES – PHYSICS

Small metallic ball
Small sphere
Snap Circuits kits ® (can be ordered from: www.elenco.com) includes: Reed switch, Light dependent resistor, thermistor, light emitting diode)
Solar reflectors
Soldering Instrument and stand
Soldering paste
Soldering wire
Solenoid
Solenoid apparatus
Spatulas
Special free-fall timing equipment (these include photogates and ball-and-pad equipment connected to a millisecond timer).
Spring balances
Springs (Hooke's Law)
Static Electricity Kit (should include ebonite rods, polythene rods, acetate rods, glass rods, chopped hair, piece of fur, pieces of silk, wool and fur)
Stop watches or stop-clocks
Straight wire
Strings
Student electricity apparatus sets
Switches
Test tubes
Thermistors
Thermometers
Ticker tape
Ticker tape timer
Tongs
Transformers
Triple beam balance
Tripods
Tuning forks (different frequencies) and sound box
Un-magnetised steel or iron bar
Van de Graaff Generator
Variable light source
Vernier Caliper
Voltaic Cell
Voltmeters
Water bath
Wire gauze

Materials
Assorted metal samples e.g. Al, Zn
Fuels Kerosene "lamp"
Lime water (calcium hydroxide)
Naphthalene
Oil (Different grades/ types)
Oil/ paraffin
Plasticine
Polystyrene balls
Potassium permanganate crystals

INSTRUCTIONAL SUPPLIES – PHYSICS

Teaching Resources
Computer
GCSE Physics cd
Globe/ map of world
Internet
LCD projector
Periodic table
Screen/ White board
Safety
Googles
Lab coats
Gloves

Miscellaneous
Small refrigerator

APPENDIX IV
PREREQUISITES FOR TENTH GRADE PHYSICS

KNOWLEDGE

Students should be able to:

- State the SI units and recognize the fundamental SI units
- Understand the relationship among prefixes of units i.e. kilo, m, mm, cm.
- Perform conversions among units e.g. kilo, m, mm, cm.
- Define pressure
- Describe qualitatively the relationship between pressure, force, and area
- State examples of pressure such as air pressure and water pressure
- State the function of a simple machine
- Identify the six types of simple machines with examples
- Use the formula moment = force x perpendicular distance
- Identify the three parts and classes of a lever, with examples
- Identify the types of pulleys and describe how they work
- Define complex machines
- Apply formulae to find the mechanical advantage
- Describe static electricity as stationary positive or negative charges
- State the law of charges
- Describe how different materials become charged by friction eg balloons
- Define current electricity as a flow of electrons through a conductor
- Distinguish between conductors and insulators of electricity
- Identify the basic parts of an electric circuit
- Recognize the symbols for the components of a simple circuit
- Draw a simple circuit diagram
- Describe the function of a switch
- Define the terms voltage and current
- Identify the volt (V) as the SI unit of voltage and the ampere (A) as the SI unit of current.
- Distinguish between open and closed circuits
- Distinguish between parallel and series circuit
- Describe the need for conservation if energy
- State methods of reducing consumption of electricity
- Read/interpret electricity bills
- Identify examples of renewable& non renewable energy resources.
- Explain the importance of electrical safety and how fuses and circuit breakers are used to prevent circuit overload
- Define magnetism
- Identify different kinds of magnets
- List the properties of magnets (magnetic materials, magnetic poles, north and south poles, law of magnetic poles)
- Draw magnetic field lines around a bar magnet
- Make an electromagnet and explain how it works
- Distinguish between permanent and temporary magnets
- Relate waves to the movement of energy
- Recognize waveform and identify parts of waves

PREREQUISITES FOR TENTH GRADE PHYSICS

- Identify the direction of wave propagation
- Distinguish between transverse and longitudinal waves
- Identify luminous sources
- Describe an experiment to show that light travels in a straight line
- Explain the formation of shadows
- State the speed of light and compare it to that of sound
- Compare transparent, translucent and opaque materials in terms of what happens when light strikes them
- Define reflection and describe reflection of light on plane surfaces
- Define refraction
- State simple examples of refraction
- State that light is refracted as it passes from one medium to another
- Describe how prisms and water droplets disperse light to form a spectrum/rainbow
- State the colours of the spectrum
- State that lenses are curved glass which refract light rays passing through
- Describe qualitatively the effect that a concave lens has on light rays
- Describe qualitatively the effect that a convex lens has on light rays
- Distinguish between primary and secondary colours of light
- Identify vibration of matter as the cause of all sounds
- State that sound waves need a medium to travel, and therefore cannot travel in a vacuum
- Compare the rate at which sound travels in solids, liquids and gases
- Explain that echoes are formed when sound waves are reflected from a hard surface
- Distinguish between infrasonic and ultrasonic frequency
- State the components that make up the solar system
- Explain the effects of gravity on the behaviour of planets
- Define satellite, orbit, star, meteorite, comet and galaxy
- Explain what causes tides
- Describe the role of the sun in the solar system
- Define an atom
- Draw and label a diagram of an atom

APPENDIX V

Perspectives That Enrich Instruction

Scientific Literacy is an essential support for sustainable development in the global economy. It therefore stands to reason that one of the main goals of the Science Instructional Programme would be the promotion of Scientific Literacy.

The benefits that accrue from the promotion of Scientific Literacy in the curriculum are numerous. For, as Scientific Literacy increases, so does the students' appreciation of the **application of scientific principles to problem solving**. In addition, students are encouraged to focus their creative energies, spawned by alert inquiring minds, to produce positive end results that can be of economic, social and emotional value to themselves and society.

As educators zealously attempt to prepare students for coping with the challenges of life in a technology driven world, care should be taken to incorporate current and innovative practices in the Science Instructional Programme. These and other instructional strategies will:

- Motivate students to increase their understanding of the subject through practical immersion and discovery encounter experiences.
- Increase the effectiveness of Science instruction
- Build students' confidence and competence
- Heighten students' expectations
- Promote higher overall achievement

This section is intended to provide teachers at the primary level with a wide range of perspectives and innovative practices for implementing an effective Science Instructional Programme. These strategies comprise:

- Inquiry-based Learning
- Constructivism
- Bloom's Taxonomy
- Process Skills Development
- Use of the Scientific Method
- Cooperative Learning Technique
- Student-centred vs Teacher-centred Learning
- Multiple Intelligences and Learning Styles
- Assessment Strategies
- Information Technology Linkages
- Science Safety

Inquiry-based Learning

Inquiry–based Learning places emphasis on experiential learning; where practical “hands-on” activities are used to motivate students to focus their innate curiosities and inquiring minds on problem solving through the application of scientific principles.

Proponents of the traditional “lecture method” of instruction (i.e. imparting information directly from text books with limited or no opportunity for students to engage exploration, questioning and discovery skills) are rapidly being convinced that this strategy (with respect to the teaching of Science) is very ineffective, and when compared with other modern approaches is now obsolete.

Research has shown that frequent use of the lecture method especially with regards to the teaching of Science results in diminished student expectation and achievement. Research “shows that people don’t learn science by absorbing stuff that has been poured unto them (via lectures) but rather by constructing meaning out of experiences that the teacher provides.” *Wendy Saul, Science Education Analyst; University of Maryland, Baltimore County, U.S.A.*

In **Inquiry–based Learning**, opportunities are provided that create an environment that enable students to gain experience as a result of Science exploration. Practical experiences are provided and open-ended questions asked to encourage experimentation that does not necessarily have a known outcome and that will lead to testable questions. During this experimentation, students are encouraged to take risks and are therefore, not afraid to make mistakes. Some of the greatest scientific discoveries come after many failures and disappointments.

Inquiry–based learning goes beyond providing students with opportunities for practical, “hands–on” experiences to illustrate established scientific principles e.g. giving them batteries, bulbs, and wires to show the concept of current electricity. This strategy takes the learning process to a different level e.g. It may challenge students to use the batteries, bulb, wire and additional materials to develop something useful for a deaf person or something that can assist with a specific chore, homework assignment, etc.

The inquiry–based approach to the teaching of Science is key to effective and meaningful instruction as it encourages students to:

- Critically evaluate situations
- Frame their own questions
- Develop diverse strategies for coping with problems in their environment
- Cultivate organizational and creative skills
- Assume leadership roles and be self motivated
- Be accountable for their learning
- Collaborate and communicate with one another
- Develop team interaction skills

Constructivism

Constructivism is closely related to **Inquiry-based Learning** therefore, effective application of **Inquiry-based Learning** is enhanced by **Constructivism. Constructivism** means generating meaning by connecting what is to be learned with personal knowledge that has been constructed from past experiences. "A Constructivist is one who believes that the learner is responsible for constructing knowledge and, therefore, the responsibility for learning must be returned to the child." *Ebenezer & Conner 1998, Learning to Teach Science, A Model for the 21ST Century.*

Students' understanding of the world is moulded by their experiences. As they think about these experiences, their views and beliefs, they construct personal meaning and acquire knowledge. Constructivists advocate that students should not be expected to just accept knowledge and skills developed over the years and imparted by the teacher. Instead they become "active seekers" of knowledge as inquiry is encouraged and they discover and decipher things for themselves.

In using Constructivism, teachers become facilitators that create stimulating environments with a variety of "hands-on" experiences that empower students to explore. The teacher's main role is to provide experiences that help students make connections between what is learned and what they already know or believe. More learning takes place when students become active participants in the learning process and are "allowed to make their own sense out of the world."

Providing students with "hands-on" experiences that reinforce ideas or perceptions that they already have results in them assimilating or absorbing new concepts easily. The knowledge that the students construct from the information that they receive as a result of these "hands - on" activities makes sense and is easier for them to relate to and apply to their everyday life and their environment.

Constructivists probe students' knowledge base, examine and classify their concepts then provide them with opportunities to share and debate common knowledge. They then convert and expand students' knowledge by asking open-ended questions and presenting problems which cause them to gain new understanding of the concepts being taught. By doing this they challenge and promote conceptual change.

When using the Constructivism Theory, it should be noted that there are times when knowledge has to be imparted directly by the teacher in a detailed and explicit way. Although many benefits can be accrued from utilizing the Constructivism Theory if it is not used properly, learning may become sporadic and disorganized. Although students should not be stifled in their exploration to acquire knowledge, when using this theory it is important to:

- Set clear precise goals for the knowledge and skills that the students are expected to acquire
- Communicate these goals to the students and ensure that they are understood
- Organize assignments in a clearly planned sequence
- Provide guidance for the students

BLOOM'S TAXONOMY

STEPPING UP TO HIGHER LEVELS OF THINKING

Benjamin Bloom is accredited with identifying a list of behavioural terms that are reflective of various levels of learning. This list is referred to as Bloom’s Taxonomy and it enables us to better understand the cognitive level at which students process information. Students that process information at the higher levels develop critical thinking skills and are able to analyse, synthesize, and evaluate. They construct new meanings, and become original and creative thinkers. Students that process information at the lower levels may not become independent thinkers and may not be empowered to problem solve. The list of behavioural terms are as shown.

Students can express objective and subjective opinion supported by fact. It is the ability to detect fallacies in reasoning based on facts and the ability to judge

Evaluation

Decide, rate, evaluate, dispute, discuss, verify, judge, grade, choose, assess, select, conclude, have discussion, panel, give opinion, give verdict, recommend, debate

Students are able to create a new body of information from previous information. It is the ability to put elements together to form a new pattern with an emphasis on originality and creativity.

Synthesis

compose, imagine, infer, hypothesize, invent, create, estimate, produce, forecast, design, predict, film, formulate, invent, write poem, devise, develop, create project, create new game, write story, media, interpret

Students break an idea into its parts, and show that they understand their relationship, organization, and basic assumptions.

Analysis

Summarize, abstract, classify, dissect, compare, contrast, deduce, order, show bias, investigate, differentiate, categorize, separate, compile, questionnaire, survey, report, graph, chart, outline, diagram, conclude, plan

Apply students’ concepts learned to their environment and everyday life. They apply knowledge in new and/or practical ways to solve new problems in new situations

Application

show, apply, translate, illustrate, record, teach, construct, demonstrate, photograph, diagram, collect, map, complete puzzle, model, keep diaries, compile, report

This is the lowest level of understanding. Students are expected to explain materials, which may be presented in a variety of forms – paragraphs, tables, charts, graphs, cartoons, etc. They also make inferences or solve problems when told what to do.

Comprehension

draw, review, match, define, explain graph, give example, convert, test

This is the most basic level, the rote memorization of facts. Students are expected to recognize or recall information with an emphasis on remembering.

Knowledge

identify, locate, memorize, name, enumerate, read, reproduce, recall, label, use, list, recite

BEHAVIOURAL TERMS

Process Skills Development

Process skills are practical skills that allow students to use previous experiences, build upon them and link knowledge and skills learned at school to their environment and every day life.

Process skills help students to develop and apply critical thinking. Once given the opportunity to use and apply process skills, students develop the ability to reflect on and to evaluate their approaches to problem solving. As a result, students will come to the realization that there may be several solutions to any given problem. In this way, students can formulate hypotheses as testable ideas in their minds and can demonstrate deductive patterns of thought. Through integration of the basic and complex process skills listed, students should develop the ability to think logically and abstractly.

Basic Process Skills

Observing
Using one or more of the five senses (seeing, hearing, tasting, smelling, feeling) to find out about the world. Observing increases students' perceptions so that they can learn more about objects and events.

Classifying
Grouping objects or events based on similarities and/or categorizing based on existing relationships among objects or events.

Inferring
Explaining and interpreting observed events and collected data and explaining why they might have happened.

Communicating
Passing on information, proposing interpretations, explanations, and causes from observed events and collected data.

Recognizing and Using Spatial Relationships
Observing where things are in relation to other things by estimating the relative positions of moving and non-moving objects to one another.

Measuring
Finding out the size or amount of an object or substance when compared to a certain unit. Identifying and ordering length, area, volume, mass, and temperature to describe and quantify objects or events.

Predicting
Suggesting possible results or outcomes that will happen in the future based on observations and inferences drawn form previous experiences. The suggestions have to be based on correct information.

Using Numbers
Applying ordering, counting, adding, subtracting, multiplying, and dividing to quantify data where appropriate in investigations or experiments.

Complex Process Skills

Interpreting Data
Explaining the meaning or importance of information.

Forming Hypotheses
Asking questions about a problem and making assumptions in order to draw out and test different solutions to the problem.

Separating and Controlling Variables
Recognizing the many factors (variables) that affect the relationship of the factors to one another so that one factor (variable) can be manipulated while the others are controlled.

Experimenting
Test hypotheses or predictions by first identifying things (variables) that are important, then deciding which variables to change or manipulate which will be held constant, and what results to expect.

Formulating Models
Constructing mental, verbal, or physical representations or ideas, objects, or events. The models are then used to clarify explanations or to demonstrate relationships.

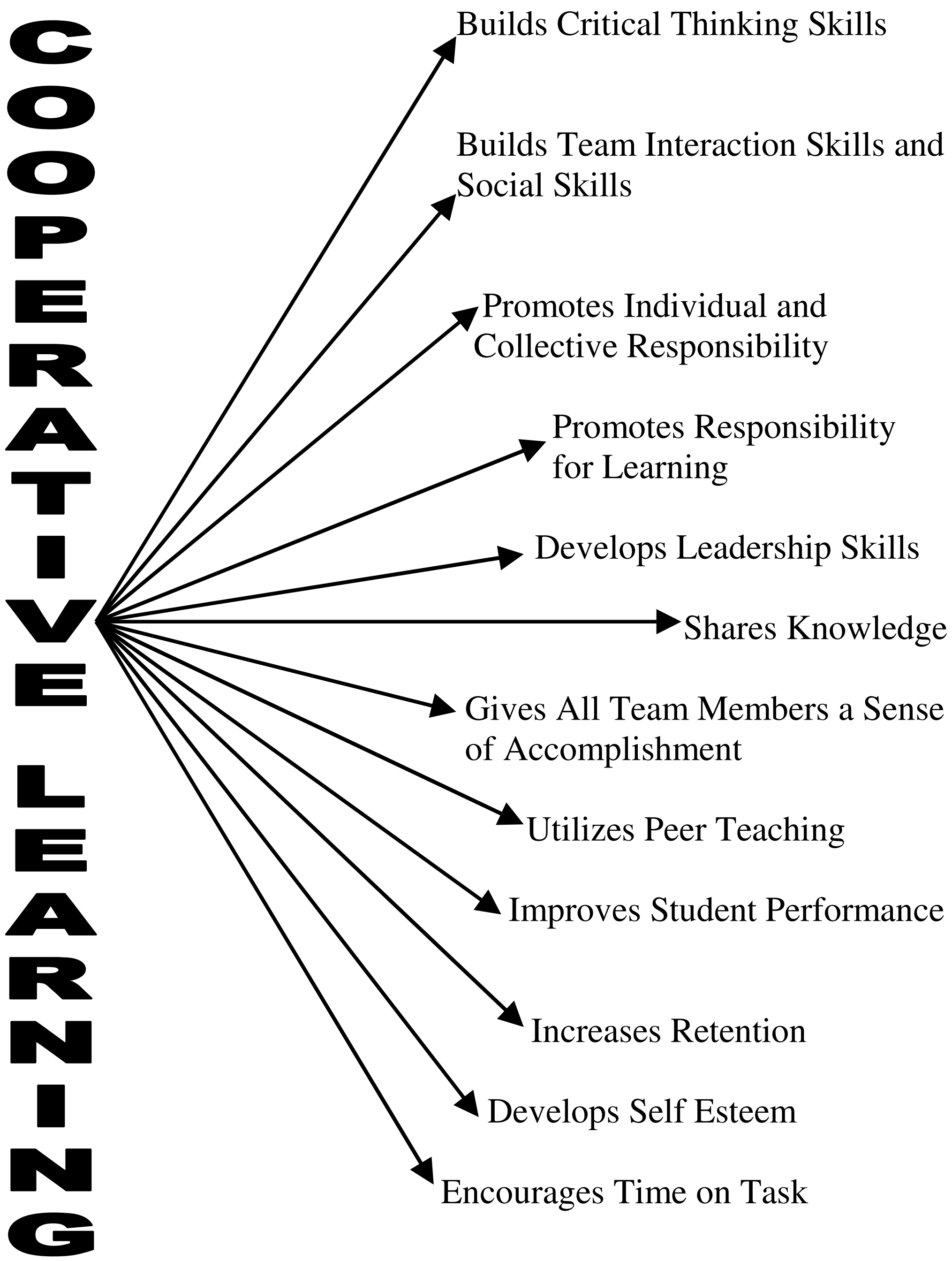
Defining Operationally
Describing the properties of things and their functions. These working definitions are based on actual experiences that the student had.

USE OF THE SCIENTIFIC METHOD

Students need to be taught valuable problem solving skills in order to react appropriately to the many situations that confront them on a daily basis. The **Scientific Method** sets out a sequence of logical steps that are employed in problem solving. It is applicable to **ALL** areas of life and is not restricted only to the teaching of Science.

The components of the **Scientific Method** and their descriptors are set out below. It is to be noted that students should utilize this format when writing up experiments or laboratory reports.

1. PURPOSE	The purpose is the question that is to be answered by doing the experiment. State the reason or reasons why you are doing the experiment. State the purpose as a question needing an answer.
2. HYPOTHESIS	A hypothesis is an educated guess on how the experiment/ activity will turn out, that is based on prior knowledge. Although a good hypothesis is testable, it may not be correct. Experimenting can find out whether or not he hypothesis is correct or not.
3. MATERIALS	All materials required for the activity/ experiment need to be identified. One must be as accurate as possible in describing the materials. Be sure to give exact amounts and quantities.
4. PROCEDURE	The procedure describes everything that will be done during the experiment. The procedure affects the result of the experiment therefore, care should be taken to explain the procedure as accurately as possible. State the procedure as numbered steps. (It would help if they are written with behavioural terms at the beginning.)
5. OBSERVATION	The observation describes exactly what happens during an experiment. Report the observations made and the data collected during the experiment. Data are recorded facts or measurements from an experiment. Data should be presented as tables, charts, and graphs, to be easily understood.
6. CONCLUSION	The conclusion is a comparison between the results and the hypothesis of an experiment. To draw a conclusion, the data needs to be analyzed to see what is meant. Explain observations and describe how the data relates to the problem. The conclusion should state whether or not the data supports the hypothesis. Part of the conclusion may be a statement or a new hypothesis based on findings and suggestions for testing the new hypothesis in a further experiment.



The **Cooperative Learning Technique** allows all students to have a sense of accomplishment. **Cooperative Learning** promotes group work and opportunities for verbal face-to-face interactions, which assist students to acquire and apply concepts.

Cooperative Learning builds interpersonal skills and positive interdependence characterized by specific roles, sharing of knowledge and materials and achievement of mutual goals. It encourages group processing as students analyse how well their groups are functioning and design and employ strategies to ensure that they function effectively.

When using the **Cooperative Learning Technique**, the teacher functions as a facilitator and students are more accountable for their learning and share the responsibility for the learning of others. It is important for the teacher to set and evaluate social and academic goals for the groups and the quantity and quality of students' learning.

When forming cooperative groups, it is recommended that groups work together for three to six weeks before students are assigned new roles or groups changed. During the year, each student should have an opportunity to function in each role. Once groups are formed, ensure that all members realize that they are jointly responsible for achieving group goals. They do this by:

- Contributing ideas to the group
- Listening carefully for ideas from others
- Helping the group make good decisions
- Cooperating rather than competing
- Solving problems in a calm manner

Reference: Circle of Learning: Cooperative Learning in the Classroom by D. W. Johnson et al, 1986

STUDENTS' ROLES AND FUNCTIONS

Supervisor, Leader or Investigator
Does experiments, manipulates materials

Assistant, Helper or Organizer
Collects, organizes and distributes materials and makes sure group cleans up any mess.

Manager or Motivator
Assists supervisor, leader or investigator, encourages the group, encourages time on task and adherence to goals and safe practices, and also times activities, if necessary.

Writer or Recorder
Records observations, questions, answers, illustrations etc.

Reporter
Collaborates with Writer or Recorder and shares group's data, results, and conclusion with class.

STUDENT-CENTRED vs. TEACHER-CENTRED LEARNING

Student-centred Learning develops self-directed learners who are confident in doing Science, proactive in the learning process and willing to share and accept responsibility for their own learning. Student-centred Learning activities are adaptive and cater to the learning needs of students.

COMPARISON OF STUDENT-CENTRED AND TEACHER- CENTRED LEARNING

STUDENT-CENTRED	TEACHER-CENTRED
♦ Students' conceptions and experiences are explored.	♦ Teacher is the authority figure and has the final say.
♦ Teacher challenges students to question before accepting information.	♦ Students must never question the teacher.
♦ Discussion is encouraged between students and teacher.	♦ Students only respond when a question is asked.
♦ Students are allowed to move about in an orderly manner to discuss and problem solve.	♦ Students must remain seated at all times.
♦ Students share and help each other. They use peer tutoring.	♦ Collaboration between students is discouraged and regarded as cheating.
♦ Students actively participate in decision-making.	♦ Students do not participate in decision-making.
♦ Learning activities cater to multiple intelligences and different learning styles.	♦ There is very little variation in learning activities.

MULTIPLE INTELLIGENCES

HOWARD GARDNER

The theory of Multiple Intelligences is a way of understanding the different facets of the intellect and each person's level of intelligence. The intelligences can work individually or in collaboration with the other intelligences, so a person could be operating in more than one intelligence. As we teach children, we should ensure that appropriate provision is made for individual differences and multiple intelligences.

- **Linguistic Intelligence** is a person's ability to construct and comprehend language. It is the capacity to use language to express feelings and to understand other people. It may be in a person's native language or another language. Poets, writers, orators, speakers, lawyers specialize in linguistic intelligence.

- **Naturalist Intelligence** is the ability to identify and classify patterns in nature. It the way a person relates to his environment and the recognition of the role that the environment plays in our lives. It is the ability to discriminate among living things like plants and animals and sensitivity to changes in nature e.g. weather patterns, rock configurations.

- **Spatial Intelligence** is how persons comprehend shapes and images in three dimensions. Spatial Intelligence is utilized to perceive and interpret things that we may or may not see. It is the ability to represent the spatial world internally in your mind--the way a sailor navigates the seas with only the stars or airplane pilot navigates aerial space, or the way a chess player or sculptor represents the spatial world. Spatial intelligence can be used in the arts or in the sciences. Persons with this type of Spatial Intelligence are usually painters, sculptors, architects and scientists who deal with anatomy and topology.

- **Musical Intelligence** is the ability to perform and compose music. It is the capacity to think in music, to be able to hear patterns, recognize them, remember them, and perhaps manipulate them. Persons with strong musical intelligence are completely preoccupied with music, it is always playing in their minds. Persons with musical intelligence use music to face their challenges and to assist them in solving their problems.

- **Bodily - Kinesthetic Intelligence** is a natural sense of how the body should act and react in demanding situations. These persons have extraordinary control of their movements, balance, agility and grace. They have the capacity to use their whole body or parts of their body to solve a problem, make something, or put on some kind of a production. **Bodily - Kinesthetic Intelligence** is evident in athletes and persons in the performing arts, particularly dance or acting.

- **Logical – Mathematical Intelligence is the ability to mentally process logical problems.** Persons with a highly developed **Logical-Mathematical Intelligence** can manipulate numbers, operations and quantities, and they have the ability to process logical questions at an unusually fast rate. These persons have the ability to understand the underlying principles of some kind of a causal system, the way a scientist or a logician does.

- **Intrapersonal Intelligence is a person's cognitive ability to** sense and understand him or herself. It refers to a very strong self-concept and strength of character, which gives the person the ability to solve internal problems. These persons know who they are, what they can do, what they want to do, how they react to things, which things to avoid, and which things to gravitate toward. These persons have a strong sense of purpose and are not easily deterred from that purpose. They know their strengths and their limitations and know where to go if they need help.

- **Interpersonal Intelligence** is understanding and interacting with others and interpreting their behaviour. As social beings, it is an essential ability that we all need however, persons with Interpersonal Intelligence have a greater perception of distinctions between persons and have the ability to judge their moods, temperaments, intentions and motivations. Persons with **Interpersonal Intelligence** become teachers, clergy, leaders, clinicians, salespersons, or politicians. Anybody who deals with other people has to be skilled in the interpersonal sphere.

Learning Styles

DAVID A. KOLB

Persons have their unique, individual way of learning. Understanding how students learn and planning activities that cater to various learning styles will enhance their learning and ensure higher achievement.

- **Visual Style**
  Persons who prefer the visual style convert what they hear and read to pictorial images in their brain. When recalling information they go through a process similar to reviewing pictures in a movie. These students have no problems in obeying conventional classroom rules. They will sit quietly, write neatly and use all materials well. These persons often choose careers like engineer, surgeon, designer, architect and positions of leadership that requires visionary thinking.

- **Auditory Style**
  These persons learn best by hearing and listening, they process information through their listening and repeating skills. They are good storytellers and can successfully talk through their problems. These students can easily repeat what they heard just as it was said. They are the most talkative and the most likely to participate in discussion however, they may experience difficulty in writing. These persons often become psychologists, disc jockeys, great musicians and other occupations that require a great deal of listening.

- **Kinesthetic Style**
  These persons process and remember information through their bodies and their feelings. Kinesthetic learners need to touch and feel what they are learning about. They may become restless unless they are actively involved in the learning process.

Assessment Strategies

WHAT IS ASSESSMENT?

- Whenever we interact with other people we obtain and interpret information about their knowledge and understanding, and may well make judgments about their ideas, abilities and attitudes.
- Assessment whether direct or indirect is a human encounter and is a central feature of social life.
- Educational assessment includes a wide range of methods for evaluating student performance that describes the nature and extent of learning and how it matches up to the objectives of teaching.

When assessing there must be alignment between what is in the curriculum, what is actually taught and what is tested.

WHY DO WE ASSESS?

- The main purpose of assessment is to judge the attainment or performance level of students, with a view of evaluating or grading them for one purpose or another.
- Purpose might include:
  - ⇒ Placing students in appropriate teaching sets;
  - ⇒ Providing extra motivation for learning and an aid to remembering;
  - ⇒ Informing parents about progress;
  - ⇒ Informing other teachers who have to make decisions about students e.g. when students transfer to a new school or new courses, which may have been studied;
  - ⇒ Accumulating records of achievement;
  - ⇒ Acting as a diagnostic tool e.g. diagnosing weaknesses so that remedial action may be taken;
  - ⇒ Making decisions about examination entries involving predictions about future performance;
  - ⇒ Informing further education institutions or employers about attainment so that suitable placement may be made. In doing this, we are using measured attainment to make predications about likely future performance.

Hence assessment has primarily been used as a means of judging the attainment and progress of students, providing a reporting system and deciding appropriate action.

FORMS OF ASSESSMENT

Assessment may be:

⇒ Informal

⇒ Formal

- **Informal assessment** takes place during normal learning activities. Much information can be picked up by teachers in their normal interaction with individual students, allowing problems to be overcome at an early stage and progress accelerated. Hence **informal assessment** is often used **diagnostically.**
- It is often said that **informal assessment** should be unobtrusive if the teacher is to gain reliable insights about students' abilities and the state of development, and that it should be for a specific purpose and for private use only.
- With **formative i.e. informal assessment** the results are fed back to the learner. Such feedback can be **confirmatory** (a recognition that the particular tasks have been mastered at that particular time) or can be **corrective,** allowing dialogue between teacher and learner to show where the learner went wrong.
- **Formal assessment** is only aimed at obtaining knowledge about the student. It is obtrusive and may not be able to provide direct instructional function.
- **Formal assessment** becomes **summative** when information is not available for feedback purposes because it is obtained too late in the learner's career to be used in this way.
- **Formal** and **summative assessment** is used largely for public purposes (e.g. BJC, BGCSE and RSA Examinations)
- Even this is changing with the advent of initiatives such as the GLAT where **formal and summative assessments** are made with students at grade 3 and 6. The results of formal assessments made at an early stage can be used for the benefit of the learner at the next stage of education.

ASSESSMENT MAY ALSO BE TRADITIONAL OR AUTHENTIC

Traditional Assessment measures what the students were taught and basically assesses their ability to recall information. This type of assessment includes **homework, quizzes** and **tests.**

Authentic Assessment measures what students have actually learned and can promote further learning. This type of assessment includes **portfolios**, **journal keeping, anecdotal records**, student **conferencing, self and peer assessment, projects and reports.**

Although there is no alternative for traditional assessment in certain situations, authentic assessment should be frequently used in the High School Science Instructional Programme.

Contributed by Shena Williams, Examination and Assessment Division

APPENDIX VI

Safety in the Teaching/Learning Environment

Teachers should communicate the following safety rules to their students and ensure that they are obeyed.

In the Classroom

- Know the location and proper use of the fire extinguisher and first aid kit.
- Never eat, drink or smell any substance in the laboratory unless you are instructed to do so by the teacher.
- Listen to your teacher for special safety directions. If you do not understand something, ask for help.
- Wear safety goggles when your teacher tells you to wear them.
- Wear safety aprons if you work with anything messy or anything that might spill.
- Read all of the directions before doing experiments or using equipment. Make sure you understand them. If you do not, ask your teacher for assistance.
- Carefully read the label on the container of a product before you use it; follow the manufacturer's instructions and pay special attention to health or safety warnings.
- Be careful around a hot plate, Bunsen burner or other sources of heat. Only use these items if instructed to do so by the teacher.
- Keep your hair and clothes away from open flames. Tie back long hair and roll up long sleeves.
- When heating materials in test tubes, always slant the tubes away from yourself and others.
- Keep your hands dry around electrical equipment.
- Never run or play around in the Science Laboratory classroom.
- Never draw any material into a tube with your mouth.
- Tell your teacher if something breaks or spills. Move away from it and wait for the teacher's instructions.
- Put away tools and equipment safely the way your teacher tells you to, as soon as you finish using them; do not leave them where they may be stumbled over.
- Clean your work area, and wash your hands afterwards.

On Field Trips

- Always be accompanied by a trusted adult approved by the principal – like your teacher, a parent/guardian or an expert about the field trip.
- Never touch animals or plants without the adult's approval. The animal might bite. The plant might be poisonwood or another harmful plant.
- Stay with your group and keep within sight of the accompanying adult. Report any scrapes, cuts, and injuries to your teacher immediately.

Responsibility

- Treat living things, the environment, and each other with respect.

Refer to the Safety Manual (High School Science) for further information.

APPENDIX VII

Physics Curriculum

Grade Level Evaluation Form

Kindly complete this format the end of the first year using it with Grade *10.*

Section A

Place a tick in the box which best describes your response to items 1 – 11. Your honest responses are both valuable and appreciated.

No.	Item	Always	Often	Seldom	Never
1.	Are the content and concepts included in the *tenth* grade curriculum age-appropriate?				
2.	Is sufficient information given in the content column to provide guidance as to the depth to be covered?				
3.	Are sufficient opportunities given for students to develop the designated 17 skills?				
4.	Are the suggested methods of assessment directly related to the learner outcomes and targeted skill?				
5.	To what extent did you use the suggested methods of assessment?				
6.	Did students complete assignments?				
7.	Were the identified resource materials available?				
8.	Are the suggested activities appropriate for concept formation and reinforcement of main points?				
9.	Were you able to use the suggested activities?				
10.	Did the curriculum provide sufficient guidance in how to adapt it to meet the needs of students of higher or lower ability levels?				
11.	Were you able to introduce local examples to relate to students' interest and experiences?				

Section B

Indicate your responses in the space provided.

12. Which topics/concepts, if any were too difficult?

____

____

13. Which topics/concepts if any would be better suited at *junior high* level?

____

____

14. Which skills, if any, were over-emphasized?

____

____

15. Which skills, if any, were under-emphasized?

____

____

16. Which units, if any, were given too much time to be completed?

____

____

Physics Curriculum
Grade Level Evaluation Form

17. Which units, if any, were allocated insufficient time to be completed?

18. Which skills, if any, did students show an improvement in during the year?

19. What is the approximate percentage of students who was able to attain the standards for *Grade ten*?

20. Which part(s), if any, of the grade level curriculum was/were successfully implemented? Why?

21. Which part(s), if any, of the grade level curriculum was/were not successfully implemented? Why?

22. Was there any aspect of the curriculum for *tenth* grade that placed the students at a disadvantage because of their location (island/district/type of school)? If so, state which parts and why.

Section C
Please circle the appropriate category which describes the school to which you are posted and your years of teaching experience.

School Type:	Junior High	Secondary	All-Age
Student Population:	30 – 199	200 – 450	451 +
Location:	Family Islands	Grand Bahama	New Providence

Your years of experience in the Bahamian school system:

0 – 3 years	4 – 9 years	10 – 15 years	16 + years