

SENIOR SCHOOL



MINISTRY OF EDUCATION
DEPARTMENT OF EDUCATION

Essential Curriculum

2008

**Curriculum and Instructional Leadership
Performance Standards Summary**

SCIENCE



PERFORMANCE STANDARDS ARE LEARNING EXPECTATIONS

“THE ESSENTIAL CURRICULUM”

The mission of the Bermuda Public School System (BPSS) is *to be the first choice in education by providing rigorous and stimulating learning experiences in safe, responsive environments from which our students emerge confident and prepared to compete and contribute locally and globally.*

Performance Standards are statements of what students should know and be able to do and how they should demonstrate their knowledge and skills at the end of each year. Included within the Performance Standards document are **strands, performance statements** and **assessment indicators** for English language arts, mathematics, science and social studies. It is important to note that the assessment indicators listed in this booklet represents the “Essential Curriculum.” They are the critical guidelines for ongoing and island-wide curriculum based assessment. They are guideposts in the journey our students make from the time they enter our schools to the time they graduate *confident and prepared to compete and contribute locally and globally.*



Serving as guideposts, performance standards establish shared expectations for the:

- completion of each year of our school system,
- guidance in terms of how we may need to redirect our efforts during any given year of our school system
- direction in terms of what we should be able to expect of students entering each subsequent year of our school system.

As they serve as guideposts for teachers responsible for maximizing students' learning experiences, performance standards tell us not only the *ultimate* goals for each year level but also provide direction towards achievement of the goals *during* each year.

Bermuda Performance Standards will be used to:

- emphasize the concepts and processes all students should learn with understanding.
- provide explicit goals for student expectation at the end of each year.
- guide Bermuda Criterion Reference and classroom assessments

Bermuda Public School System Performance Standards

Science (SC)

Physical Science (P)

Life Science (L)

Earth and Space Science (E)

Nature of Science (N)

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- Life Science
- Earth and Space Science
- Nature of Science

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- P2 Force and Motion
- P3 Energy
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- L3 Cells, Organs and Organ Systems
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- N1 Scientific Investigation
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- N3 Designed World: Science Technology and Society

S2 SCIENCE (SC)

Introduction to Science Performance Standards5

- Physical Science
- Life Science
- Earth and Space Science
- Nature of Science

References

Physical Science (P).....19

- P1 Matter and Materials
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Life Science (L)21

- L1 Diversity of Life
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- L4 Interdependence
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Earth and Space Science (E)23

- E1 Astronomy
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Nature of Science (N)25

- N1 Scientific Investigation
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- N3 Designed World: Science Technology and Society

BERMUDA SCIENCE PERFORMANCE STANDARDS (SC)

The study of science is an intellectual and social endeavour – the application of human intelligence to figuring out how the world works.

Benchmarks for Science Literacy: Project 2061 (1993)

The *Bermuda Science Performance Standards* document is an amalgam of widely respected science documents that have been developed in many different countries, including the United Kingdom, United States and Canada. As is easily recognizable in standards documents from other jurisdictions, *Benchmarks for Science Literacy* has been used as the basis for *Bermuda Science Performance Standards*. Science in the schools provides an introduction to many different scientific disciplines from the traditional physics, chemistry and biology to geology, environmental science and meteorology. These standards are therefore wide ranging and provide the foundation for not only scientific literacy, but also the critical knowledge and skills for those who intend to study science as a requisite for their careers.

The National Science Education Standards (NSES, National Research Council, 1995) define scientific literacy as the knowledge and understanding of scientific concepts and processes which are required for participation in civic and cultural activities, economic productivity and personal decision making. The philosophy of The Bermuda Science Curriculum (Bermuda Ministry of Education, 1997) echoes the intent of the NSES statement and indicates that science education should empower all students to make informed choices concerning personal, societal, environmental and technological issues, thus fostering an appreciation and a sense of responsibility for the future.

In Bermuda, science is considered a critical component of education for *all* children and is therefore mandated as a core subject from preschool through to senior school. *The Bermuda Science Performance Standards* are not a curriculum. They provide the framework for our year-by-year science curriculum that spans the fourteen years from preschool to senior school. They expand the “what” students should know and be able to do to the “how” and “to what extent” students should demonstrate their understanding of scientific concepts and skills.

As stated in the National Curriculum for England, the standards must be “*robust enough to define and defend the core of knowledge and cultural experience and flexible enough to give teachers scope to build their teaching around it in ways that will enhance its delivery to pupils*” (The National Curriculum for England, 2000).

The *Bermuda Science Performance Standards* are categorized into four (4) strands, recognizable as organizers in curriculum documents of many jurisdictions:

- 1. Physical Science (P)**
- 2. Life Science (L)**
- 3. Earth and Space Science (E)**
- 4. Nature of Science (N)**

The first three strands, communicate the knowledge and concepts of science using traditional categories. The Nature of Science emphasizes the way that science and scientists work and how, together with mathematics and technology, the world has been shaped by human endeavour.

The strands are divided into standards that spiral throughout the compulsory years of the science programme in Bermuda. When the goal is deep understanding it is essential for concepts to be revisited over time. Standards are further broken down into indicators for assessment.

Students show conceptual understanding when they can:

- *use a concept accurately to explain observations and make predictions, first in familiar then unfamiliar situations*
- *represent the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

Both aspects of understanding – explaining and representing – are required to meet the standard.

PHYSICAL SCIENCE (P)

Physical science, which consists of concepts of chemistry and physics, involves the study of matter and materials, forces and energy. There are four (4) physical science standards.

The student will produce evidence that demonstrates understanding of:

- P1 Matter and Materials** - their properties, components, interactions and changes
- P2 Force and Motion** - the relationship between force, mass and motion of an object and the nature and interaction of waves and matter
- P3 Energy** - the sources and forms of energy, including transmission and transformations and how energy helps explain the structure of matter and the universe
- P4 Forces of Nature** - gravitational, electrical and magnetic forces as the fundamental forces acting in nature

LIFE SCIENCE (L)

Life Science, which consists of concepts of biology and ecology, deals with the diversity of living organisms, their organization, life processes, relationships with one another and their environment. There are six (6) Life Science standards.

The student will produce evidence that demonstrates understanding of:

- L1 Diversity of Life** - the variety of living things and the processes responsible for the maintenance of life
- L2 Heredity** - biological traits and how they are passed on from generation to generation
- L3 Cells, Organs and Organ Systems** - the structure, function and reproduction of cells that maintain the organization essential for life and specialized organs systems that interact with each other to maintain internal balance
- L4 Interdependence of Life** - relationships amongst organisms and their dependence on their environment
- L5 Flow of Matter and Energy** - the linking of organisms to one another and their physical setting by the transfer and transformation of matter and energy
- L6 Evolution of Life** - the evolution of life on earth and natural selection as an explanation of biological processes

EARTH AND SPACE SCIENCE (E)

Earth and Space Science consists of concepts of astronomy, geology, resources, meteorology and oceanography. Earth and Space Science involves the study of the earth, the universe, their components and interactions. There are five (5) Earth and Space Science standards

The student will produce evidence that demonstrates understanding of:

- E1 Astronomy** - the current scientific view of the nature, components, matter and energy sources of the universe
- E2 Geology** - the features of the earth's surface, how they were formed and how they are continually changing
- E3 Resources** - the earth's limited and varied materials that supply many of the resources that humans use
- E4 Meteorology** - the interactions of structures of the earth's system and the sun's energy which cause weather and climate patterns
- E5 Oceanography** - the features of oceans and the impact of these features on the global ecosystem

NATURE OF SCIENCE (N)

The Nature of Science strand involves of the understanding and application of scientific investigative techniques and data analysis. Nature of Science also includes the study of the interrelationships among science, technology, and society. There are three (3) Nature of Science standards.

The student will produce evidence that demonstrates understanding of:

- N1 Scientific Investigation** - People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to things and noting

what happens. Investigations are conducted for different reasons, which include exploring new phenomena, checking on previous results and comparing different theories. Investigations usually involve collecting evidence, reasoning, devising hypotheses, and making predictions.

N2 Data Representation and Interpretation - Data must be analysed in order to make sense of what has been collected. Sometimes the evidence collected might not be what you expected or might not be sufficient to draw a conclusion. Clear and accurate communication is important in doing science and an essential part of sharing an investigation order to inform others.

N3 Designed World: Science, Technology and Society - Over the course of the history of world exploration, humans have shaped and reshaped the world we live in by using technology in tandem with expanding science knowledge. Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Science influences society through its knowledge and world view. Technology influences society through its products and processes. Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.

REFERENCES

It should be noted that there is a great deal of similarity amongst standards. The main sources for the Bermuda Performance Standards document contain hundreds of pages of detail that cannot be provided in the Bermuda *Science Performance Standards*. If further amplification of standards is required, it would appropriate to research the sources cited in this section.

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Physical Science (P)

Physical science (P), which consists of concepts of chemistry and physics, involves the study of matter and materials, forces and energy.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

P1 - Matter and Materials -
their properties, components,
interactions and changes

SC.S1.P1

Students will produce evidence that demonstrates understanding of :

- a) Matter is composed of atoms and molecules or ions.
- b) Atoms are composed of electrons protons and neutrons.

Assessment limits:

- When using the term atomic mass, also include mass number (i.e., atomic mass or mass number).
- c) Elements are placed in the periodic table based on the structure of their atoms.

Assessment limits:

- reactivity trends across period and down groups
- families (alkali metals, alkaline earth metals, halogens, noble gases
- coinage metals, and transition metals.
- d) About 100 different elements have been identified, out of which everything is made. Some groups of elements have similar properties. Some elements do not fit into any categories, such as carbon and hydrogen, the essential elements of living matter. The periodic table is a classification system of elements.
- e) Chemical changes occur when one or more substances react together to form another substance with different properties. Burning and rusting are examples of oxidation, when oxygen is combined with another substance. Some factors that influence reaction rates include temperature, and particle size.

P2 - Force and Motion -
the relationship between
force, mass and motion of
an object and the nature and
interaction of waves and
matter.

SC.S1.P2

Students will produce evidence that demonstrates understanding of :

- a) Energy can be transmitted as waves.

Assessment limits:

- characteristics, nature, interactions of waves
- amplitude, wavelength, frequency
- various forms of electromagnetic waves
- sound and light waves
- speed of sound,
- visible light: reflection, refraction; including angle of incidence
- types of electromagnetic radiation
- electromagnetic spectrum: infrared, ultraviolet, x-rays, microwaves, radio waves
- colour and wavelength

Physical Science (P) (continued)

Physical science (P), which consists of concepts of chemistry and physics, involves the study of matter and materials, forces and energy.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

P3 - Energy -

the sources and forms of energy, including transmission and transformations and how energy helps explain the structure of matter and the universe.

P4 - Forces of Nature -

gravitational, electrical and magnetic forces as the fundamental forces acting in nature.

SC.S1.P3

Students will produce evidence that demonstrates understanding of :

- a) Energy cannot be created or destroyed only transformed. During many processes, energy is transferred to the environment in the form of heat.

Assessment limits:

- Conduction, convection, radiation
- Understanding of specific heat - solve problem if given formula
- b) Heat energy in a material consists of disordered motions of its atoms or molecules.

Assessment limits:

- change of phase
- Kinetic theory -movement of particles

SC.S1.P4

Students will produce evidence that demonstrates understanding of :

Not assessed at this level on the Bermuda Criterion Reference Test (BCRT)

Life Science (L)

Life Science (L) which consists of concepts of biology and ecology, deals with the diversity of living organisms, their organization, life processes, relationships with one another and their environment.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

L1 - Diversity of Life -

the variety of living things and the processes responsible for the maintenance of life.

SC.S1.L1

Students will produce evidence that demonstrates understanding of :

a) Biological diversity is the variety of living things. Scientists classify organisms and give each one universally accepted scientific name.

Assessment limits:

- binomial nomenclature;
- Linnaeus's system of classification,
- taxonomic categories
- Dichotomous keys

L2 - Heredity –

biological traits and how they are passed on from generation to generation

SC.S1.L2

Students will produce evidence that demonstrates understanding of :

Not assessed at this level on the Bermuda Criterion Reference Test (BCRT)

L3 - Cells, Organs and Organ Systems –

the structure, function and reproduction of cells that maintain the organization essential for life and specialized organ systems that interact with each other to maintain internal balance

SC.S1.L3

Students will produce evidence that demonstrates understanding of :

a) A cell is a well-specialized and complex system.

b) Cells function best under particular conditions of water and temperature. The maintenance of these conditions is called homeostasis.

Assessment limits:

- Basic understanding of an organism's response to changes in the environment.
 - regulation of body temperature and water balance
- c) Organelles in the cells use chemical reactions to carry out life processes.

Assessment limits:

- cell theory
- prokaryotes and eukaryotes
- eukaryotic cell structure
- structure and function of organelles in plant and animal cells extended to nucleolus, endoplasmic reticulum, Golgi apparatus, centrioles, ribosome
- transport across cell boundaries – functions of cell membrane and cell wall

Life Science (L)

(continued)

Life Science (L) which consists of concepts of biology and ecology, deals with the diversity of living organisms, their organization, life processes, relationships with one another and their environment.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

L4 - Interdependence of Life –
relationships amongst organisms and their dependence on their environment.

SC.S1.L4

Students will produce evidence that demonstrates understanding of :

Not assessed at this level on the Bermuda Criterion Reference Test (BCRT)

L5 - Flow of Matter and Energy
- the linking of organisms to one another and their physical setting by the transfer and transformation of matter and energy.

SC.S1.L5

Students will produce evidence that demonstrates understanding of :

Not assessed at this level on the Bermuda Criterion Reference Test (BCRT)

L6 - Evolution of Life –
the evolution of life on earth, natural selection as an explanation of biological processes.

SC.S1.L6

Students will produce evidence that demonstrates understanding of :

- a) Biological classifications are based on how organisms are related.
- b) Living things evolve over time. Natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms and striking molecular similarities observed among the diverse species of living organisms.
- c) The millions of different species of plants, animals and microorganisms that live on earth today are related by descent from common ancestors.

Earth And Space Science (E)

Earth and Space (E) Science consists of concepts of astronomy, geology, resources, meteorology and oceanography. Earth and space science involves the study of the earth, the universe, their components and interactions.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

E1 - Astronomy -

the current scientific view of the nature, components, matter and energy sources of the universe.

SC.S1.E1

Students will produce evidence that demonstrates understanding of :

- a) The universe has evolved over billions of years and will continue to evolve.
- b) Stars were condensed by gravity out of clouds of molecules of the lightest elements until nuclear fusion of light elements into heavier ones began to occur.

Assessment limits:

- Fusion released great amounts of energy over millions of years.
- Eventually some stars exploded producing clouds of heavy elements from which other stars and planets could later condense.
- This process of star formation and destruction continues
- c) The stars differ from one another in size, temperature and age, but appear to be made up of the same elements that are found on earth.

Assessment limits:

- Hertzsprung – Russell diagram as stimulus for questions
- making comparisons and interpreting diagrams
- d) The bodies of the solar system are bound together by gravitational force. This force of attraction is exerted by every object on every other object.

Assessment limits:

- organization of solar system
- characteristics of planets
- sun as star, moon, tides, eclipses
- e) Increasingly sophisticated technologies and subsequent analysis by mathematical modeling are being used to explore our universe and beyond. This includes the search for evidence of life elsewhere from earth.

Assessment limits:

- cameras, binoculars, telescopes, satellites, space probes

E2 - Geology -

the features of the earth's surface, how they were formed and how they are continually changing.

SC.S1.E2

Students will produce evidence that demonstrates understanding of :

Not assessed at this level on the Bermuda Criterion Reference Test (BCRT)

E3 - Resources -

the earth's limited and varied materials that supply many of the resources that humans use

SC.S1.E3

Students will produce evidence that demonstrates understanding of :

Not assessed at this level on the Bermuda Criterion Reference Test (BCRT)

Earth And Space Science (E) (continued)

Earth and Space (E) Science consists of concepts of astronomy, geology, resources, meteorology and oceanography. Earth and space science involves the study of the earth, the universe, their components and interactions.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

E4 - Meteorology -

the interactions of structures of the earth's system and the sun's energy which cause weather and climate patterns

SC.S1.E4

Students will produce evidence that demonstrates understanding of :

Not assessed at this level on the Bermuda Criterion Reference Test (BCRT)

E5 - Oceanography -

the features of oceans and the impact of these features on the global ecosystem

SC.S1.E5

Students will produce evidence that demonstrates understanding of :

Not assessed at this level on the Bermuda Criterion Reference Test (BCRT)

Nature Of Science (N)

Nature of Science (N) consists of the understanding and application of scientific investigative techniques and data analysis. Nature of Science also involves the study of the interrelationships between science, technology, and society.

N1 - Scientific Investigation

-People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to things and noting what happens. Investigations are conducted for different reasons, which include exploring new phenomena, checking on previous results and comparing different theories. Investigations usually involve collecting evidence, reasoning, devising hypotheses, and making predictions.

N2 - Data Representation and Interpretation -

Data must be analysed in order to make sense of what has been collected. Sometimes the evidence collected might not be what you expected or might not be sufficient to draw a conclusion. Clear and accurate communication is important in doing science and an essential part of sharing an investigation in order to inform others.

SC.S1.N1

Students will produce evidence that demonstrates understanding of :

a) Planning an investigation

Assessment limits:

- Use scientific knowledge and understanding to convert ideas into a form that can be investigated
- Support predictions with scientific reasons (from books, Internet or other sources)
- Understand concept of bias
- Write/evaluate clear step by step procedure for investigation

b) Obtaining evidence for investigation.

Assessment limits:

- Vary key variables
- Determine number of observations or measurements to be made
- Select and manipulate a range of apparatus to help to obtain precise evidence
- Read analog and digital meters on instruments used to make direct measurements of length, volume, weight, elapsed time, rates and temperature
- Repeat results to obtain average readings

SC.S1.N2

Students will produce evidence that demonstrates understanding of :

a) Summarising and organising data

Assessment limits:

- Represent data and results in multiple ways such as numbers, tables, graphs, diagrams.
- Select the best way of displaying your evidence; represent data with pie charts, graphs, tables, histograms etc.
- Create table of results with clear headings and correct units

b) Analyzing evidence and making conclusions

Assessment limits:

- Identify trends or patterns in results (best fit graphs, multi-line graphs, multiple data sets).
- Use graphs to determine relationships between variables
- Explain whether you have enough evidence to draw a conclusion
- Explain whether results are consistent with original prediction
- Draw a meaningful conclusion based on evidence in outcome
- Support conclusions with evidence from experiments or research
- Evaluate investigation (redesign investigation if necessary – how might the method be improved to obtain more evidence to support the conclusion)

Nature Of Science (N) (continued)

Nature of Science (N) consists of the understanding and application of scientific investigative techniques and data analysis. Nature of Science also involves the study of the interrelationships between science, technology, and society.

N3 - The Designed World -

Over the course of the history of world exploration, humans have shaped and reshaped the world we live in by using technology in tandem with expanding science knowledge. Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Science influences society through its knowledge and world view. Technology influences society through its products and processes. Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.

SC.S1.N3

Students will produce evidence that demonstrates understanding of :

- a) Things found in nature are different from those that are made by humans. New products and systems can be developed to help solve problems, but there could be desirable or undesirable consequences.

Assessment limits:

- Applications of technology – communications, transportation, manufacturing and construction
- formation of plastics, new fuels, synthetic fibres, pharmaceuticals,
- Science and mathematics attend to result in advances in technology (e.g., binary system to digital machines such as laptop computers, digital cameras, compact disc players)
- Increased use of energy in more industrialized countries leads to rapid depletion of Earth's energy resources and heightened environmental risks from fossil and nuclear fuels.
- Decisions to develop and use technologies often put environmental and economic concerns in direct competition (for example, preservation of open space and wetlands vs. housing and improvement of roads)

- b) Important contributions to the advancement of science, mathematics and technology have been made by different kinds of people in different cultures in different times.

Assessment limits:

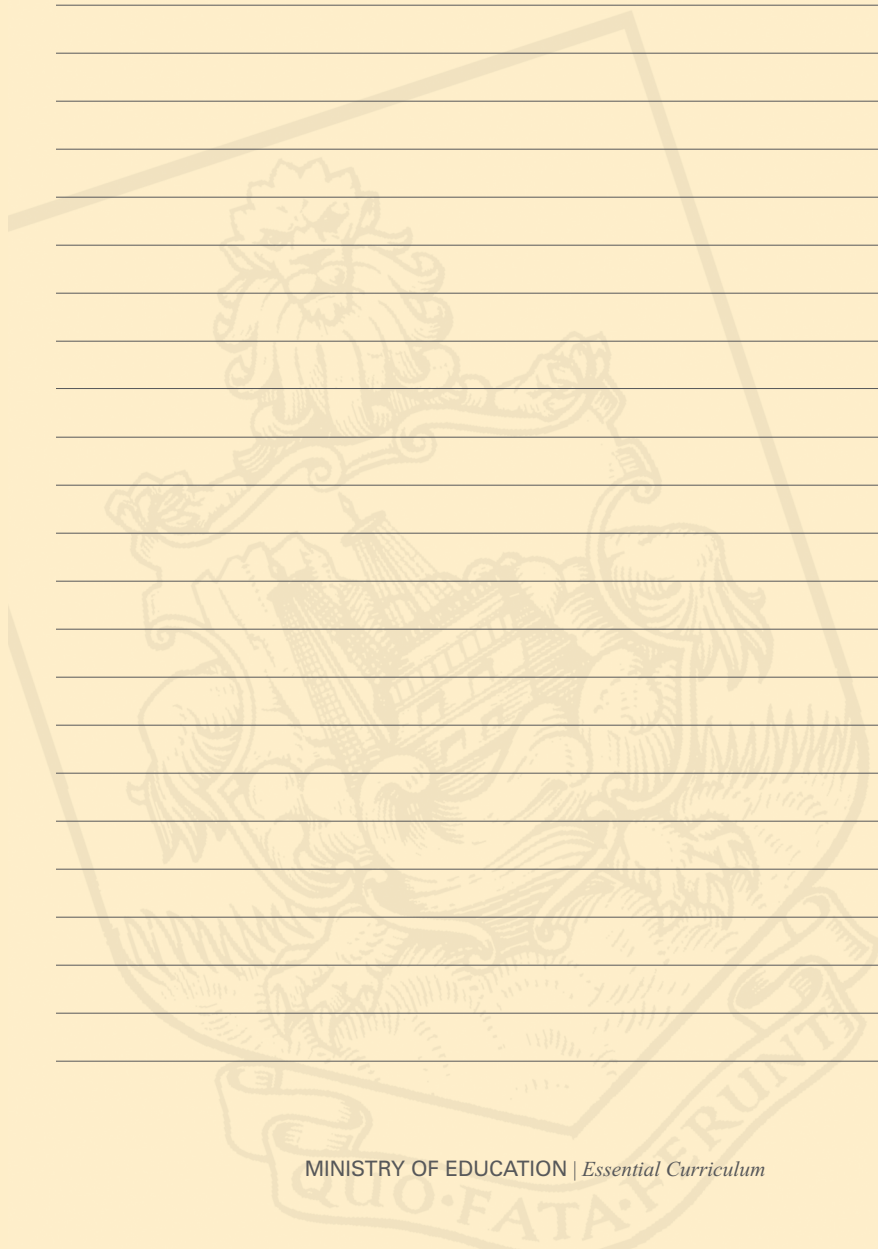
- Science disciplines differ from one another in what is studied, techniques used and outcomes sought, but they are all part of the same scientific enterprise. (physics, chemistry, biology, ecology; environmental science, meteorology and related careers; what kinds of processes are studied in the discipline by the scientists – other careers – forensic scientist, medical laboratory technician)

- c) Diet, exercise, disease and toxic substances influence the physical health of individuals. Science has contributed to health and health technologies.

Assessment limits:

- (pertaining to S1 concepts)

PLANNING NOTES





Physical Science (P)

Physical science (P), which consists of concepts of chemistry and physics, involves the study of matter and materials, forces and energy.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

P1 - Matter and Materials -
their properties, components,
interactions and changes

SC.S2.P1

Students will produce evidence that demonstrates understanding of :

- a) Reactions of elements depend on the arrangement of electrons in the atom.
- b) Compounds are formed when atoms of elements combine by gaining, losing (transferring) or sharing electrons.

Assessment limits:

- ionic vs. covalent bonding
- ionic compounds such as sodium chloride, covalent compounds such as hydrogen, water, methane, hydrogen chloride
- Lewis dot structures for electron configuration of same
- c) The arrangement of particles (atoms, molecules, ions) in a substance determines its structure and properties.

Assessment limits:

- diamond, sodium chloride, graphite, metallic bonding
- d) Chemical formulas and balanced equations are used to represent chemical reactions.

Assessment limits:

- types of reaction include synthesis, single and double displacement, decomposition, oxidation; acid/base – neutralization
- acids, bases and salt formation
- full pH scale, write formulas and balance simple equations
- e) Factors that affect reaction rates include temperature, concentration, and particle size of the reactants, catalysts.

P2 - Force and Motion -
the relationship between
force, mass and motion of
an object and the nature and
interaction of waves and
matter.

SC.S2.P2

Students will produce evidence that demonstrates understanding of :

- a) Forces have both magnitude and direction (vectors).
- b) Forces cause changes in motion. The change in motion of an object is proportional to the force applied and inversely proportional to the mass of the object.
- c) When two objects interact, they exert equal and opposite forces on each other.

Assessment limits:

- Newton's Laws of Motion
- d) Apply formula to a problem.

Assessment limits:

- words and symbols in formulas (not symbols by themselves)
- $\text{force} = \text{mass} \times \text{acceleration}$
- $\text{work} = \text{force} \times \text{distance}$
- $\text{power} = \text{work done} / \text{time taken}$

Physical Science (P) (continued)

Physical science (P), which consists of concepts of chemistry and physics, involves the study of matter and materials, forces and energy.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

P3 - Energy -

the sources and forms of energy, including transmission and transformations and how energy helps explain the structure of matter and the universe.

SC.S2.P3

Students will produce evidence that demonstrates understanding of :

- a) Energy is transferred from batteries to other components in electrical circuits. Electrical energy in circuits can produce heat, light sound and chemical changes. Components in a circuit resist a current flowing through them.

Assessment limits:

- Understanding and application of circuits
- direct/alternating current
- more complicated circuits at this level
- understand resistors
- household circuits, wiring plugs and safety features -fuses, circuit breakers
- calculation of power (current x voltage)
- simple calculations related to household electric use

P4 - Forces of Nature -

gravitational, electrical and magnetic forces as the fundamental forces acting in nature.

SC.S2.P4

Students will produce evidence that demonstrates understanding of :

- a) Gravitational force is an attraction between masses.
b) Electric forces between electrons, protons hold atoms and molecules together and are involved in all chemical reactions. Materials are electrically neutral.
c) Different kinds of materials respond differently to electric forces.
d) Moving electric charges produce magnetic forces and moving magnets produce electric forces.

Assessment limits:

- explanation of magnetic effect of an electric current
- application of principles of electricity and magnetism to a simple electric motor
- e) Large amounts of energy are released from nuclear reactions in the sun and other stars because of the strength of forces that hold the nucleus of the atom together.

Life Science (L)

Life Science (L) which consists of concepts of biology and ecology, deals with the diversity of living organisms, their organization, life processes, relationships with one another and their environment.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

L1 - Diversity of Life -

the variety of living things and the processes responsible for the maintenance of life.

L2 - Heredity –

biological traits and how they are passed on from generation to generation

L3 - Cells, Organs and Organ Systems –

the structure, function and reproduction of cells that maintain the organization essential for life and specialized organ systems that interact with each other to maintain internal balance

SC.S2.L1

Students will produce evidence that demonstrates understanding of :

- a) The great diversity of species increases the chance that at least some living things will survive after significant changes to the environment.
- b) Kinship can be estimated from similarities of DNA sequences.

SC.S2.L2

Students will produce evidence that demonstrates understanding of :

- a) Sorting and recombination gives a variety of possible combinations.

Assessment limits:

- Complete and interpret Punnett square - monohybrid cross only
- understanding of homozygous, heterozygous, complete dominance, genes, alleles
- b) Asexual reproduction produces offspring that are identical to the parent (clones). Sexual reproduction is a source of genetic variation.

Assessment limits:

- Information passed from parent to offspring is coded in DNA molecules
- Comparison of mitosis and meiosis
- ordering the phases of meiosis - pictures
- Understanding of the role of meiosis

SC.S2.L3

Students will produce evidence that demonstrates understanding of :

- a) Humans and other animals have body systems for obtaining and providing energy, defense, reproduction and the coordination of body functions.

Assessment limits:

- Human male and female reproductive systems -anatomy
- role of hormones
- factors that affect fetal development;
- flowering plants, flowers as reproductive organs structure and function -sepals and petal and stamens and carpels
- wind and insect pollination e.g. dandelion and hibiscus respectively

Life Science (L)

(continued)

Life Science (L) which consists of concepts of biology and ecology, deals with the diversity of living organisms, their organization, life processes, relationships with one another and their environment.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

L4 - Interdependence of Life – relationships amongst organisms and their dependence on their environment.

SC.S2.L4

Students will produce evidence that demonstrates understanding of :

a) Ecosystems can be reasonably stable, but can change.

Assessment limits:

- levels of organization – species, populations, communities, ecosystems, biomes
 - change due to climate or appearance of new species
 - basic concept of succession
- b) Humans alter equilibrium in an ecosystem.

L5 - Flow of Matter and Energy – the linking of organisms to one another and their physical setting by the transfer and transformation of matter and energy.

SC.S2.L5

Students will produce evidence that demonstrates understanding of :

a) Limiting factors such as water, energy, oxygen and minerals, determine the amount of life that an ecosystem can support.

Assessment limits:

- energy flow – producers, consumers
 - feeding relationships – food chains, food webs,
 - trophic levels
 - ecological pyramids – energy pyramid, biomass pyramid, pyramid of numbers
- b) The sun is the source of most of the energy resources on earth. These resources are being burned by people and this stored energy is being transferred back into the environment as heat and carbon dioxide.

Assessment limits:

- fossil fuels – oil, gas, coal
 - cycles of matter – water cycle , nutrient cycles including nitrogen cycle, carbon cycle
- c) The impact of humans on ecosystems depends on factors such as population size, levels of consumption and waste, technological and industrial processes (social and economic factors). The principle of sustainable development is critical to survival.
- d) The transfer of chemical elements through food webs - the continual impact of energy from sun light to maintain the process.

Assessment limits:

- photosynthesis, respiration

L6 - Evolution of Life – the evolution of life on earth, natural selection as an explanation of biological processes.

SC.S2.L6

Students will produce evidence that demonstrates understanding of :

Not assessed at this level on the Bermuda Criterion Reference Test (BCRT)

Earth And Space Science (E)

Earth and Space (E) Science consists of concepts of astronomy, geology, resources, meteorology and oceanography. Earth and space science involves the study of the earth, the universe, their components and interactions.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

E1 - Astronomy -

the current scientific view of the nature, components, matter and energy sources of the universe.

E2 - Geology -

the features of the earth's surface, how they were formed and how they are continually changing.

E3 - Resources -

the earth's limited and varied materials that supply many of the resources that humans use

SC.S2.E1

Students will produce evidence that demonstrates understanding of :

Not assessed at this level on the Bermuda Criterion Reference Test (BCRT)

SC.S2.E2

Students will produce evidence that demonstrates understanding of :

a) Water is stored and moves in pervious sediments and rocks called aquifers (water bearers).

Assessment limits:

- In Bermuda there are different rock formations which have different hydrologic characteristic. These rocks are the container for the groundwater
- Fresh groundwater is found in five separate areas in Bermuda (in approximately 20% of the island).
- Fresh ground water occurs in lens-shaped bodies (Gyhen-Herzberg lens) that are laterally surrounded and underlain by a zone of brackish ground water which is a mixture of fresh groundwater and seawater
- b) The Bermudian hydrologic cycle shows the paths and processes involved in the passage of water from the atmosphere to the ocean. Recharge of the lens is basically from rainwater.

Assessment limits:

- Rainfall percolates through the soil and limestones to the water table.
- Rainfall lands on marshes which are outcroppings of the groundwater reservoir.
- Rainfall lands on the roofs and is passed into storage tanks.
- Some roads have drainage wells for excess rainwater. This water reaches the water table.
- Rainwater from other roads evaporates or runs off into land area
- Discharge is loss due to pumping, plant usage, tidal action seepage into the marshes etc.
- Waste disposal is from individual household cesspits

SC.S2.E3

Students will produce evidence that demonstrates understanding of :

- a) The earth has limited resources some of which are non renewable.
- b) The local and global environment is affected by national policies and practices relating to energy use, waste disposal, ecological management, manufacturing and population.
- c) In Bermuda sustainable development is of critical importance since there is a limited land mass.

Earth And Space Science (E) (continued)

Earth and Space (E) Science consists of concepts of astronomy, geology, resources, meteorology and oceanography. Earth and space science involves the study of the earth, the universe, their components and interactions.

Conceptual understanding should be demonstrated by

- *Using a concept accurately to explain observations and make predictions*
- *Representing the concept in a variety of ways including words, diagrams, charts and graphs, as appropriate*

E3 - Resources -

the earth's limited and varied materials that supply many of the resources that humans use

SC.S2.E3 (continued)

Students will produce evidence that demonstrates understanding of :

Assessment limits:

- management of lands
- reclaiming of land
- groundwater
- waste management techniques etc.

d) Fresh (drinking) water is a limited resource in Bermuda.

Assessment limits:

The sources are:-

- Term potable (drinkable) water
- rainwater collected in household and other tanks
- treated well water from government-licensed wells
- reverse osmosis plants – use of brackish water
- water pollution
- water treatment methods- filtering, screening, disinfecting (boiling, chemical treatment including chlorination)

E4 - Meteorology -

the interactions of structures of the earth's system and the sun's energy which cause weather and climate patterns

SC.S2.E4

Students will produce evidence that demonstrates understanding of :

- a) The transfer of energy in and out of the atmosphere (such as in the water cycle) affects weather and climate. Living things are adapted to their surroundings, including the contents of the atmosphere retained by the planet's gravity and the water cycle which is influenced by the intensity of the sun's radiation.
- b) Water dissolves minerals and gases and carries them to the oceans via the water cycle.

E5 - Oceanography -

the features of oceans and the impact of these features on the global ecosystem

SC.S2.E5

Students will produce evidence that demonstrates understanding of :

- a) Oceans currents affect climate and therefore life on earth.
 - b) Earth's oceans are ever changing bodies of water.
- Assessment limits:
- impact of global warming
 - melting of icecaps and sea level rise
 - impact on Bermuda's water-front properties
- c) People have a significant impact on the health of the oceans.

Assessment limits:

Bermuda issues include

- preservation of the coral reef,
- over-fishing,
- pollution of the inshore waters,
- cruise ship capacity,
- sewage outfalls from large businesses and hotels
- increased use of leisure craft

Nature Of Science (N)

Nature of Science (N) consists of the understanding and application of scientific investigative techniques and data analysis. Nature of Science also involves the study of the interrelationships between science, technology, and society.

N1 - Scientific Investigation

-People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to things and noting what happens. Investigations are conducted for different reasons, which include exploring new phenomena, checking on previous results and comparing different theories. Investigations usually involve collecting evidence, reasoning, devising hypotheses, and making predictions.

N2 - Data Representation and Interpretation -

Data must be analysed in order to make sense of what has been collected. Sometimes the evidence collected might not be what you expected or might not be sufficient to draw a conclusion. Clear and accurate communication is important in doing science and an essential part of sharing an investigation in order to inform others.

SC.S2.N1

Students will produce evidence that demonstrates understanding of :

a) Planning an investigation

Assessment limits:

- Use scientific knowledge and understanding to convert ideas into a form that can be investigated
- Support predictions with scientific reasons (from books, Internet or other sources)
- Understand concept of bias
- write/evaluate clear step by step procedure for investigation

b) Obtaining evidence for investigation.

Assessment limits:

- vary key variables
- determine number of observations or measurements to be made
- Select and manipulate a range of apparatus to help to obtain precise evidence
- Read analog and digital meters on instruments used to make direct measurements of length, volume, weight, elapsed time, rates and temperature
- Repeat results to obtain average readings

SC.S2.N2

Students will produce evidence that demonstrates understanding of :

a) Summarising and organising data

Assessment limits:

- Represent data and results in multiple ways such as numbers, tables, graphs, diagrams.
- Select the best way of displaying your evidence; represent data with pie charts, graphs, tables, histograms etc.
- Create table of results with clear headings and correct units

b) Analyzing evidence and making conclusions

Assessment limits:

- Identify trends or patterns in results (best fit graphs, multi-line graphs, multiple data sets.
- Use graphs to determine relationships between variables
- Explain whether you have enough evidence to draw a conclusion
- Explain whether results are consistent with original prediction
- Draw a meaningful conclusion based on evidence in outcome
- Support conclusions with evidence from experiments or research
- Evaluate investigation (redesign investigation if necessary – how might the method be improved to obtain more evidence to support the conclusion)

Nature Of Science (N) (continued)

Nature of Science (N) consists of the understanding and application of scientific investigative techniques and data analysis. Nature of Science also involves the study of the interrelationships between science, technology, and society.

N3 - The Designed World -

Over the course of the history of world exploration, humans have shaped and reshaped the world we live in by using technology in tandem with expanding science knowledge. Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Science influences society through its knowledge and world view. Technology influences society through its products and processes. Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.

SC.S2.N3

Students will produce evidence that demonstrates understanding of :

- a) Things found in nature are different from those that are made by humans. New products and systems can be developed to help solve problems, but there could be desirable or undesirable consequences.

Assessment limits:

- Applications of technology – communications, transportation, manufacturing and construction
- Formation of plastics, new fuels, synthetic fibres, pharmaceuticals,
- Science and mathematics attend to result in advances in technology (e.g., binary system to digital machines such as laptop computers, digital cameras, compact disc players)
- Waste management includes considerations of quantity, safety, degradability and cost. Waste disposal problems are political, economic as well as technical
- Different ways of obtaining, transforming and distributing energy have different environmental consequences
- Increased use of energy in more industrialized countries leads to rapid depletion of Earth's energy resources and heightened environmental risks from fossil and nuclear fuels.
- Decisions to develop and use technologies often put environmental and economic concerns in direct competition (for example, preservation of open space and wetlands vs. housing and improvement of roads)

- b) Important contributions to the advancement of science, mathematics and technology have been made by different kinds of people in different cultures in different times.

Assessment limits:

- Science disciplines differ from one another in what is studied, techniques used and outcomes sought, but they are all part of the same scientific enterprise (physics, chemistry, biology, ecology; environmental science, meteorology and related careers; what kinds of processes are studied in the discipline by the scientists – other careers – forensic scientist, medical laboratory technician)

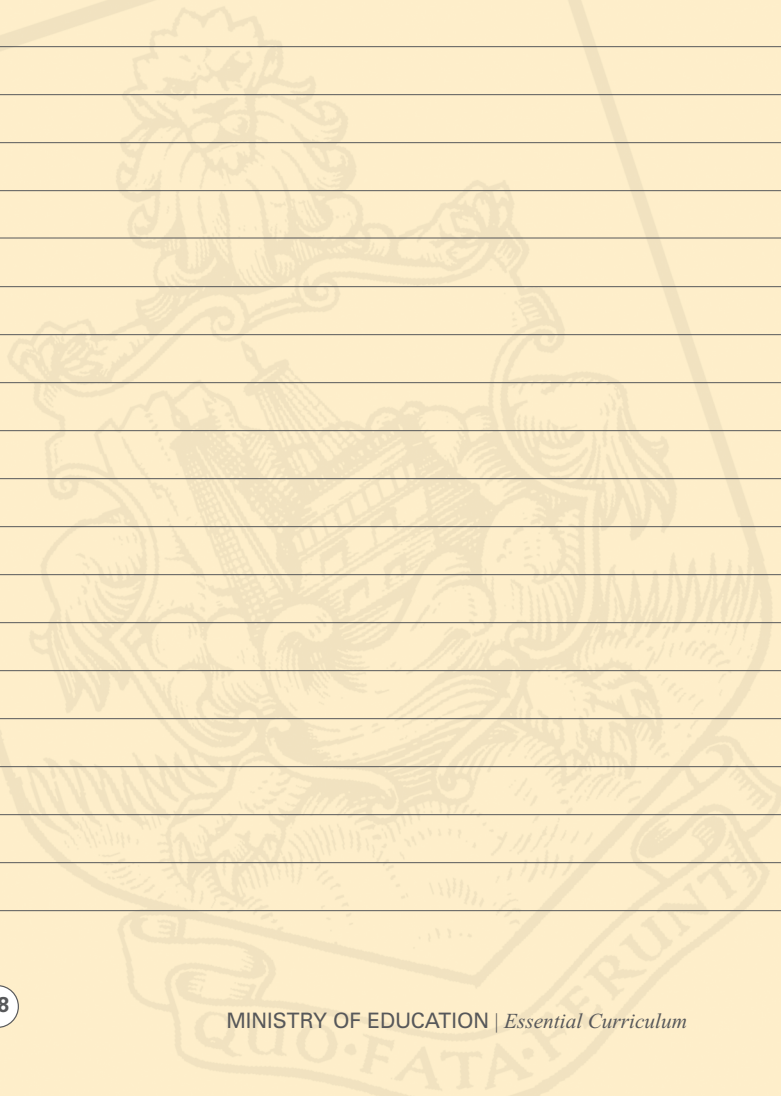
- c) Diet, exercise, disease and toxic substances influence the physical health of individuals. Science has contributed to health and health technologies.

Assessment limits:

- waste management, water purification and potable water from seawater or brackish water
- knowledge of genetics is opening new fields of health care (geneticists).

A large, faint, light-colored watermark of the University of Toronto crest is visible in the background of the page. The crest features a shield with a building, a book, and a lion, surrounded by decorative elements and a banner.

PLANNING NOTES





MISSION STATEMENT

The mission of the Bermuda Public School System is to be the 1st choice in education by providing rigorous and stimulating learning experiences in safe responsive environments from which our students emerge confident and prepared to compete and contribute locally and globally.



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