REPUBLIC OF TRINIDAD AND TOBAGO
MINISTRY OF EDUCATION

Secondary Education Modernization Programme

SECONDARY SCHOOL CURRICULUM

Forms 1–3

Integrated Science

Curriculum Planning and Development Division, Ministry of Education
September 2008

Published in 2008 by the
Curriculum Planning and Development Division
Ministry of Education
Rudranath Capildeo Learning Resource Centre
Mc Bean, Couva
Republic of Trinidad and Tobago

ISBN:

Printed by

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Minister's Foreword

The Government of Trinidad and Tobago, in its *Vision 2020 Draft National Strategic Plan*, has articulated a vision of "a united, resilient, productive, innovative, and prosperous nation with a disciplined, caring, fun-loving society comprising healthy, happy and well-educated people and built on the enduring attributes of self reliance, respect, tolerance, equity and integrity" (p. 9). Five developmental pillars have been identified to achieve this goal:

Developing Innovative People
Nurturing a Caring Society
Governing Effectively
Enabling Competitive Business
Investing in Sound Infrastructure and Environment

The Ministry of Education is one Ministry that is expected to play a pivotal role in *developing innovative people.* We therefore accept as one of our primary responsibilities, the establishment of an education system that will nurture imaginative, innovative, and eager learners. It must also facilitate the seamless progression of learners from early childhood education up to the tertiary level. Graduates of the system must emerge as creative, committed, and enterprising citizens who are prepared intellectually, and who have the will to become global leaders.

A critical contributor to this process is the national curriculum. These Curriculum Guides represent the core subjects of the national curriculum at the lower secondary level. They describe the formal content and process by which students at this level will gain the knowledge and skills that contribute to the achievement of our national goals. We expect that teachers will use these Guides to implement a school curriculum that is diversified, relevant, and of high quality, meeting the varied learning needs, interests, and abilities of all students. We expect, too, that students will be taught in ways that suit their own learning preferences. The curriculum will also connect them to their national heritage, help them to understand the issues facing their world today, and prepare them to meet the challenges and opportunities of the future.

On behalf of the entire education community, I congratulate and thank all those educators—curriculum personnel, teachers, editors, and others—who have worked together over the eight years of development and revision to produce these Curriculum Guides for secondary schools. The nation owes you a debt of gratitude. I urge you to continue to be shining lights in your communities as we move forward together to achieve our goals.

Esther Le Gendre
Honourable Minister of Education

A Note to Teachers

These Curriculum Guides have been developed by educators, including practising teachers, for teachers. They are intended to assist you to prepare students to meet the rapidly changing demands of life in the 21st century, while ensuring that they acquire the core of general knowledge and experience essential for later education and employment. The new curriculum that they represent is designed to guide the adoption of a more student-centred approach to instruction, and the provision of learning opportunities that are relevant to today's students and inclusive of varied learning needs and interests.

Since the beginning of the curriculum development process, we have seen profound changes in the use of technology in education and there is no doubt that similar shifts will take place in the coming years. The challenge for us as educators is to find ways to make our approach to teaching flexible, progressive, and responsive, so that we embrace and motivate change where it benefits learners. This entails becoming lifelong learners ourselves and creating environments that provide necessary community support and foster professional development.

The Guides embody the culmination of seven years of development and revision activity. The national curriculum will, however, be regularly reviewed to ensure that it continues to meet the needs of all students and matches the goals of society. Your input in this process is vital and we welcome and encourage your ongoing feedback.

Instructional decisions must be based on sound, contemporary educational theory, practice, and research. These documents will serve as important guides for the development of instructional programmes to be implemented at the school and classroom levels. They are organized in several parts. Part 1 is common to all and provides the general philosophy and aims in which every subject is anchored. Part 2 is specific to each subject and includes specific outcomes and sample activities and strategies that may be used to achieve them. The rest of the document is designed to suit the particular needs of each subject area. All the Guides include suggested assessment strategies and recommended resources.

We in the Curriculum Planning and Development Division are confident that the new National Curriculum Guides for Forms 1–3 will contribute significantly to enhanced teaching and learning experiences in our secondary schools and, consequently, the achievement of personal learning and national educational goals.

Sharon Douglass Mangroo
Director of Curriculum Development
August 2008

Acknowledgements

The Ministry of Education wishes to express its sincere appreciation to all those who contributed to the curriculum development and revision processes from 2000 to the present.

- The Inter-American Development Bank (IDB) and its staff
- The staff of the Coordinating Unit of the Secondary Education Modernization Programme (SEMPCU), past and present, provided technical assistance and planned, organized, and conducted the various exercises over the years. They include Mr. Maurice Chin Aleong, Mr. Lloyd Pujadas, Mr. Arnott West, Dr. Stephen Joseph, Ms. Patricia Sealey, Ms. Renee Figuera, and Ms. Roslyn Elias.
- Mrs Sharon Douglass Mangroo, Director of Curriculum Development, led the curriculum development sub-component and coordinated the curriculum development and revision activities.
- Dr. Robert Sargent guided the early curriculum development process.
- The principals of the pilot schools generously contributed teachers and participated in regular meetings to provide valuable feedback on field tests.
- The principals of non-pilot schools kindly released teachers to take part in writing activities.
- The staff of the School Libraries Division actively joined in workshops, facilitated research, and contributed to the infusion of information technology into the curriculum.
- Editors, past and present: Ms. Avril Ross, Ms. Lynda Quamina-Aiyejina, and Ms. Patricia Worrell devoted time, energy, and knowledge to editing the several versions of the documents.
- The Administrative staff of the Curriculum Development Division spent long hours typing and retyping the documents.
- Officers of the Divisions of Educational Services, Schools Supervision, Student Support Services, and Educational Research and Evaluation provided support as needed.
- Teachers throughout the secondary school system responded to requests for comments and other forms of feedback.
- The Curriculum Officers and members of the Curriculum Writing Teams brought their knowledge, skills and practical experiences of teaching and learning to the curriculum development workshops and skilfully synthesized all to produce these documents.

Members of the Curriculum Writing Team

Name	School/Institution
Ms Asha Ajodha Mohoyodeen	Pleasantville Senior Comprehensive School
Ms. Hamida Baksh	Success Laventille Secondary School
Ms. Suzanne Gayah	San Fernando Secondary School
Ms. Lalita Maharaj	Naparima College
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Ms. Shameem Narine	La Romain High School
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Part 1
The National Curriculum for Forms 1–3

Background

From the Ministry of Education's *Corporate Plan 2008–2012* (p. 4)

The Government of Trinidad and Tobago, in its *Vision 2020 Draft National Strategic Plan*, has articulated a vision of "a united, resilient, productive, innovative, and prosperous nation with a disciplined, caring, fun-loving society comprising healthy, happy and well-educated people and built on the enduring attributes of self reliance, respect, tolerance, equity and integrity…"

Towards the achievement of this Vision, the Government has articulated five developmental pillars:

Developing Innovative People
Nurturing a Caring Society
Governing Effectively
Enabling Competitive Business
Investing in Sound Infrastructure and Environment

The Ministry of Education has been identified as one of the champions for *developing innovative people.* Central to the realization of this pillar is "A highly skilled, well-educated people aspiring to a local culture of excellence that is driven by equal access to learning opportunities."

In conjunction with other key ministries, the Ministry of Education has been charged with the realization of the following goals:

The people of Trinidad and Tobago will be well known for excellence in innovation.

Trinidad and Tobago will have a seamless, self-renewing, high-quality education system.

A highly skilled, talented and knowledgeable workforce will stimulate innovation driven growth and development.

The richness of our diverse culture will serve as a powerful engine to inspire innovation and creativity.

…Nationally, the reform of the education system is driven by several local, regional and international perspectives. We are committed to a seamless, self-renewing, high-quality education system underpinned by a National Model for Education. This National Model has three (3) foci as follows:

i. To ensure an alignment of the education system to government's strategic plan Vision 2020 which mandates that the education system produces caring and innovative citizens

ii. To ensure that the education system produces citizens with a sense of democracy, respect for the rights of others and elders and with the ability to contribute meaningfully to the social and economic development of the country
iii. To build a strong sense of nationalism and patriotism in our citizens. (p. 7)

The Secondary Curriculum

In its commitment to comprehensive reform and expansion of the secondary school system, the Government of the Republic of Trinidad and Tobago, in 1996, adopted the report of the National Task Force on Education as educational policy. The specific recommendations for the improvement of secondary education led to discussions with the Inter-American Development Bank (IDB) for loan funding arrangements for a programme, the Secondary Education Modernization Programme (SEMP), to modernize secondary education in Trinidad and Tobago. One of the intended outcomes of this programme was improved educational equity and quality.

The curriculum guides for Forms 1–3 in eight subject areas are among the products of the programme and contribute to this outcome.

The Curriculum Design and Development Process

In order to achieve the outcomes defined by the underpinning philosophy and goals, the Curriculum Development Division of the Ministry of Education embarked on a design and development programme consonant with accepted approaches to curriculum change and innovation.

Curriculum Design

This curriculum displays a learner-centred design. Its philosophical assumptions are mainly constructivist. Its major orientation is to curriculum as self-actualization. The curriculum is student-centred and growth oriented. It seeks to provide personally satisfying experiences for each student. As the student moves from one level to another, activities also expand to allow new insights and approaches to dealing with and integrating new knowledge.

Curriculum Development

The first stage of the curriculum development process consisted of consultations with stakeholders from a cross-section of the national community. Consultations were held with primary and secondary school teachers; principals; members of denominational school boards; members of the business community; the executive of the Trinidad and Tobago Unified Teachers' Association (TTUTA); representatives from The University of the West Indies (UWI), John S. Donaldson Technical Institute, San Fernando Technical Institute, Valsayn Teachers' College, and Caribbean Union College; parents; librarians; guidance counsellors; students; curriculum officers; and school supervisors. These consultations focussed on the philosophy, goals, and learning outcomes of education.

The result of these consultations was agreement on:

- the concept of a "core," that is, essential learning outcomes consisting of skills, knowledge, attitudes, and values that students must acquire at the end of five years of secondary schooling;
- the eight subjects to form the core;
- the desirable outcomes of secondary school education in Trinidad and Tobago.

In Stage 2 of the process, the officers of the Curriculum Development Division studied the reports of the consultations, the Education Policy Paper, the reports of the Curriculum Task Force and the Task Force for Removal of Common Entrance, as well as newspaper articles and letters to the editor on education during the preceding five years. The School Libraries Division and the Division of School Supervision assisted the Curriculum Development Division in this task. The result of the study was the identification and articulation of a set of desirable outcomes and essential exit competencies to be possessed

by all students on leaving school. All learning opportunities, all teaching and learning strategies, and all instructional plans are to contribute to the realization of these outcomes and competencies.

At Stage 3, 10 existing schools were identified to pilot the new curriculum. Teachers from eight subject areas were drawn from these schools to form curriculum writing teams for each subject. Teachers with specific subject or curriculum development skills from other schools were also included in the teams. The outputs of this phase included learning outcomes specific to each subject that contribute to the fulfilment of the national outcomes; subject content; and teaching, learning, and assessment strategies to support the outcomes.

The draft curriculum guides for Forms 1 and 2 were approved by Cabinet for introduction into schools on a phased basis in September 2003. The draft guides for Form 3 were completed and introduced in the following year. Introduction of the new guides was accompanied by professional development and training for principals and teachers. The Ministry also began to supply new and/or upgraded facilities for teaching and learning, and educational technology. At the same time, work began on a new assessment and certification system.

Curriculum Revision

As implementation proceeded, feedback was sought by the Curriculum Development Division through school visits, workshops, and reviews by UWI lecturers and other stakeholders. In 2007, a survey was conducted among teachers, followed by focus group meetings, in order to concretize feedback before embarking on the revision process. As in the original curriculum development exercise, revision—the final stage—was carried out by teams of practising teachers led by officers of the Curriculum Development Division.

Curriculum Underpinnings

The national curriculum has been informed by a wealth of available curriculum theories and processes.

The major forces that influence and shape the organization and content of the curriculum include:

1. Educational philosophy and understandings about the nature of knowledge
2. Society and culture
3. The learner and learning process
4. Learning theories
5. The nature and structure of subject matter to be learned

Thus, these areas represent the foundation on which the national curriculum is built. The philosophical concerns and educational goals that shaped the curriculum also formed the basis for the dialogue with stakeholders in which the Curriculum Development Division engaged, with the aim of developing a coherent, culturally focussed, and dynamically evolving curriculum.

An internal analysis of the education system, together with research conducted in international forums, has shown that the curriculum is core to the development of innovative people. This curriculum is aimed at attaining six essential learning outcomes. The six outcomes identified help to define universally accepted goals that have been developed and underscored by other educational jurisdictions and that have been agreed to be essential. The essential learning outcomes help to define standards of attainment for all secondary school students.

Education Policies That Impact on the Curriculum

There are several Ministry of Education policies that impact on the national secondary curriculum, though some are still in the process of formalization. These include the National Model for Primary and Secondary Education in Trinidad and Tobago, the ICT policy, Standards for the Operation of Schools, and Quality Standards. Copies of these documents may be obtained from the Ministry offices or the website at *www.moe.gov.tt*. Three other policies that have direct impact on the development and implementation of the curriculum are discussed in some detail below.

National Curriculum Policy

A Draft National Curriculum Policy has been approved by Cabinet for consultation with stakeholders. The Policy statements are summarized as follows:

1. The curriculum must articulate with the goals of national development and be supportive of the aspirations of individuals and their personal development. It must provide opportunities for every student to be equipped with the knowledge, skills, attitudes, values, and dispositions necessary for functioning in an interactive, interdependent society.
2. The curriculum must be so managed as to ensure the provision of a quality curriculum experience for all students at all levels of the system.
3. At every level of the system, there must be equitable provision of requisite facilities, resources, services, and organizational structures that are conducive to and supportive of effective learning and teaching and healthy development.
4. Continuous quality management must support all curriculum and related activities at every level of the system.
5. Ongoing research and professional development activities must equip education practitioners for continued effective practice.

Though the policy has not yet been formally issued, these statements are worthy of consideration at all stages of the curriculum cycle.

Inclusive Education Policy

The Ministry of Education is committed to "support the delivery of inclusive education in all schools by providing support and services to all learners, and by taking appropriate steps to make education available, accessible, acceptable and adaptable to all learners." An inclusive curriculum is acknowledged to be the most important factor in achieving inclusive education. In planning and teaching the school curriculum, teachers are therefore required to give due regard to the following principles:

- The National Curriculum Guides set out what most students should be taught at lower secondary school but teachers should teach the required knowledge and skills in ways that suit students' interests and abilities. This means exercising flexibility and drawing from curricula for earlier or later class levels to provide learning opportunities that allow students to make progress and experience success. The degrees of differentiation exercised will depend on the levels of student attainment.

- Varied approaches to teaching, learning, and assessment should be planned to allow all students to participate fully and effectively. Account should be taken of diverse cultures, beliefs, strengths, and interests that exist in any classroom and that influence the way students learn.

- Students with special needs should be given additional instructional support in negotiating the regular curriculum, not a different one. The guiding principle of equity is to supply students who need it with additional help to achieve set standards, but not to lower the standards.

- Continuous formative evaluation must be used to identify learning needs and to shape instruction, thus maximizing students' opportunities for achieving success. Assessment strategies must be appropriate to the way the curriculum is designed and delivered, as well as to each student's individual learning profile and stage of development.

- Suitable technology must be used in instruction to facilitate learning and enhance success.

ICT in the Curriculum

The following statements are taken from the Ministry of Education's ICT in Education Policy (pp. 28–29).

Curriculum Content and Learning Resources

- Curriculum and content must increasingly maximize the use of ICT.

- ICT must be integrated into the development and delivery of the curriculum.

- ICT integration and ICT competency measures across the curriculum shall be driven through the development and delivery of an ICT-infused curriculum.

Essential Learning Outcomes

The learning outcomes which have been deemed essential are in the areas of:

- Aesthetic Expression
- Citizenship
- Communication
- Personal Development
- Problem Solving
- Technological Competence

The achievement of these essential learning outcomes by all students is the goal that every core curriculum subject must facilitate. The core curriculum subjects, their content, and the suggested teaching, learning, and assessment strategies are the means to fulfil this end.

It is expected that by the end of the third year of secondary school, students' achievement in all six areas will result in a solid foundation of knowledge, skills, and attitudes that will constitute a platform for living in the Trinidad and Tobago society and making informed choices for further secondary education.

The essential learning outcomes are described more fully below.

Aesthetic Expression

Students recognize that the arts represent an important facet of their development, and they should respond positively to its various forms. They demonstrate visual acuity and aesthetic sensibilities and sensitivities in expressing themselves through the arts.

Students, for example:

- use various art forms as a means of formulating and expressing ideas, perceptions, and feelings;

- demonstrate understanding of the contribution of the arts to daily life, cultural identity, and diversity;

- demonstrate understanding of the economic role of the arts in the global village society;

- demonstrate understanding of the ideas, perceptions, and feelings of others as expressed in various art forms;

- demonstrate understanding of the significance of cultural resources, such as museums, theatres, galleries, and other expressions of the multicultural reality of society.

Citizenship

Students situate themselves in a multicultural, multi-ethnic environment, and understand clearly the contribution they must make to social, cultural, economic, and environmental development in the local and global context.

Students, for example:

- demonstrate understanding of sustainable development and its implications for the environment locally and globally;

- demonstrate understanding of Trinidad and Tobago's political, social, and economic systems in the global context;

- demonstrate understanding of the social, political, and economic forces that have shaped the past and present, and apply those understandings to the process of planning for the future;

- examine issues of human rights and recognize and react against forms of discrimination, violence, and anti-social behaviours;

- determine the principles and actions that characterize a just, peaceful, pluralistic, and democratic society, and act accordingly;

- demonstrate understanding of their own cultural heritage and cultural identity, and that of others, as well as the contribution of our many peoples and cultures to society.

Communication

Students use their bodies, the symbols of the culture, language, tools, and various other media to demonstrate their deeper understandings of synergies inherent in the exchange of ideas and information, and thus to communicate more effectively.

Students, for example:

- explore, reflect on, and express their own ideas, learning, perceptions, and feelings;

- demonstrate understanding of facts and relationships presented through words, numbers, symbols, graphs, and charts;

- demonstrate sensitivity and empathy where necessary in communicating various kinds of emotions and information;
- present information and instructions clearly, logically, concisely, and accurately for a variety of audiences;
- interpret and evaluate data, and express their conclusions in everyday language;
- critically reflect on and interpret ideas presented through a variety of media.

Personal Development

Students "grow from inside out," continually enlarging their knowledge base, expanding their horizons, and challenging themselves in the pursuit of a healthy and productive life.

Students, for example:

- demonstrate preparedness for the transition to work and further learning;
- make appropriate decisions and take responsibility for those decisions;
- work and study purposefully, both independently and in cooperative groups;
- demonstrate an understanding of the relationship between health and lifestyle;
- discriminate among a wide variety of career opportunities;
- demonstrate coping, management, and interpersonal skills;
- display intellectual curiosity, an entrepreneurial spirit, and initiative;
- reflect critically on ethical and other issues;
- deal effectively with change and become agents for positive, effective change.

Problem Solving

Students have a range of problem-solving strategies and apply them appropriately to situations they encounter. They demonstrate critical thinking and inquiry skills with which they process information to solve a wide variety of problems.

Students, for example:

- acquire, process, and interpret information critically to make informed decisions;
- use a variety of strategies and perspectives flexibly and creatively to solve problems;

- formulate tentative ideas, and question their own assumptions and those of others;
- solve problems individually and collaboratively;
- identify, describe, formulate, and reformulate problems;
- frame and test hypotheses;
- ask questions, observe relationships, make inferences, and draw conclusions;
- identify, describe, and interpret different points of view;
- distinguish facts from opinions.

Technological Competence

Students are technologically literate, understand and use various technologies, and demonstrate an understanding of the role of technology in their lives, in society, and in the world at large.

Students, for example:

- locate, evaluate, adapt, create, and share information using a variety of sources and technologies;
- demonstrate understanding of existing and developing technologies and use them appropriately;
- demonstrate understanding of the impact of technology on society;
- demonstrate understanding of ethical issues related to the use of technology in local and global contexts.

The Core Curriculum Subjects

The core curriculum subjects are those for which every student is required to demonstrate achievement of the stated outcomes in Forms 1–3. Additional subjects that contribute to students' holistic development and further their interests and aspirations may also be offered thereafter.

A minimum time allocation is recommended for each core subject. The principal, as instructional leader of the school, will make the final decision as to time allocation, according to the needs of the students and the resources available at any given time.

The subjects and the recommended time allocations are as follows:

Subject	**No. of Periods**	**Subject**	**No. of Periods**
English Language Arts	6	**Mathematics**	5
Science	4	**Health and Physical Education**	2
Spanish	4	**Technology Education**	4
Social Studies	4	**Visual and Performing Arts**	4

At the end of Form 3, students will be assessed for the National Certificate of Secondary Education (NCSE), Level I.

Language Across the Curriculum

The development of language skills and the ability to understand and use language correctly, competently, and effectively is fundamental to the learning outcomes expressed in the national curriculum. Language is a uniquely human capacity. Three simultaneous uses of language for learning are envisaged as students experience the national curriculum: students will learn language, they will learn through language, and they will learn about language.

Language plays a major role in learning, which occurs when students use the major modes of language—listening, speaking, reading, and writing—to achieve various purposes, among them: to communicate with others; to express personal beliefs, feelings, ideas, and so on; for cognitive development in various subjects of the curriculum; and to explore and gain insight into and understanding of literature. Language is linked to the thinking process, and its use allows students to reflect on and clarify their own thought processes and, thus, their own learning.

The national curriculum is predicated on the assumption that since students' language development takes place across the curriculum, the development process must be addressed in all subject areas. Students will develop and use patterns of language vital to understanding and expression in the different subjects that make up the curriculum.

However, the student of Trinidad and Tobago functions in a bidialectal context, that is, the natural language of the student, the Creole, differs from the target language and language of instruction, Internationally Accepted English. The philosophical position taken in the national curriculum is that both languages are of equal value and worth, and both must be respected. Students use their own language as a tool for interpreting the content of the curriculum and for mastering it. In addition, they must be taught to use the target language as effectively and effortlessly as they would their natural language.

The exponential growth in information and the use of information and communication technologies provide opportunities for students to become critical users of information. Language development and use in this context is also addressed in all subject areas.

Curriculum Implementation

Implementation of the curriculum is a dynamic process, requiring collaboration of the developers (curriculum teams) and users (teachers). In implementation, teachers are expected to use the formal curriculum, as described in the curriculum guides, to plan work and teach in a manner that accomplishes the objectives described. Teachers translate those objectives into units of study, determining the appropriate sequence and time allocation according to the learning needs of their students. The new Curriculum Guides provide sample teaching and assessment strategies, but it is also the role of the professional teacher to select and use sound teaching practices, continually assessing student learning, and systematically providing feedback to curriculum teams for use in revising and improving the guides.

A curriculum development system provides support for the tasks of curriculum implementation. The system advocated by the Ministry of Education involves stakeholders, specialist curriculum officers, principals, heads of departments, and teachers, each with specific roles and responsibilities. Some of these are outlined in the table below.

System Component	Members	Role
National Curriculum Advisory Council/ Committee	Stakeholders	• Advise on curriculum policy, goals, and standards
Curriculum Planning and Development Division (Head Office and District-based)	curriculum officers	• Plan and develop curriculum • Provide leadership in identifying curriculum goals and determining the process for development of curriculum materials • Lead writing teams (which include teachers) • Monitor implementation • Provide teacher support • Facilitate teacher professional development for curriculum implementation • Advise on processes and materials for effective implementation and student assessment • Evaluate curriculum
School Curriculum Council	Principal/Vice Principal and Heads of Departments	• Make major decisions concerning the school curriculum, such as assigning resources • Provide guidelines for Instructional Planning Teams
Instructional Planning Teams/School Instructional Committees	Teachers	• Cooperate on tasks necessary for effective implementation, such as: yearly work plans, units of study, development of materials to individualize the curriculum, identification and development of learning materials, student assessment and evaluation

Curriculum Implementation at School Level

The "School Curriculum" refers to all the learning and other experiences that the school plans for its students. It includes the formal or written curriculum, as well as the informal curriculum, which is comprised of other developmental opportunities provided by the school, such as those offered by student clubs, societies and committees, and sporting organizations (e.g., cricket team, debating society, Guides, Cadets).

The School Curriculum Council develops a School Curriculum that must be in alignment with the National Curriculum. The School Curriculum Council usually consists of the Principal and/or Vice Principal and Heads of Department. The duties of the Council include the development of school culture, goals, vision, and curriculum in alignment with the national curriculum and culture. It also provides support for curriculum work and performs evaluation functions.

In providing support for curriculum work, the Council may, for instance:

- encourage teachers to identify challenges and try new ideas;
- develop timetables to allow for development of curriculum materials, for example, year plans, units, instructional materials;
- ensure availability of learning materials;
- provide instructional leadership;
- ensure that appropriate strategies are formulated to promote student success.

In performing evaluation functions, the Council:

- monitors the curriculum (using, for example, observation, test scores, student books, formal and informal discussions with different stakeholders);
- assesses the hidden curriculum (including discipline policies, fund allocation, physical environment);
- evaluates the school programme of studies.

The roles of instructional teams and the individual teachers are described in the following tables:

Roles of School Instructional Committees
Develop/Revise/Evaluate work programmes
Determine resource needs
Identify/Develop instructional materials
Conduct classroom action research
Integrate and align curriculum
Identify and develop appropriate assessment practices
Develop reporting instruments and procedures (student and teacher performance)
Keep records

Roles of Individual Teachers
Develop/Revise instructional programme
Individualize curriculum to suit students' needs and interests
Develop/Evaluate/Revise unit plans
Develop/Select appropriate learning materials
Select appropriate teaching strategies to facilitate student success
Integrate the curriculum as far as possible, and where appropriate
Select appropriate assessment strategies
Monitor/Assess student learning and keep records
Evaluate student performance
Evaluate classroom programmes
Conduct action research
Collaborate with colleagues

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Part 2
The Integrated Science Curriculum

VISION STATEMENT

The Science Curriculum will:

- Stimulate students' curiosity and creativity
- Develop competence in the use of the knowledge and methods of science
- Develop students' critical awareness of the role of science in everyday living

Rationale for Teaching and Learning Science

Science is the study of the biological and physical environment. It is a method of problem solving which requires that all the necessary resources and skills be used to gather objective evidence, analyse and synthesize that evidence, then make inferences and draw conclusions. These activities require specific skills and habits of mind, such as accuracy, discipline, and integrity in the application of scientific principles, which are fundamental to scientific activity. The science curriculum is designed to develop these skills and habits of mind.

A properly conceptualized and implemented science programme is designed to enable students to:

1. develop personal strengths, which include the ability to read, write, and complete mathematical operations; communication skills; interpersonal and intra-personal skills; problem-solving skills; and positive attitudes to work. Students involved in science activities may have many of their social and psychological needs met, such as the need for recognition, affection, security, and belongingness;

2. demonstrate an awareness of social realities and natural phenomena. Students' natural curiosity can be tapped and made the prime motivating device in inspiring them to learn about science;

3. appreciate science as an enjoyable activity, which includes artistic experiences. Creating projects, carrying out investigations that they planned, taking part in science games and contests, and recognizing that recreational activities and sports such as basketball and swimming can be explained by using scientific concepts and principles, all make science more relevant for students;

4. recognize science as a means of advising them on how to live healthy and safe lives. Science teaches us about the causes and prevention of disease. It can also introduce students to the real, scientific reasons why they should avoid dangerous drugs and alcohol;

5. recognize vocational potentials. The future revolves around science and technological competence. There is no vocation of the future that will not be influenced by science and technology. A science education helps us to induct our students into the technological society.

It is clear, therefore, that science helps us to understand ourselves as well as our environment. That understanding can naturally transfer to the development of the healthy, safe, and successful interdependence of all people.

At the lower secondary level, students' experiences in science will lead them to have a conceptual understanding of the natural world, of man's place in it, and of his responsibility to maintain and preserve it. At the same time, science education will prepare students with scientific knowledge and skills for employment or for further education in technology, in science-related fields, and in different trades.

Thus, greater emphasis is placed in this curriculum on the outcomes of relating science and technology to each other, and to the world outside the school, as well as on the need for sustainable development. The development of students' understanding of the concept of sustainability is stressed in a variety of contexts (e.g., in the study of ecology). Communication skills and the use of appropriate terminology are given greater emphasis, for example, students are expected to describe what they are doing by using the terminology associated with specific scientific and technological concepts.

This science curriculum also builds on and reinforces certain aspects of the language and mathematics curricula. For example, it emphasizes the importance of clear, concise communication, and requires the use of various charts, tables, and graphs for communicating observations and measurements. It also includes other forms of communication, for example, the use of SI metric units, and experimental reports. Care must be taken to ensure that expectations involving SI metric units and other communication-related knowledge and skills are consistent with the expectations in language and mathematics for the relevant year levels.

Characteristics of a Good Scientist

In this curriculum**,** the study and practice of science should support individuals' development in three important areas: attitudes, processes (methods), and products. To be a successful scientist, one must first possess the right attitudes. Science helps us to develop a positive attitude to nature and how it affects us, and to the environment. Other attitudes that will be useful to us as we engage in science activities are curiosity, open-mindedness, healthy scepticism, perseverance, a positive approach to failure, cooperation, impartiality, humility, and tolerance.

A good scientist must also be able to apply certain processes in the study and practice of science. Scientific ways of solving problems involve the application of special methodologies that demand different types of thinking and reasoning skills. These can be divided into two areas: basic and integrated process skills. Basic process skills relate to enquiry skills such as observation, classification, communication, measurement, estimation, prediction, and inference. Integrated process skills relate to conceptual understanding. For science to make sense, it must be placed in a familiar context and be relevant.

Observation is an important process in science as it requires the use of the senses and requires that some form of measurement be made. Measurement is central to science because the types of results gained may be seriously affected by the accuracy of the measurements. It is therefore crucial that students be properly grounded in the skills of length, mass, time, temperature, and current measurement.

General Intended Learning Outcomes

The following general intended learning outcomes identify competencies expected of students upon completion of the study of Integrated Science in the lower secondary school:

1. Understanding of the nature of science

2. Empowerment, attained through their knowledge of the role of science in addressing the complex social issues related to the environment

3. Mastery of the skills and knowledge required for scientific enquiry

4. Willingness to acquire and apply scientific and technological knowledge to the mutual benefit of self, society, and the environment

These outcomes can best be arrived at through investigative approaches where students assume an active role in meaning-making. All instructional activities proposed within the curriculum units prepare students for relevant assessment tasks by supporting the development of the concepts and skills required for solving problems in society and their application to everyday life.

Structure of the Curriculum Document

The Integrated Science curriculum is designed to incorporate topic areas from the separate sciences that must be integrated during the teaching/learning process. A spiral curriculum design has been utilized to ensure that students progress smoothly as they develop knowledge and skills in science. The deliberate sequencing of the units in the curriculum will allow them to develop the knowledge and skills required to complete the final end-of-year assessment tasks.

The curriculum is intended to support the development of conceptual understanding. "Conceptual understanding" refers to the knowledge that students gain from their experiences in and out of the class setting while carrying out instructional activities identified in the document, such as investigations, discussions, or the presentation of findings and interpretations. Conceptual understanding will be derived from the overarching concepts in the topics in science that are identified for each unit. Although the concepts remain the same, the expected outcomes should change, depending on the age and developmental level of the student. Much of this conceptual understanding can best be assessed using the alternative forms of assessment proposed in this curriculum.

Curriculum Content

Form 1

Standard: Recognize That There Are International Standards of Units and Instruments for Measurement
Topic: Scientific measurement

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. list two reasons for the importance of measurements	• Measurement is global and needs to be standardized	• Accuracy • Consistency	• Teacher gives students a quantity of a substance and asks them to identify how much is present
2. explain the following concepts: length, mass, volume, time, and temperature	• Length – the distance between two points • Mass – the amount of matter in an object • Volume – the amount of space taken up by an object • Time – a measurement period • Temperature – how hot a substance is	• Unreliability of senses	• Teacher then explains the unreliability of senses and the need for measuring instruments • Classroom discussion with students
3. identify the International System of Units (SI) symbol and its conversion when measuring length, mass, volume, time, and temperature	• The same units are used internationally for measurement	• Length – metre (m); kilometre (km); centimetre (cm); millimetre (mm) • Mass – grams (g); kilograms (kg) • Volume – cubic centimetre (cm^3); litre (l); millilitre (ml) • Time – seconds (s); minutes (min); hours (hr) • Temperature – degree Celsius (^oC) and degree Kelvin (^oK)	• Give students instruments to measure length, mass, volume, and time. Ask students to identify the units used in each instrument and the abbreviated term used in measurement

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
4. demonstrate the appropriate use of metric measurement devices to promote consistency in investigations	• There are standard instruments used for measurement in science	• Length – metre rule • Mass – laboratory balance • Volume – measuring cylinder • Time – stop clock • Temperature – thermometer	
5. explain the limitation of measuring instruments	• There are limitations in accuracy of instruments used	• Inaccuracy • Error • Range • Tolerance • Precision	• Give students a variety of measurements to perform and have classroom discussion on difficulties incurred

Standard: Understand the Composition of the Universe and the Earth's Place in it
Topic: Solar System

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. identify components of our solar system	• Our solar system is one of the systems in the universe	• The relative size and position of the planets	• Make models and collect pictures of celestial bodies
2. describe the organization of the solar system, emphasizing the positions and sizes of the planets relative to the Sun	• Solar systems consist of celestial bodies revolving around the Sun	• Relevant terms: universe, galaxy, star, planet, meteoroids, meteors, meteorites, comets, asteroids	• Deliver presentations (e.g., PowerPoint) on the solar system • Create an acronym to recall the names and sequence of the planets away from the Sun
3. identify the bodies in space that emit light and those that reflect light	• The Sun is the nearest star	• Stars are good emitters whereas planets and moons are good reflectors of light	
4. describe, simply, fusion reactions taking place in the Sun	• Nuclear reactions within the Sun release large quantities of energy (equation not required)	• Hydrogen atoms combine to form helium atoms, which release energy in the form of heat and light	
5. explain that day and night are caused by the Earth's rotation	• Rotation of the Earth causes day and night	• The rotation of the Earth means that the Earth turns once a day. The part facing the Sun has daytime and the part not facing the Sun has night-time	• Model the rotation of the Earth and its physical relationship to the Sun
6. explain that gravitational forces hold celestial bodies in their orbit	• Forces of attraction exist between bodies	• Planets are held in their orbits by gravity • Gravitational attraction between the Moon and the Earth is responsible for the	• Research how a satellite is held in its orbit around the Earth

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
7. list the instruments used for observation of celestial bodies	• Technology allows close-up observations of the planets and their satellites	changes in tides • High tide and low tide occur as a result of the changing distance between the Moon and Earth • The use of instruments such as binoculars, telescopes, radio telescopes, and space probes facilitates observation, research, and data collection of the planets	• View the night sky using binoculars and/or simple telescopes • Field trip to science centres such as YAPOLLO • Collaboration with organizations such as Trinidad and Tobago Astronomical Society

Standard: Know That the Total Energy in the Universe is Constant; It is Neither Created Nor Destroyed But Can Be Transformed From One Form to Another

Topic: Forms of Energy

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. identify the forms of energy that come from the Sun	• The Sun is the principal source of energy	• Energy gives us the ability to do work • The Sun releases light and heat energy	• Conduct a simple experiment to show how sunlight changes the temperature of a container of water
2. explain that food is a source of energy	• Light energy from the Sun is used by plants to manufacture food	• The food made by plants is eaten by animals (including humans) and provides energy	• Identify the energy content of a food, e.g., by burning a peanut
3. identify the various forms of energy	• Energy exists in different forms	• Energy can be classified as mechanical or non-mechanical • Mechanical energy includes kinetic energy (the energy of a moving body) and potential energy (stored energy) • Potential energy may be classified as chemical, gravitational, or elastic • Non-mechanical energy includes light, heat, sound, electrical, and nuclear	• Construct a concept map to show relationships among all forms of energy • Use examples such as batteries, fuel, moving objects, etc. to identify the forms of energy
4. compare renewable and non-renewable sources of energy	• Energy sources can be classified as renewable and non-renewable	• Non-renewable sources of energy must be conserved • Fossil fuels need to be replaced by renewable sources of energy such as solar, wind, geothermal, tidal, and hydroelectric	• Research an alternative source of energy and discuss how it can replace fossil fuels

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
5. investigate the conversion of energy from one form to another	• Law of conservation of energy	• Energy can neither be created nor destroyed but it can be changed from one form to another	• Demonstrate energy changes in a simple pendulum, microphone, loudspeaker, wound-up toy, etc.
6. differentiate between heat and temperature	• Heat is a form of energy while temperature measures the "hotness" and "coldness" of a body	• When heat energy is absorbed there is a rise in temperature of the body, and when it is given out there is a drop in temperature	• Measure temperature, at regular time intervals, of a beaker of water as it is heated to a temperature of approximately 70^0 C and then allowed to cool. Represent graphically if possible **N.B.** Ensure that thermometer is read at eye level
7. measure the temperature change that results from using different materials	• Different materials have different heat capacities	• Different materials, when provided with the same quantity of heat, show different temperature changes	• Heat equal masses of two different substances, e.g., paraffin wax and water, for 2-3 minutes in a water bath and record changes in temperature
8. explain how heat is transferred	• The three modes of heat transfer are conduction, convection, and radiation	• Conduction is the transfer of heat through a solid • Convection is the transfer of heat through a fluid (liquid and gas) • Radiation is the transfer of heat through electromagnetic waves	• Identify the method of heat transfer in the following: - a pot being heated on a stove - land and sea breezes - heating of Earth by the Sun

Standard: Examine the Structure and Function of Plants as Organisms
Topic: Structure and Function of the Flowering Plant

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. identify the root and shoot systems of a plant	• The part of the plant above the ground is the shoot and the part below the ground is the root	• The shoot comprises leaves borne on a stem, flowers, buds, fruits, node, internode, etc.	• Draw and label a common dicotyledonous plant, e.g., shining bush, *Bidens* (railway daisy) • Draw and label a monocotyledonous plant, e.g., grass
		• There are two types of root systems - tap - adventitious (e.g., fibrous)	• Grow red bean and corn to observe root structure • Investigate the arrangement of leaves (alternate, opposite, and whorl)
2. outline the functions of the stem	• The stem supports all plant structures above the ground	• The stem: - spaces out the leaves in order to receive adequate sunlight for photosynthesis - supports the flower above the ground to facilitate pollination - allows for the movement of water and food within the plant	• Field trip to nature resorts such as the Botanical Gardens, La Vega, Pointe-a-Pierre Wild Fowl Trust, Asa Wright Nature Reserve, or school yard • Immerse a plant that has a translucent stem (e.g., shining bush) in water coloured with ink. Cut stem at intervals to show movement of the coloured water throughout the plant or leave overnight and observe

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
3. outline the functions of the root	• The root, although not often seen, is essential to the life of the plant	• The root: - anchors the plant in the soil - absorbs water and mineral salts from the growth medium (e.g., soil and in hydroponics) - stores food	• Uproot a plant to show root hairs clinging to soil particles • Suspend a seedling in a liquid medium containing nutrients and observe growth of root • Observe and draw root storage organs, e.g., cassava, carrot, sweet potato

Standard: Examine the Structure and Function of Plants as Organisms
Topic: Photosynthesis

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. outline the process of photosynthesis	• Light energy and other raw materials are necessary for photosynthesis	• Light energy is used to combine carbon dioxide and water to produce glucose and oxygen • The conditions necessary for this process are the presence of light, energy, and chlorophyll	• Write a word equation to represent the process • Conduct an experiment to determine if a destarched plant can photosynthesize using artificial light
2. explain that photosynthesis takes place mainly in the green parts of the plants	• The plant pigments trap light energy	• The green pigment chlorophyll is the most common pigment in plants • Other coloured pigments, e.g., carotene, exist in plants	• Extract coloured pigments from leaves and use paper chromatography to show presence of different coloured pigments • The chromatography strip can be scanned and used to make a bookmark
3. identify the products of photosynthesis	• The products of photosynthesis sustain life	• Glucose and oxygen are the two end products of photosynthesis. Glucose is then converted to starch	• Test leaves of the plant for starch • Conduct an experiment to demonstrate the evolution of oxygen in *Elodea*

Standard: Demonstrate an Understanding of Ecosystems
Topic: Feeding Relationships

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to: 1. relate feeding relationships to the transfer of energy from the Sun through plants to other organisms	• The Sun is the original source of energy for all living things	• Plants trap light energy and convert it to chemical energy • Energy from plants is transferred directly or indirectly to animals through feeding • Some energy taken in by the organism is used to sustain its life, some is lost to the environment, and a portion provides food for other organisms • Some organisms share specific feeding relationships, e.g., predator-prey, parasite-host	• Observe different ecosystems such as the school garden, a pond, or aquarium, etc. and list organisms and their feeding habits • Use information collected to construct food chains • Link the food chains to form food webs • Identify predators from data collected • Research and list some parasites in humans and plants and their source of food

Standard: Demonstrate an Understanding of Ecosystems
Topic: Micro-organisms

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. compare viruses, bacteria, and fungi	• Viruses, bacteria, and fungi are examples of micro-organisms	• Micro-organisms can only be seen with the aid of a microscope • Viruses are found within living organisms only while bacteria and fungi can be free-living • Viruses are the smallest known micro-organisms	• Mount a photo exhibit or book display to show a range of viruses, bacteria, and fungi. Draw and compare photographs • Compile a portfolio showing examples of micro-organisms (portfolio to be continued with activities relevant to other objectives)
2. explain the role of micro-organisms as decomposers in an ecosystem	• Decomposition is one of the important processes carried out by micro-organisms	• Decomposition by bacteria and fungi releases materials locked in the bodies of dead organisms, which can then be reused by plants • The rate of decomposition is affected by environmental conditions such as temperature and humidity	• Conduct experiments to observe and record changes in slices of bread under the following conditions for one week: (i) kept in sealed plastic bags at room temperature and in a refrigerator (ii) by varying moisture content
	• Many common diseases are caused by micro-organisms	• Some viruses, bacteria, and fungi cause certain diseases in plants and animals	• Make a list of common diseases • Research these diseases and tabulate the diseases and their causes

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
	• Certain substances are used to control these disease-causing organisms	• Antiviral drugs control the growth of viruses, antibiotics control the growth of bacteria, and fungicides control the growth of fungi	• Check information in/on boxes of medication used to treat infections in humans and match the type of medication (antibiotic, fungicide) with the micro-organisms it controls • Conduct a similar exercise for chemical sprays on plants
		• Vaccines are used to help our bodies fight infections caused by some micro-organisms	• Research steps in the treatment of cuts and bruises and relate this procedure to the prevention of infection by micro-organisms
	• Humans use micro-organisms for various purposes	• Yeast is a fungus that is used in baking and in the alcohol industry (e.g., beer, wine)	• Research and list ways in which humans use micro-organisms
		• Micro-organisms are also used in the production of drugs through genetic engineering, e.g., a vaccine against hepatitis, a drug to prevent blood clots, production of insulin	
		• Bacteria are also used in the production of cheese and yogurt	
		• Biological weapons are also made using micro-organisms	• Explore the ethical considerations of this use

Standard: Recognize That Patterns and Similarities Allow for Organization of Information About the Universe

Topic: Classification

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to: 1. Organize information based on patterns of similarities or differences	• Classification is a system of organizing things based on similarities and differences	• All things can be grouped or classified into living or non-living • Each group can be further subdivided, e.g.: - living things into plants and animals - elements into groups and periods in the periodic table - energy into renewable and non-renewable sources	• Brainstorm and justify groupings in everyday life • Construct dichotomous keys (e.g., from samples, pictures, etc.) • Explore the usefulness of keys

Standard: Recognize That Patterns and Similarities Allow for Organization of Information About the Universe

Topic: Structure and Properties of Matter

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. differentiate among the three states of matter	• Matter can exist in different forms called states and refers to all substances and materials	• Matter can be classified as solid, liquid, or gas	• Classify materials as solids, liquids, and gases
		• Matter has mass and occupies space (volume)	• Measure the mass and volume of various materials • Refer to moon rocks, meteors, substances, and materials in the biotic and abiotic environment as having mass and volume
2. relate the properties of matter to the arrangement of particles	• Properties of the states of matter are determined by the arrangement of particles	• The arrangement of particles gives rise to the general properties of solids, liquids, and gases: - compressibility (changes shape) - ability to flow (takes shape of container) - density - pressure	• Use models and draw diagrams to show arrangement of particles in solids, liquids, and gases • Relate properties of matter to everyday use, e.g.: - compressibility: compressed natural gas (CNG), liquefied petroleum gas (LPG) - density: anchors, hot air balloons - pressure: balloons

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
3. explain diffusion and osmosis in terms of particle movement	• Diffusion – the movement of substance particles from an area of high concentration to one of lower concentration • Osmosis – the movement of water particles across a permeable membrane from an area of high water concentration to a lower water concentration		• Teacher asks students to perform experiments illustrating diffusion and osmosis. The teacher guides discussions of results and explains the concepts of *diffusion* and *osmosis*
4. explain how temperature causes changes in states of matter	• Change in temperature has an effect on the arrangement of particles in matter	• Changes in temperature bring about: - melting - freezing - evaporation/vaporization - condensation/liquefaction - sublimation • These processes are reversible	• Relate changes in state of matter to the water cycle • Explore the environmental impact of global warming on the melting polar ice cap and rising sea levels • Investigate simple heating/ cooling curves for ice and water
5. describe the structure of the atom	• The atom is the basic unit of matter	• An atom consists of electrons (–) orbiting a nucleus • The nucleus consists of protons (+) and neutrons (o)	• Draw and label the structure of the atom • Use models and charts for an interactive session with students • Build a model of an atom • Examine the structure of the first 10 elements of the Periodic table

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
		• Atoms are found naturally or can be man-made	• Use the Periodic table to identify naturally occurring and man-made atoms
6. distinguish among elements, molecules, and compounds	• Atoms bond together to form elements, molecules, and compounds	• Similar atoms form elements • Molecules can be formed from the same or different atoms • Compounds are formed from two or more different types of atoms	• Use models to make molecules and compounds • Classify a number of given substances as elements or compounds
7. distinguish between compounds and mixtures	• Compounds are chemically combined substances while mixtures are physically combined	• Compounds and mixtures have properties that are unique to each	• Classify substances as either mixtures or compounds • Use models and substances to make compounds and mixtures
8. distinguish between types of mixtures	• Mixtures are formed when two or more different substances combine	• Two or more substances combine to form mixtures: - Gas/gas - Gas/liquid - Liquid/liquid - Solid/liquid - Solid/solid	• Research the composition of air (gas/gas mixture) • Explore different kinds of mixtures, e.g.: - solids – alloys such as bronze, brass, baking powder, solder - liquids – carbonated drinks, nail polish - gases – air
9. describe the formation of different types of solutions		• Homogenous mixtures are solutions • Solutes dissolve in solvents to form solutions • Solutions can exist in the three states of matter	• Prepare various types of solutions using different materials

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
10. describe heterogeneous mixtures		• Heterogeneous mixtures are suspensions, colloids, or mechanical mixtures	• Make suspensions, colloids, and mechanical mixtures • Filter solutions, colloids, and suspensions • Examine some colloids (e.g., gels, paints, glue) and make inferences about their homogeneity. Make use of hand lens and microscopes to do so • Examine mechanical mixtures such as iron filings and sulphur, and gravel and sand

Form 2

Standard: Recognize That Organisms Are Made Up of Interconnected Organ Systems That Work Together for Them to Function Efficiently

Topic: Organ Systems and Specialization

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. identify the importance of organ systems in the functioning of an organism	• The body of large, complex organisms is composed of organ systems that carry out different functions	• Organ systems allow for division of labour within the organism	• Use a model of the human and plant body to identify organs and organ systems that carry out different functions • Dissect a virtual organism to show organs and systems • Construct salt-dough/plasticine models of organs and/or organ systems
		• Division of labour increases the efficiency of the organism	• Have students note similar divisions of labour in their communities
2. explain that organs are made up of specialized cells that perform different functions	• Cells vary widely in form and function	• A cell is the smallest structural unit of living things that can perform all the processes (functions) necessary for life	• Prepare a skit to show how division of labour increases the efficiency of a complex organism
		• Specialized cells perform specific functions in living organisms, e.g., neuron, blood cells, sperm, ovum, smooth muscle, palisade, guard cells, root hair	• Develop a media presentation, e.g., PowerPoint, to show a range of modified cells, highlighting their function

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
3. describe the basic structure of a generalized plant and animal cell	• All cells possess basic structures regardless of cell specialization	• There are a number of structures common to both plant and animal cells—nucleus, chromosomes, cytoplasm, cell membrane, and mitochondria • There are a number of structures found in plant cells that distinguish plant cells from animal cells—cell walls, large central vacuole, chloroplasts, and starch grains • Each part of the cell performs a specific function	• Use a light microscope to view plant and animal cell structure, e.g., *Rheo* epidermis and root squash to show chromosomes • Construct a model of a plant and animal cell to highlight cell structure • Construct a table to summarize structure and function of parts of the cell

Standard: Recognize That Organisms Are Made Up of Interconnected Organ Systems That Work Together for Them to Function Efficiently

Topic: Diffusion and Osmosis

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. relate the movement of particles and Brownian motion to diffusion and osmosis	• Particles in constant motion is a property of matter	• Brownian motion demonstrates the existence of particles that are in constant random motion	• Demonstrate Brownian motion
		• Diffusion is the movement of particles from a region of higher concentration to a region of lower concentration	• Investigate diffusion in liquids and gases, e.g., smelling perfume, and relate to gaseous exchange in organisms
		• Osmosis is the movement of water particles from a region of higher water concentration to a region of lower water concentration through a selectively permeable membrane	• Investigate osmosis in living things, e.g., cucumber when sprinkled with salt releases water
2. describe how substances move into and out of cells	• The cell membrane controls movement of substances into and out of cells	• The cell communicates with its environment by taking in and releasing materials	• Demonstrate the application of osmosis, e.g., in rehydrating dried fruits, shaping food garnishes from fruit and vegetable
		• Osmosis and diffusion are two processes by which this exchange takes place	• Conduct simple experiments to demonstrate osmosis and diffusion

Standard: Recognize That Organisms Are Made Up of Interconnected Organ Systems That Work Together for Them to Function Efficiently

Topic: Human Body Systems

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. identify the excretory organs and their excretory products	• Excretion is the process by which organisms get rid of metabolic waste	• The kidneys produce urine • The lungs remove carbon dioxide • Sweat glands in the skin produce sweat • The liver gets rid of nitrogen by producing urea, which is excreted in urine	• Construct table of organs and their excretory products • Use charts/models to identify organs concerned with excretion and their positions in the body
2. describe the structure and function of the urinary system	• The kidney is responsible for the production of urine	• The urinary system consists of kidneys, ureter, bladder, and urethra • Urine contains salts, water, and urea/uric acid *(The process of formation of urine is not required)*	• Use a chart/model to trace the flow of urine from kidneys to urethra
3. investigate the treatment of malfunctioning kidneys	• The accumulation of metabolic waste is harmful to the organism	• The accumulation of wastes such as urea could be fatal. A malfunctioning kidney may be treated by kidney transplant or dialysis	• Research kidney transplants and treatment by dialysis

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
4. outline the constituents of a balanced diet	• Diet includes everything that a person eats or drinks	• A balanced diet contains the different nutrients (carbohydrates, proteins, fats, water, vitamins, minerals, and fibre) in the correct proportions	• Identify foods that contain the different nutrients • Prepare meal plans for: vegetarian, non-vegetarian, athlete, pregnant woman, elderly person, etc.
5. explain that animals obtain nutrients by breaking down food into simpler substances	• Food contains nutrients that are needed by all body cells	• This breaking-down process is called digestion • Digestion entails physical and chemical changes in the food • Physical changes are brought about by chewing and churning of the stomach • Chemical changes release simpler substances from the food, e.g: - carbohydrates $\longrightarrow$ simple sugars (e.g., glucose) - proteins $\longrightarrow$ amino acids - fats $\longrightarrow$ fatty acids and glycerol • These simple substances enter the blood stream and are taken to the body cells	• Give an oral presentation showing a poster of the different parts of the alimentary canal • Produce a cartoon depicting parts and function of the alimentary canal • Compose a monologue to narrate the digestion of a sandwich • Conduct food tests, e.g., protein, starch, and glucose

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
6. describe the process of breathing	• Breathing is the process by which air moves in and out of the lungs (inhalation and exhalation)	• Breathing involves the movement of muscles (intercostals and diaphragm), which brings about changes in volume and pressure in the chest cavity	• Observe the changes in the body (the thorax) as students inhale and exhale • Make a working model of the lung (e.g., bell jar model)
7. compare the composition of inhaled and exhaled air	• Inhaled and exhaled air differs in composition	• Inhaled air contains more oxygen than exhaled air, which contains more carbon dioxide	• Analyse a table showing the compositions of inhaled air and exhaled air
8. relate increase in physical activity to increase in breathing rate	• The body needs oxygen to carry out its daily activities	• The more oxygen needed, the faster the breathing rate	• Compare breathing rates before and after physical activity (e.g., running up and down a staircase)
9. outline the process of respiration	• Oxygen is used to release energy from food	• Respiration is the process that releases energy from food and takes place in the mitochondria in the cells • Oxygen is used up and carbon dioxide is produced as a waste product in respiration	• Write a word equation to represent respiration: Oxygen + Food $\longrightarrow$ Energy + Carbon dioxide + Water
10. outline the structure and function of the circulatory system	• The circulatory system transports substances throughout the body	• The circulatory system is made up of a muscular pump (heart), arteries, veins, capillaries, and blood • Blood is made up of cells in a liquid medium called plasma	• View models/charts/ transparencies that show the circulatory system • View transparency showing structure of blood

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
		• It ensures a constant supply of nutrients to body cells and removes waste materials from these cells	• Role-play the circulatory system
11. investigate the relationship between exercise and pulse rate	• Pulse rate is related to the level of activity	• Pulse rate is directly related to heart rate • It can be measured at certain points on the body, e.g., wrist, neck, temple, ankle	• Work in groups to measure pulse rate at rest, after mild activity, and after strenuous activity • Construct a table to display and analyse data
12. outline the structure and function of the human reproductive system	• Reproduction allows for the continuation of the species	• The female reproductive system consists of ovaries, uterus, fallopian tubes, cervix, and vagina • The male reproductive system consists of testes, scrotum, sperm ducts, and penis • The female reproductive organs are the ovaries and the male reproductive organs are the testes • Ovaries produce. ova and the testes produce sperms. These are specialized reproductive cells	• Use annotated diagrams to show the structure and function of the female reproductive system • Use annotated diagrams to show the structure and function of the male reproductive system • View media presentation on reproduction (e.g., the movie: “Look Who’s Talking Now”)

Standard: The Maintenance of Good Health is a Personal Responsibility
Topic: Health and Disease

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. explain what a disease is and how it may be caused	• Disease is any dysfunction of the workings of the body. Diseases are categorized according to their causes	• Disease in organisms can be caused by intrinsic failures of the system or infection by other organisms • Diseases are classified as deficiency, infectious, lifestyle, socially transmitted, and hereditary (genetically linked)	• Use visuals from posters, brochures, videos, newspaper, computer, etc. to justify the definition and classify different diseases
2. discuss the impact of diseases on the economy of the country	• A healthy population is the nation's greatest resource	• Economic impact of disease (poor health): - reduces productive time spent at work - drains the country of its sources of vitality, creativity, and wealth - raises health care costs	• Debate any aspect of the topic • Write a letter to the editor of a newspaper about the cost of health care
3. describe the causes of weight gain and loss, and the health risks associated with these	• The regulation of body weight and body fat may be linked to genetic, physical, lifestyle, and behavioural factors	• Factors involved in the regulation of body weight and body fat include heredity, diet, exercise, metabolic rate, and disturbed eating patterns such as overeating, purging, binge-eating, and self-starvation, which cause health problems such as heart disease	• Summarize and analyse health information from magazines/ newspaper articles • Role-play a scenario convincing someone to maintain a healthy body weight

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
4. design a personal plan for successfully managing body weight	• Achieving and maintaining a healthy body weight is important to good health	• Eating a balanced diet and exercising regularly is the "secret" to maintaining a healthy body weight	• Use health-weight chart to determine "recommended" body weight • Use a journal to monitor individual diet for a week, determine how much fat and sugar is consumed, and make a list of specific steps that can be taken to maintain a healthy body weight • Interview people who have successfully lost weight and kept it off and analyse their strategies • Make a list of at least five things that can be done to become more physically active • Implement and evaluate the personal plan
5. explain the transmission of HIV infection	• HIV (Human immunodeficiency virus) infection is a chronic disease that progressively damages the body's immune system resulting in AIDS (Acquired immunodeficiency syndrome)	• HIV lives only within cells and body fluids, not outside the body • Transmission of HIV takes place via blood and blood products, semen, vaginal and cervical secretions, and breast milk	• Use textbook, video, health brochures, etc. to summarize information

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
		• The three main routes of transmission are: - specific kinds of sexual contact, especially unprotected anal or vaginal intercourse - direct exposure to infected blood - from an HIV-infected woman to her offspring during pregnancy, childbirth, or breastfeeding	• Perform an activity simulating the spread of HIV using starch and iodine
6. describe the diagnosis and treatment of HIV infection		• The HIV antibody test is a blood test to determine whether a person has been infected by HIV • HIV infection results in AIDS, which makes an otherwise healthy person less able to resist a variety of infections and disorders and is the leading cause of death in many parts of the world • There is no known cure for HIV infection but medications can significantly change the course of the disease and extend life. These medications are extremely expensive and cause serious side effects	• Design a brochure for use in a local health centre

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
7. list strategies for protecting themselves against HIV infection	• Making careful choices about sexual activities and the use of injected drugs reduces the risk of contact with HIV	• One sure way to prevent HIV infection is abstinence from any sexual activity that involves the exchange of body fluids • People who are having intercourse should: - always use a latex or polyurethane condom properly - limit the number of partners - get tested for HIV regularly - People who inject any drug should avoid sharing needles or syringes	• Use stories from newspapers, magazines, etc. to stimulate discussions and list the positive behaviours that help avoid HIV infection • Compose a calypso, rap, poem, skit, etc. to reflect strategies for protecting yourself from HIV infection • Role-play situations that may be responsible for the transmission of HIV and highlight methods of protecting oneself
8. describe ways in which compassion can be shown to persons who are infected with HIV		• Persons who are HIV positive need support and respect • A person is not at risk of getting HIV infection by being in the same classroom, dining room, or even household with someone who is infected	• Role-play situations that show compassion when dealing with persons infected with HIV • Design a puppet or cartoon character for use in HIV education

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
9. discuss the effects of alcohol abuse on the drinker and others	• Abuse of alcohol affects other people, and not just the drinker	• One does not have to be an alcoholic to have problems with alcohol • Warning signs for alcohol abuse: - drinking alone or secretly - using alcohol deliberately and repeatedly to perform or get through difficult situations - feeling uncomfortable on certain occasions when alcohol is not available - increasing alcohol consumption beyond an already established drinking pattern - consuming alcohol heavily in risky situations, such as before driving - getting drunk regularly or more frequently than in the past - drinking in the morning or at unusual times	• Use video, posters, etc. to gather information and role-play different scenarios highlighting the effects of alcohol abuse and dependence • Carry out an anonymous survey within the form/age level to determine some effects of drinking alcohol on peers

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
		• A common form of alcohol abuse among students is binge drinking. Some possible effects can be: - missing classes - falling behind in school work - arguing with friends - experiencing unwanted sexual advances - being pushed/hit/assaulted - death from alcohol-related injuries, e.g., motor vehicle accidents • Women who drink while pregnant risk causing birth defects known as foetal alcohol syndrome (FAS) in their children	
10. describe strategies used to treat alcohol abuse and dependence	• Many different kinds of treatment programmes for alcohol abuse and dependence exist and no single treatment works for everyone	• Some alcoholics recover without professional help, usually due to an alcohol-related crisis such as a health problem or the threat of being fired/expelled	• Research methods used to stop drinking • Use the information to convince a friend or relative to seek help for their alcohol problem in a skit, rap, calypso, letter, e-mail, etc.

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
		• Examples of treatment programmes are: - Alcoholics Anonymous - Al-Anon (for family and friends of alcoholics) - inpatient hospital rehabilitation - employee assistance programmes - school-based programmes	
11. explain the health risks associated with tobacco use and exposure to environmental tobacco smoke	• Tobacco smoke is made up of several hundred different chemicals, including some that are carcinogenic or poisonous or that damage the respiratory system	• Regular tobacco use causes physical dependence on nicotine, which acts on the nervous system as a stimulant or depressant • Smoking tobacco causes cardiovascular disease, lung cancer, emphysema, chronic bronchitis, miscarriages, etc. • Environmental tobacco smoke can cause headaches, eye and nasal irritation, sinus problems, lung cancer, and heart disease in the non-smoker • Smoke from an unfiltered cigarette contains about 5 billion particles per cubic millimetre. These particles, when condensed, form cigarette tar	• Make a “cocktail” of some tobacco ingredients to stimulate students’ reactions • Use artificial lung to show the effect of tobacco smoke • Summarize information from video, posters, etc. and role-play different scenarios highlighting the effects of tobacco use on smokers and non-smokers

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
12. describe strategies for giving up tobacco use and for avoiding environmental tobacco smoke	• Individual and group action may be taken to prevent tobacco-related diseases	• Giving up smoking is a difficult and long-term process. Strategies for quitting tobacco use include: - quitting “cold turkey” - over-the-counter and prescription medications - support groups • Smoking restrictions may reduce exposure to environmental tobacco smoke. These include: - the right to a smoke-free environment - bans on smoking in public places - peer pressure	• Convince a friend or relative to stop smoking tobacco in a skit, calypso, letter, etc. • Create a board game/poster/ brochure to be used in educating young people about the dangers of tobacco use and strategies for quitting • Write a letter to a newspaper editor, mayor, or local government representative highlighting the need to reduce environmental tobacco smoke

Standard: Understand the Importance of Electricity and Magnetism in Our Everyday Activities
Topic: Electricity and Magnetism

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. describe static electricity	• Static electricity is a charge that does not move	• Charges can be both positive and negative • There are forces of attraction between unlike charges and repulsion between like charges	• Bring charged rods next to each other and observe attraction and repulsion
2. explain how objects can become charged	• When objects are charged, they show attraction or repulsion	• Objects can be charged by rubbing (friction), induction, and contact	• Observe and analyse different ways in which objects can be charged, e.g., rub a pen on clothing for approximately two minutes and then attempt to pick up small pieces of paper • Observe the production of static electricity in everyday activities, e.g., lightning, hair standing on end when near a television screen
3. describe electricity	• Electricity is a flow of electrons	• Movement of electrons from a negative pole to a positive pole produces an electric current • Current flows from the (-) terminal of a cell to the (+)	• Set up a simple circuit

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
4. classify materials as either conductors or insulators	• Some materials are conductors while others are insulators	• A conductor allows an electric charge to flow through it, while an insulator does not	• Use a simple circuit to classify different materials as conductors and insulators • Build a circuit using two alligator clips instead of a switch. When the clips touch, a bulb should light. Use different materials to investigate whether or not the bulb lights and note its brightness. Classify materials as either good conductors or good insulators
		• Liquids can also be classified as conductors or insulators	• Give examples of liquid conductors and insulators
5. explain that current flows when a circuit is complete	• A closed or complete circuit allows the flow of electric current (electrons) • Current is measured in amperes (A)	• The circuit is complete when there is an unbroken pathway for the current to flow, i.e., a conductor, source of electrons (battery), and a closed switch	• Using an ammeter, measure current flowing in different circuits
6. use circuit symbols to construct simple circuits	• Circuit symbols are used to simplify circuits	• Some common circuit components are: cells, bulbs, ammeters, voltmeters, resistors, switches	• Draw circuits using the appropriate circuit symbols

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
7. differentiate between series and parallel circuits	• Circuits may be series or parallel	• In a series circuit, the current has the same value (ampere) at every point • In a parallel circuit, the current splits at the junctions and the values vary at different points	• Design and build circuits to investigate the brightness of bulbs in series and in parallel
8. differentiate between actual and conventional current flow	• Current flows in one direction in a circuit	• Actual current flows from the (-) terminal of a cell to the (+), while traditionally it is represented as flowing from the (+) terminal to the (-)	• Construct circuit diagrams showing the flow of electricity
9. identify safety practices when using electricity	• Electricity can be dangerous if not handled properly	• Insulators can be used to protect individuals handling electricity, e.g., rubber and plastic • Electrical appliances should not be used around water or with wet hands • Care should be taken when picking fruits or flying kites around high tension wires	• Create cartoons and posters to educate the public on the proper handling of electricity • Collect flyers from T&TEC and display around school
10. explain the importance of resistors in circuits	• A resistor limits the flow of current through a circuit	• The larger the value of the resistor, the smaller the current flowing through the circuit	• Design and build circuits to measure the effect of resistors on current by comparing the brightness of the bulbs

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
11. classify materials as magnetic or non- magnetic	• Materials may or may not be magnetic	• A magnetic material is attracted and repelled by a bar magnet	• Use an assortment of materials to determine which ones are magnetic
12. distinguish between temporary and permanent magnets	• Magnets may be either temporary or permanent	• A permanent magnet may be magnetized for a very long time • A temporary magnet loses its magnetism after a short time	• Research what materials are suitable for making magnets
13. investigate forces between magnets	• Forces exist between magnets	• Forces of attraction exist between unlike poles of magnets and forces of repulsion exist between like poles	• Observe the behaviour of like and unlike poles of two bar magnets placed next to each other
14. investigate the effect of distance on magnetic force	• Force is inversely proportional to distance	• As distance increases, magnetic force decreases	• Design and perform an experiment to observe the effect of increasing distance on the magnetic force between two bar magnets
15. investigate the field around a magnet	• A magnetic field is experienced in the region around a magnet	• The magnetic field is strongest at the poles of a magnet • Field lines move **from** the north **to** the south pole	• Use iron filings and/or a plotting compass to determine the field around a bar magnet
16. discuss the importance of magnetic shields	• A magnetic shield confines the magnetic field in it	• A material that is attracted to a magnet may not necessarily be magnetic in nature • A non-magnetic material can block the magnetic field between two bar magnets	• Examine the effect of a magnetic shield, e.g., lead, around a magnetic material • Examine what happens when magnetic and non-magnetic materials are placed between two bar magnets

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
17. discuss the Earth's magnetism and its use in finding direction	• The Earth is magnetized	• The Earth has a magnetic north and south pole • A compass can be used to find direction since it points to the magnetic north	• View video or other visual presentation about the Earth's magnetism • Observe the behaviour of a freely suspended magnet and note the direction in which it points • Design and make a compass to find direction

Standard: Understand That Changes in Nature Can Be Physical or Chemical
Topic: Physical and Chemical Changes

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. differentiate between physical and chemical changes	• Changes in conditions determine whether or not physical or chemical changes take place	• Physical changes are readily reversible and do not produce new substances	• Conduct simple experiments to demonstrate physical changes using ice • Discuss the physical changes occurring in the water cycle
		• A chemical change is difficult to reverse and requires a chemical reaction • The reaction occurs in fixed proportions by mass and new substances are formed	• Conduct simple experiments to demonstrate chemical changes, e.g., burning of Mg ribbon • Investigate how physical and chemical processes change materials found at home (e.g., cooking)
2. identify physical and chemical properties	• Substances have different properties	• These properties can be physical or chemical • Some physical properties include hardness, elasticity, texture, size of particles, colour, shape, strength, solubility, conductivity, magnetism, etc.	• Relate these properties to uses in everyday life
3. investigate factors affecting the solubility of substances	• A soluble substance dissolves in a solvent	• Chemical properties describe how substances react. Some reactions produce heat, take in heat, decompose, produce gases, etc.	• Conduct experiments to show that substances react differently

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
		• Solubility of substances depends on the nature of the solvent and the solute, temperature, pressure (for gases)	• Investigate the solubility of solutes in solvents at different temperature • Investigate how solubility of gases in water is used in industry (e.g., carbonated beverages) • Discuss the importance of dissolved gases to aquatic life, deep sea divers, and gaseous exchange

Standard: Recognize That the Properties of Substances Determine the Separation Techniques That Can Be Used

Topic: Separation Techniques

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to: 1. identify methods of separating mixtures	• Separation method used depends on the nature of the materials	• A soluble solid can be separated from a liquid by: - evaporation - simple distillation - crystallization • An insoluble solid can be separated from a liquid by: - filtration • Miscible liquids can be separated by: - fractional distillation • Immiscible liquids can be separated by: - separating funnels • A magnetic solid can be separated from a solid/liquid by: - magnetism • Solids of different particle size can be separated by: - sieve	• Perform investigations to separate mixtures using magnets, separation funnel, filter paper, distillation apparatus, sublimation, and crystallization • Separate plant pigments and dyes by chromatography • Discuss the criteria for using identified methods for separation • Students design methods for the separation of mixtures • Identify the source of materials found in products (e.g., plastics from petroleum, glass from sand)

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
2. identify methods of separating compounds	• Compounds can be separated into pure substances by using electricity and other chemicals	• Compounds are difficult to separate and require a considerable amount of electricity and/or heat, e.g: - aluminium smelter plants are normally constructed with their own electrical power plant - iron plants (e.g., ISCOTT) use a considerable amount of heat energy to bring about the separation of iron ore	• Demonstrate a simple experiment to separate water into its elements by electrolysis • Relate volume of gas produced to formula of water

Form 3

Standard: Light is a Form of Energy That Travels in Straight Lines
Topic: Light

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. investigate the straight line propagation of light	• Light travels in straight lines	• A ray gives the direction in which light travels. It is denoted by a line and an arrow • A beam is a group of rays • There are three types of beams: parallel, convergent, and divergent • The speed of light is 3.0×10^8 m/s	• Observe practical examples of straight line propagation of light, e.g., camera, projector • Identify common devices that produce divergent, convergent, and parallel beams, e.g., torchlight, laser light, headlights, magnifying glass
2. differentiate between luminous and non-luminous bodies/objects	• All bodies may be classified as luminous or non-luminous	• A luminous body produces its own light • A non-luminous body reflects light	• Give examples of bodies that are luminous or non-luminous
3. compare the passage of light through different materials	• Materials may be classified depending on the amount of light that passes through them	• Materials may be opaque, translucent, or transparent • An opaque object allows no light to pass through it • A translucent material allows some light to pass through • A transparent material allows all light to pass through	• Classify an assortment of everyday materials into opaque, translucent, and transparent

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
4. compare shadows using a point source and an extended light source	• Shadows are formed when an opaque object is placed in the path of light	• Shadows can be formed using a point source (small) of light	• Generate shadows from a point source of light • Make shadow puppets
		• Shadows can also be formed using an extended source (large) of light	• Generate shadows from an extended source of light
		• The region of total darkness is the umbra and the region of partial darkness is the penumbra	
		• Solar and lunar eclipses are the result of shadow formation	• Make models/posters and draw ray diagrams to explain solar and lunar eclipses
		• The Sun acts as an extended source of light	
		• A solar eclipse occurs when the Moon is between the Sun and the Earth	
		• A lunar eclipse occurs when the Earth is between the Sun and the Moon	
5. investigate identified properties of light	• Light can be reflected, refracted, dispersed, or absorbed	• Reflection is the “bouncing” of light off a surface. The light ray does not pass through the medium	• Demonstrate reflection of light using a mirror/reflective surface
		• For reflection, the angle of incidence is equal to the angle of reflection	

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
		• Refraction is the “bending” of light moving from one medium to the next	• Demonstrate refraction using a pencil in water
		• Dispersion of light is the splitting of white light into its constituent colours (ROYGBIV)	• Conduct experiments to observe the dispersion of white light using a prism
		• Absorption is the complete transmission of the light into another material • The colour of a material is determined by the colour of light reflected	• Investigate colours of objects when exposed to differently coloured lights
6. differentiate between images formed by a plane mirror and lenses	• The image formed by a plane mirror is virtual and that formed by a lens is real	• An image in a plane mirror is virtual, upright, and laterally inverted	• Stand in front of a plane mirror and observe the image
		• There are two types of lenses: convex (convergent) and concave (divergent) • A real image can be captured on a screen and is always inverted	• Project an image on a screen using an overhead projector • Construct a pinhole camera, using a convex lens, to show a real image
7. describe the structure and functions of parts of the eye	• The eye is an organ that allows us to perceive light	• Parts of the eye include: pupil, retina, cornea, ciliary muscles, lens, iris, sclera, choroid, fovea, blind spot, aqueous humour, vitreous humour, and optic nerve	• Use an annotated diagram (chart) and models of the eye to construct a table of structure and function of the parts of the eye

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
		• An object can be seen when light is reflected from the object into the eye	• Draw a ray diagram to illustrate how light falls on the retina • Draw and label a diagram of the eye to be displayed for Blind Awareness Day
8. compare the parts of the eye to the parts of the camera	• The eye is very similar to the camera	• The retina can be likened to the film; the eye lens to the camera lens; the ciliary muscles to the focus; the iris to the shutter; the pupil to the aperture • The camera forms a permanent image	• Use a 35 mm camera in class and compare to the eye
9. discuss defects of vision and methods of correcting them	• Some eye defects can be corrected using lenses	• Two common eye defects are: 1. Shortsightedness – in which the image forms in front of the retina. This can be corrected by a concave lens 2. Longsightedness – in which the image forms behind the retina. This can be corrected by a convex lens	• Draw ray diagrams to show the common eye defects and their correction • Determine the number of students in class with normal/defective vision using a simple eye test

Standard: Understand Forces and Motion and Their Relationship to Each Other
Topic: Forces

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. investigate some properties and types of forces	• A force is anything that changes or tends to change the state of rest or uniform motion of a body in a straight line	• A force has magnitude and direction. Forces are measured in newtons • A force acts on a body causing changes in motion • Forces can act in directions opposite to that of the motion	• Measure force using a spring balance • Find the resultant of two or more forces acting on a body • Investigate the effect of the same force on different masses
		• Some common forces are: gravitational, contact (friction), magnetic, and electric	• Give examples of forces (pushes and pulls) and explore the effects of each type of force
2. describe the effect of forces that act from a distance	• Some forces can act from a distance	• Forces that act from a distance are called distance multipliers, i.e., a small force is used to lift a large load	• Conduct an experiment to observe the effect of using varying lengths of wooden poles to move a large load • Demonstrate the importance of levers as distance multipliers in everyday life, e.g., see-saw, the human forelimb, a wheelbarrow
3. explain action and reaction forces	• For every action there is an equal and opposite reaction	• If a body A exerts a force on a body B, body B exerts an equal and opposite force on body A	• Highlight some action and reaction forces that occur in everyday life, e.g., student sitting on chair exerts an action force on the chair and the chair in turn exerts a reaction force on the student

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
4. distinguish between mass and weight	• Weight is a force and is the product of mass and gravity (W = mg)	• Mass is the amount of matter a body is made up of. It is measured in kilograms (kg) • Weight is dependent on the "gravity" acting on a body and as such will vary from planet to planet	• Compare how mass and weight vary on Earth and the Moon: g (earth) = 10 N/kg g (moon) = 1.67 N/kg
5. investigate the properties of the mass of a moving body	• Inertia and momentum are both properties of the mass of a moving body	• Inertia is a body's resistance to being moved. The larger the mass, the greater the inertia • Momentum is a product of mass and velocity • The larger the mass, the greater the momentum • The larger the velocity, the greater the momentum	• Try moving bodies of different mass and compare the resistance • Calculate the momentum of small and large vehicles moving at the same or different velocities

Standard: Understand Forces and Motion and Their Relationship to Each Other
Topic: Pressure

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. investigate the relationship among pressure, force, and area	• Pressure is defined as force per unit surface area (P = F/A)	• The unit of pressure is the pascal (Pa) or N/m^2. As the force increases, the pressure increases; as the surface area increases, pressure decrease	• Use a rectangular block to determine the pressure produced when placed on its different faces
2. describe the effects of atmospheric pressure on living and non-living bodies	• Atmospheric pressure is the pressure exerted by the air on all living and non-living things	• Atmospheric pressure decreases as one moves up • Atmospheric pressure is the greatest at sea level	• Perform experiments to show the action of drinking straws, siphons, and rubber suckers • Research the need for pressurized cabins in aeroplanes, submarines, and spacecrafts
3. investigate pressure in liquids	• Liquids exert a pressure	• The pressure of a liquid is the same at the same horizontal level • Pressure of a liquid increases with depth • A liquid is incompressible and transmits all of its pressure	• Perform experiments to show that pressure is the same at the same horizontal level and increases with depth • Research the “bends” that can be experienced by divers • Demonstrate the use of hydraulic machines

Standard: Understand the Environmental Implications of Human Activities and Steps That May be Taken to Manage the Environment

Topic: Man's Effects on the Environment

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to: 1. explain how human activities are changing the environment globally, with serious consequences	• Human activities are altering the environment in dramatic and far-reaching ways	• Causes of alteration of the environment: - industrialization - urbanization - developments in agricultural technology - the deliberate or accidental introduction of species to new habitats - the removal of endemic species have led to the environment being altered • Consequences - deforestation - habitat destruction - depletion of natural resources - increased levels of pollution - changes in the natural balance of the ecosystem	• Work in groups to research a topic and do a presentation, e.g., on the effects of any one of man's activities on the environment

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
		• Changes in the environment have also led to worldwide phenomena such as: - the greenhouse effect (global warming) - damage to the ozone layer - a decrease in the availability of drinking water (potable water) - a decrease in some plant and animal populations to dangerously low levels	• Design posters to educate the public on one of these worldwide environmental concerns • Dramatize the consequences, in 30 years, of human activities if it goes unchecked
2. identify steps that may be taken to manage the environment so that a balance can be maintained, despite human activities	• Conservation aims to preserve habitats, protect wildlife, and ensure that natural resources are used in a way that allows for sustainability	• Habitats can be preserved by: (i) setting aside areas for restricted access and use, e.g., national nature reserves such as the Aripo Scientific Reserve, Buccoo Reef, Bird of Paradise Island, and Central Forest Reserve, Tobago (the oldest reserve in the Western Hemisphere)	• Work in groups and take photographs or make a documentary on a local environmental concern and suggest how the problems can be addressed

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
		(ii) setting up conservation organizations responsible for the environment, e.g., The Ministry of Public Utilities and the Environment, Environmental Management Authority, The Asa Wright Nature Centre, Emperor Valley Zoo, Pointe-a-Pierre Wild Fowl Trust	• Research systems that are in place in Trinidad and Tobago to ensure conservation
		(iii) developing and enforcing laws that limit the impact of industries, etc. on the environment, e.g., The Environmental Commission of Trinidad and Tobago	• Debate topics related to conservation vs industrialization • Field trip to any site of interest
		• The protected species in Trinidad and Tobago are: ocelot, silky anteater, porcupine, pawi, red howler monkey, scarlet ibis, pelican, manatee, leatherback sea turtle, sabre wing humming bird, macaw	• Role-play an exchange between a game warden and a poacher in a game sanctuary

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
		• Wildlife are protected by: (i) game sanctuaries, e.g., the Caroni Wildlife Sanctuary and the Bush Bush Wildlife Sanctuary in the Nariva Swamp, where no hunting is allowed (ii) legislation, e.g., the Conservation of Wildlife (Amendment) Regulations, which set a fixed period for the hunting season (iii) issuing permits to hunters during hunting season (iv) ensuring that animals with low populations cannot be hunted. Examples of these protected animals are ocelot, silky anteater, porcupine (v) regulation of mesh size in fishing nets • Natural resources are maintained by more efficient use of the biotic resources (e.g., trees, fish), mineral resources, water, and fuel, and by developing alternative sources of energy	• Prepare a speech aimed at educating the public on the value of hunting only during the fixed season, when hunting is allowed, and of not hunting the protected species • Research the applicable environmental laws • Research and list some possible alternative sources of energy • Tabulate items we use on a daily basis and identify the natural resources that are used to make each item

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
3. outline an individual's role in conservation	• Conservation is an active process, which is the responsibility of every individual	• Individuals can cultivate habits of: - **reusing** (e.g., glass jars, plastic containers) - **reducing** (e.g., use less water, electricity, plastics, foil, etc.) - **recycling** (e.g., paper and glass bottles can be sorted for recycling, organic waste can be used to form compost, etc.) - **restoring** the environment by replanting trees, cleaning litter on beaches, etc. - **refusing** to be involved in activities such as the unnecessary destruction of trees, setting of bush fires, littering, introducing plants and animals to the country without the necessary permission, etc.	• For one week, keep a record of household garbage, and group items as biodegradable or non-biodegradable, and suggest how each can be sorted and reused • Design a simple compost machine • Students record in portfolios, over a period of one month, what was done by them to aid in conservation • Organize activities to promote environmental awareness, e.g., displays, lectures by students for World Environment Day on June 5th each year

Standard: Understand the Nature of Acids, Bases, and Salts
Topic: Acids/Bases/Salts

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
Students will be able to:			
1. identify substances that are acids and alkalis	• Many common substances are acidic or alkaline in nature and can be identified by the use of indicators	• Acidic substances are sour, corrosive, and turn blue litmus red • Hydrochloric acid is found in our stomach • Alkaline substances are soluble bases. They are caustic, soapy to the touch, and turn red litmus blue • Saliva is slightly alkaline	• Using a range of everyday substances, identify acids and alkalis
		• Colour changes are used to identify an acidic or alkaline substance	• Test a range of substances with different indicators to determine whether they are acids or alkalis • Make indicators using plant extracts from hibiscus petals, sorrel, red cabbage, etc.
		• The pH scale can be used to determine whether substances are either strong or weak acids or alkalis	• Test a range of substances with pH paper (universal indicator) and classify as strong or weak acids or alkalis

Instructional Objectives	Content Concepts	Content Scope	Suggested Teaching/Learning/ Assessment Activities
	• Acids and alkalis have chemical names that are represented by formulae	• The name and chemical formula of some common acids and alkalis: - hydrochloric (HCl), nitric (HNO_3), sulphuric (H_2SO_4), and ethanoic acids (CH_3COOH), etc. - sodium (NaOH), ammonium ($NH_4(OH)_3$), calcium ($Ca(OH)_2$), and potassium (KOH) hydroxides, etc.	• Match name to chemical formula
2. outline some chemical reactions that take place with acids	• Acids react with substances to form salts and other products	• acid + alkali $\rightarrow$ salt + water (neutralization reaction) • acid + metal $\rightarrow$ salt + hydrogen • acid + carbonate $\rightarrow$ salt + carbon dioxide + water • Word equations and very simple chemical equations that need no balancing are used to represent these reactions	• Illustrate using treatment of ant bites, bee stings, stinging nettles, wasp stings, etc. • Perform simple acid reactions. Observe and tabulate results • Perform gas tests to identify hydrogen and carbon dioxide
3. explain how some factors affect the solubility of salts	• The rate at which a substance dissolves is affected by many factors	• Solubility depends on: - temperature - nature of solute - nature of solvent	• Perform experiment to determine the effect of temperature on mass of solute. Plot graph of temperature vs. mass of solute • Investigate the solubility of a solute in different solvents and vice versa at room temperature

Part 3
Teaching and Assessment Strategies

Proposed Teaching and Learning Strategies

Teaching and Learning Science

> *If school is not inviting, if the tasks are not clear, interesting and at an appropriate level, how can we expect pupils to be on task? Adverse student reactions should be expected when classes are dull, teaching is uninspired, and failure is built in.*
>
> William Morse (1987, p. 6)

No good educator would deny that the quality of teaching and learning plays a vital role in promoting students' understanding and learning of scientific concepts.

Science classrooms need to be places where creativity and innovation are encouraged, appreciated, and recognized. Teachers need to take care not to dispense content in a boring and unappealing manner. Instead, they need to operate in a manner that would capture and sustain the interest of various types of learners. Thus, the science classroom needs to be one in which students are actively engaged in doing science.

Young people learn more readily about things that are tangible and directly accessible to their senses—visual, auditory, tactile, and kinesthetic. Students need to be engaged and given the opportunity to emulate and practise things that we want them to know and do. They cannot learn to think critically, analyse information, communicate scientific ideas, make logical arguments, work as a team, and acquire desired skills unless they are permitted and encouraged to do so. There needs to be repetition of activities together with constructive feedback that would enhance growth and development. In order to accomplish these things, teachers' selection of strategies for instructional delivery that employ different modes is strongly advocated. Approaches selected must meet the varying needs of learners, and should also appeal to their varying multiple intelligences as outlined by Howard Gardner.

Thus, many different and varying teaching strategies must be used, including both direct and indirect instructional strategies. Any strategy selected, however, must:

- match the different ways that students learn;
- provide opportunities for students to perform authentic scientific inquiry;
- allow students to operate in a collaborative and cohesive manner;
- draw upon students' previous experiences and build on them;
- be student friendly.

Teachers also need to exploit the rich resources that are present in the larger community. They need to use these to their advantage in bringing about teaching and learning of science. Some of the multiple instructional resources available include:

- the electronic media – computers, CDs, DVDs, videos, and the Internet
- the print media – textbooks, posters and maps, journals, magazines, and so on
- manipulatives – models, puzzles, specimens, games, and measuring tools
- the community – expert people, institutions, the external environment, museums, factories, and natural resorts

A list of suggested strategies and resources is presented below.

The use of such strategies and resources may demand significant changes in the deliverers of science programmes. These may include change in their perception of learners, change in their perception of scientific learning, change in their perception of teaching, and change in their modes of scientific instruction.

Suggested Instructional Strategies and Resources

Lectures
Demonstrations
Discussions
Questioning

Reading
Oral reports/Presentations
Debates

Investigations
Field trips
Problem solving
Projects
Simulations
Role play
Computer-based learning

Guest speakers
Videos/CD-ROMs
Chalk board/Marker board
Educational software/computers

Assessment in the Science Curriculum

It is strongly advocated that as teachers deliver this science programme they use a variety of different classroom assessment strategies as they deem fit. This will cater to the individual differences of learners as we try to determine the level of learning that has occurred. Assessment strategies may be selected from the list outlined at the end of this section, or teachers may use any other method that is appropriate.

> *Assessment is the systematic collection of data about what students know, understand and are able to do. Assessment is not an arbitrary or private judgement springing from professional mystique, but a matter of meeting clear criteria open to public scrutiny.*
>
> Pratt (1980)

Classroom assessment is used by various stakeholders to serve their particular needs. It is used by students to indicate to them what they know, where they are having difficulties, where they need extra assistance, and where they should place more emphasis. It also helps them to recognize what they can do and how well they can do it. Teachers use classroom assessment to guide their choice of instructional strategies and to inform decision making in other aspects of the curriculum implementation process. It also helps them to plan and to deliver reports about student progress to parents. Finally, parents use it to recognize how their children are progressing in school and if and where they need to provide extra help and guidance for them.

Brookhart (1997) contended that a variety of assessment tools should be used to measure achievement targets, and that the tools selected should depend upon the students and the subject matter being assessed. Students' perception of a task and their ability to handle the task influence both the effort they devote to such tasks and the extent to which they achieve success.

Assessment and instruction should be linked. The type of assessment selected should be carefully chosen to relate to the intended learning outcomes and should demonstrate validity and clarity of purpose. Students have individual learning styles and react differently to forms of assessment. It is therefore important to ensure that a variety of assessment strategies be used, so that the level of disadvantage implied by an over-reliance on a narrow range of assessment is minimized.

Tests and examinations have always been recognized as a classical way of measuring students' progress, and are integral to accountability in schools and in the education system. These highly visible forms of monitoring progress are known as summative assessment and are used not only by policy makers and administrators, but also by parents and employers. Summative assessment usually takes place at the end of a

programme of learning, in order to find out what has been learnt and what standard the learners have reached.

To be truly effective, assessment should also be formative. In formative assessment, teachers make frequent interactive assessment of students' understanding. This enables them to adjust their teaching to meet individual student needs. Formative assessment is ongoing assessment and helps to shape the learning process by providing feedback to learners and teachers. A more detailed or diagnostic assessment may also be necessary where students are facing particular difficulties.

A variety of summative and formative assessments strategies should be used in order to guide teaching and learning. This should not only incorporate traditional pen/pencil and paper tests, but must also use alternatives to such tests. Interest in alternative assessment has grown rapidly in the last decade or two, as a result of educators' dissatisfaction with the traditional mode of assessment, which was not meeting their changing needs. Alternative assessment methods range from writing essays to hands-on performance tasks that should be authentic.

Suggested Assessment Strategies

Pen/pencil and paper test
Final exams
Essays and assignments
Field reports
Group work
Exhibitions
Portfolios
Presentations
Performance
Projects
Laboratory work
Oral presentations
Quizzes
Simulation
Role play
Debates
Journals and learning logs
Formal and informal observation
In-class questions and learning probes
Peer assessment
Student self-assessment

Any assessment approach used must be reliable and valid. It must include an appropriate scoring rubric that is unambiguous and transparent.

Part 4
Glossary and References

Glossary

Annotate
Add a brief note to a label.

Classify
Place into groups according to similarities and differences.

Compare
Identify similarities and differences for each feature.

Define
State concisely the meaning of a word or term.

Demonstrate
Show clearly by giving evidence.

Describe
Give detailed information on the appearance and/or arrangement of a structure or process. Descriptions may employ words, drawings, and/or diagrams.

Design
(a) Plan and present an activity/item with all relevant practical detail.
(b) Plan and present an experiment applying the scientific method.

Draw
Construct a two-dimensional illustration to show accurate likeness and proportion of a specimen, using drawing guidelines.

Investigate
Use the scientific method to arrive at logical conclusions.

Measurement
Involves identifying the quantity, unit, and measuring instruments, and using instruments correctly.

Observe
Study and examine, using appropriate senses and/or extensions of them (e.g., thermometer, microscope, etc.).

Health Terms

Anorexia Nervosa

This disorder is also known as self-starvation, and is the refusal to maintain body weight at a minimally healthy level, fuelled by an intense fear of gaining weight or becoming fat. Health risks include dry skin, cessation of menstruation, diseases of the cardiovascular, skeletal, endocrine, and digestive systems, and depression.

Binge Eating

This disorder is characterized by overindulgence in eating and a general lack of control over eating.

Bulimia Nervosa

This disorder is characterized by recurrent episodes of binge eating and purging.

Obesity

This condition is a more serious degree of overweight and is associated with a number of health risks, for example, impaired heart and immune function, hypertension, kidney diseases, gallbladder, arthritis, and so on.

Purging

This disorder is the use of vomiting, laxatives, excessive exercise, diet pills, and so on to compensate for food that has been eaten so that it will not produce weight gain.

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