MINISTRY
OF
EDUCATION, YOUTH & INFORMATION
*Every Child Can Learn, Every Child Must Learn*

NATIONAL STANDARDS CURRICULUM

# SCIENCE

## GRADE 9 APSE1

NATIONAL STANDARDS CURRICULUM GUIDE

# GRADE 9

# SCIENCE

## APSE1

Ministry of Education, Youth and Information, Jamaica. 2018

# ACKNOWLEDGEMENT

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• The various stakeholder groups, who provided valuable information on societal needs in relation to the curriculum
• All others whose names do not appear, but who contributed to the production of the NSC

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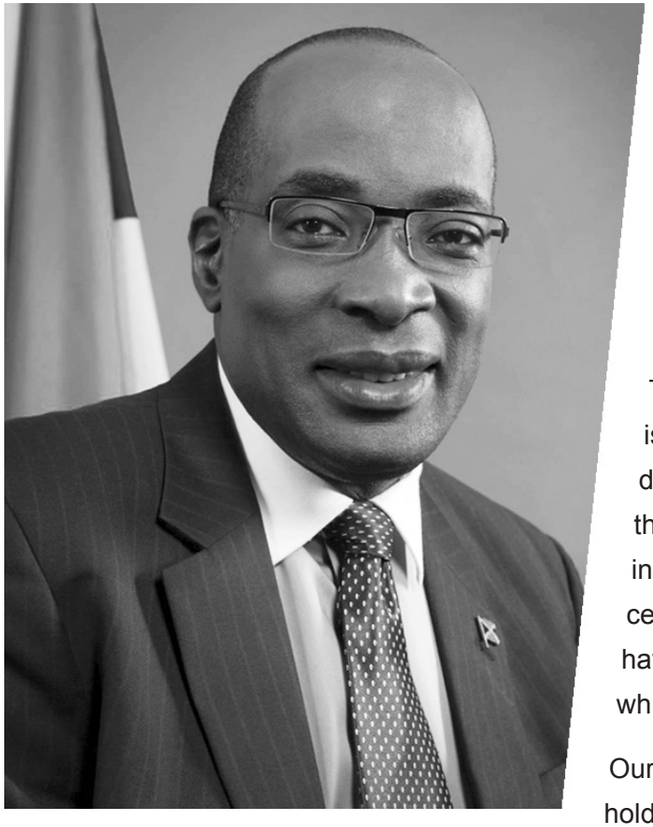


Education has always been pivotal to societal and economic development. It is for this reason that Jamaica remains unshaken and hopeful of a realized vision to be “the place of choice to live, work, raise families and do business.” The assurance of the possibility of all that such a vision entails comes from the recognition that Jamaica is endowed with tremendous God-given talent and creative potential and as a people of strong faith in spiritual principles and resilience; we are able to harness our capabilities, to make significant influence on the world. It is through this new National Standards Curriculum (NSC) that we hope to propel this vision of the education system whilst becoming more relevant, current and dynamic.

The team at the Ministry of Education Youth and Information is cognizant of the fact that the curriculum is the heart and mind of education and remains the most powerful means by which any country can develop and be sustainable. It is for this reason that the NSC has been designed with the understanding that people, learning and national development are at the core of our existence in a time of rapid change in the physical, social, economic and other dimensions of the global landscape. As a consequence, we celebrate the wisdom of the developers who through the engagement of numerous stakeholder groups, have responded favourably to the need for that kind of education that prepares our young people for life; while challenging our more mature to join in this lifelong journey of learning to learn.

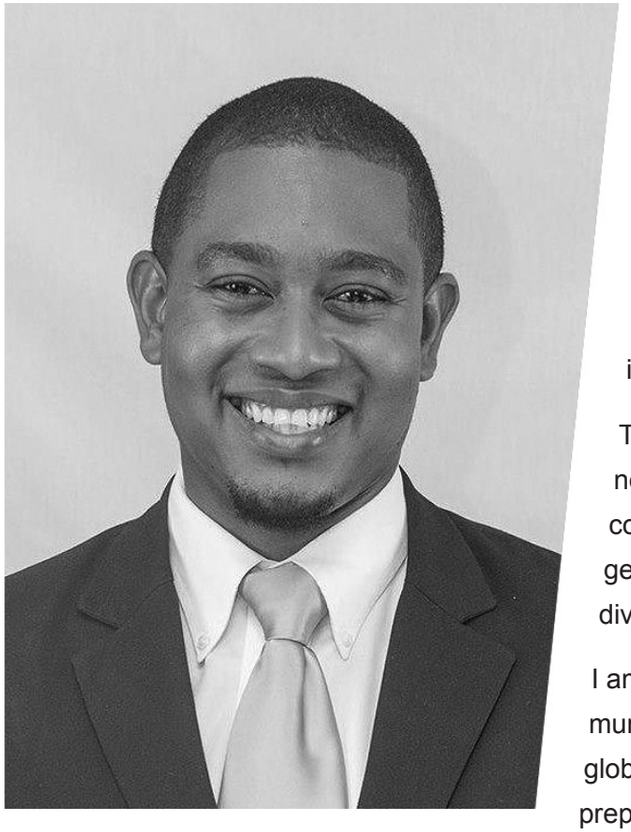
Our commitment to the development of each learner and our support and appreciation of the various stakeholder groups that are partnering with us in providing quality education, remain at the forefront of our efforts in ensuring that this journey transforms education. This commitment is conveyed through our adoption of a Pathway Approach to learning that demands of us to provide customized programmes, differentiated learning experiences and specialized support for our learners. Our actions have been fruitful as is evident by the systems and conditions we have put in place for successful implementation.

Like the rest of Jamaica, I look forward to the testimonials of students, parents, teachers and other stakeholders of the empowering effect of this learner- centred curriculum and remain confident that it will contribute to make Jamaica renown.

## The Honourable, Senator Ruel Reid,CD

**Minister of Education, Youth & Information**

# MESSAGE



Building a modern society where young people can prosper and achieve their aspirations is paramount on the Ministry of Education, Youth and Information's (MOEYI) agenda. In its bid to advance this agenda the team at the MOEYI has developed the National Standards Curriculum (NSC) on a clear set of values that will permeate learning and become embedded in young people's approach to life. Young people need to be clear about their Jamaican identity. Justice, democracy, tolerance and respect need to be more than mere words; they need to become an essential part of people's lives. Young people's understanding of, and commitment to, sustainable development is critical to the future of Jamaica and of the world. These values that permeate the new curriculum and more importantly, will by its use, be ingrained in the fabric of the Jamaican society.

The development of a new curriculum is a major achievement in the life of any country. It is even more noteworthy because this curriculum embodies the set of knowledge, skills, values and attitudes that our country deems relevant at this particular time. It is intended that these attributes be conveyed to the next generation as a means of cultural continuity in preparation to cope with the future, both nationally and individually.

I am particularly excited about the prospects of the NSC honing key twenty-first century skills such as communication, collaboration, critical thinking and creativity in our youth as they prepare to take on their roles as global citizens. I encourage parents, students, teachers and indeed the community to partner with us as we prepare our young people not just for today, but for the rapidly changing times ahead.

**The Honourable, Floyd Green, MP**

**State Minister in the Ministry of Education, Youth & Information**

# MESSAGE

In responding to the challenges confronting education in Jamaica, The Ministry of Education Youth and Information has taken strategic measures to address the need for a national curriculum that is relevant for the 21st century, the dynamics of the Jamaican context and the profile of the learners at the pre-primary, primary and secondary levels. One major output of these strategic actions is the National Standards Curriculum. This curriculum is intended to be one of the means by which the Jamaican child is able to gain access to the kind of education that is based on developmentally-appropriate practice and the supporting systems and conditions that are associated with high quality education.

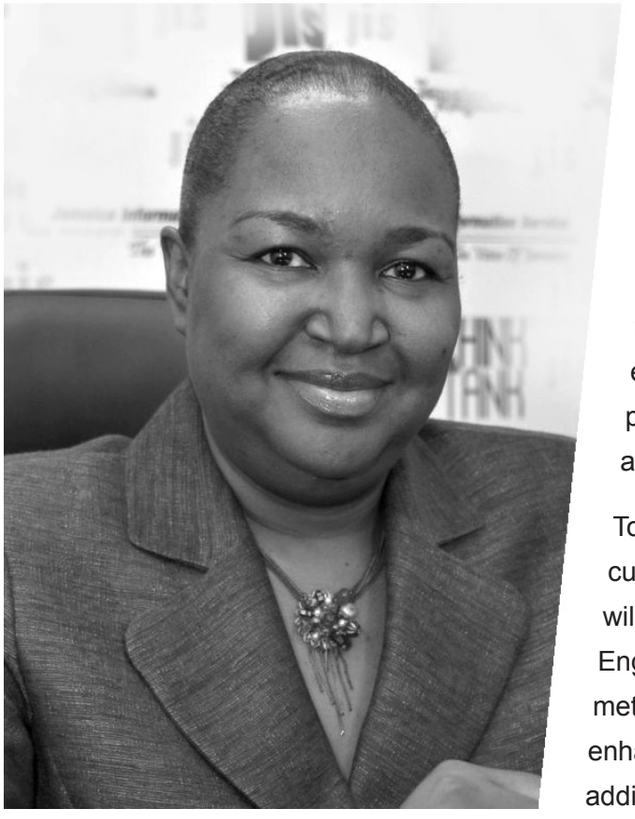
This curriculum has the potential to inspire and provide challenges in the form of problem situations that all our learners can handle in ways that are developmentally appropriate. It compels us to move beyond the traditional functional perspectives of being literate to a focus on the physical and physiological as well as the ethical, social and spiritual.

I invite all our stakeholders to fully embrace this new curriculum which promises to excite imaginations, raise aspirations and widen horizons. Learners will become critical and creative thinkers with the mindset required for them to be confident and productive Jamaicans who are able to thrive in global settings as they take their place in the world of uninhibited change.

## Mr. Dean Roy Bernard

**Permanent Secretary , Ministry of Education, Youth & Information**

# MESSAGE



It was the mandate of the Curriculum Units of the Ministry of Education, Youth and Information to spearhead the crafting of a new curriculum for the nation, in keeping with international standards, global trends in the educational landscape and societal goals and aspirations. The mandate had several facets: to establish clear standards for each grade, thereby establishing a smooth line of progression between Grades 1 and 9; to reduce the scope, complexity and amount of content; to build in generic competencies such as critical thinking across the subjects; to ensure that the curriculum is rooted in Jamaica's heritage and culture; to make the primary curriculum more relevant and more focused on skills development, and to ensure articulation between primary and secondary curricula, especially between Grades 6 and 7. To achieve this, the MoEYI embarked on an extensive process of panel evaluations of the existing curricula, consultation with stakeholders, (re)writing where necessary and external reviews of the end products.

Today, we are indeed proud that, the curriculum development teams have succeeded in crafting a curriculum which has met these expectations. Under the National Standards Curriculum (NSC) focus will be given to project-based and problem-solving learning, with an integration of Science, Technology, Engineering and Mathematics/Science, Technology, Engineering, Arts and Mathematics (STEM/STEAM) methodologies across the system. Learners will benefit from more hands-on experiences which should enhance the overall learning experience and cater to the different kinds of learners in our classroom. In addition, they will be exposed to work-based learning opportunities that will help them become productive citizens of Jamaica and the world at large.

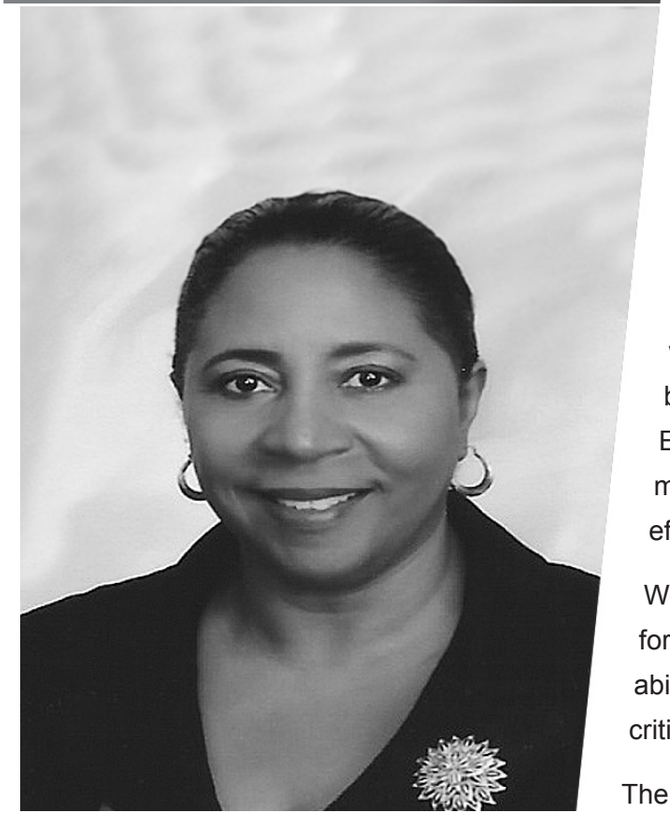
It is anticipated that as school administrators and teachers system-wide implement the National Standards Curriculum that improvements will be evident in the general academic performance, attitude and behaviour of our students.

We anticipate the participation of all our stakeholders in this process as we work together to improve the quality of life and prospects for all the children of Jamaica and to realize our mantra that *every child can, and must, learn.*

## Dr. Grace McLean

**Chief Education Officer, Ministry of Education, Youth & Information**

# MESSAGE



The Ministry of Education Youth and Information (MoEYI) is committed to providing high quality education to all Jamaican children. We have heard the cries from the various sectors of the Jamaican society about the level of preparedness/readiness of our students for life in the 21st century; and we are taking the necessary steps to ensure that our students graduate with marketable skills. The MoEYI has reviewed and redesigned the Grades 1-9 curricula around the principles of Vision 2030 Goal number one; “Jamaicans are empowered to achieve their fullest potential”.

The National Standards Curriculum (NSC) will lay the foundation for students by preparing them for working lives that may span a range of occupations, many of which do not currently exist. This has been done by way of designers carefully integrating the theoretical principles of Science, Technology, Engineering and Mathematics/Science, Technology, Engineering, Arts and Mathematics (STEM/STEAM) methodologies into the curricula at all grade levels. The NSC illustrates that in order to make education effective for our 21st century children; we need to change how we teach, and what we teach.

We are satisfied that the curriculum designers and writers have produced a curriculum that is indeed fitting for the 21st century. The NSC was designed to develop students’ understandings of subject matter and their ability to apply what is learnt; it fosters their ability to communicate and solve problems collaboratively, think critically and create novel solutions.

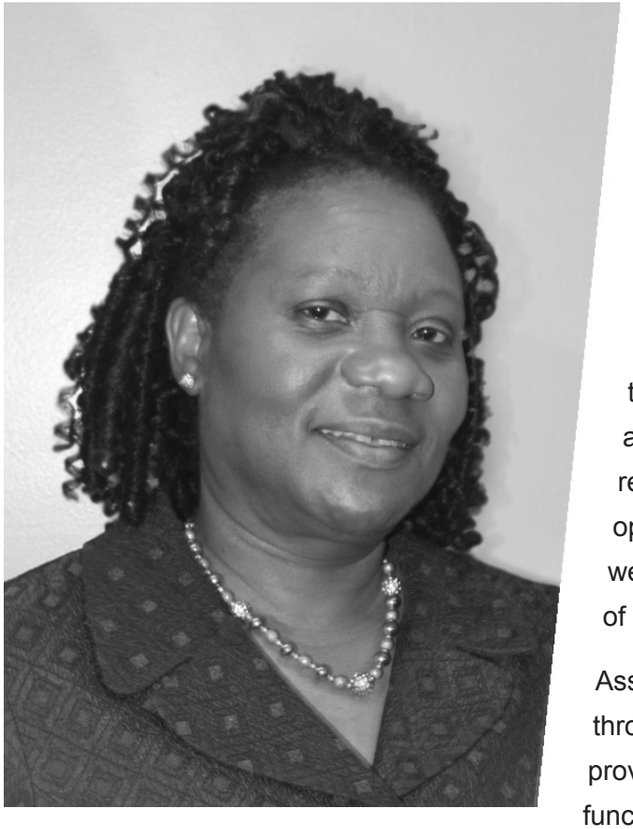
The success of our children is dependent on the participation of all stakeholders in the learning process. We encourage you all to be our committed partners in education as the true impact of this curriculum will only be felt when we have all hands on board. I am indeed proud to be associated with the development and implementation of this curriculum; it will inspire hope in our nation and future generations; kudos to the various teams that contributed to its development.

## Mrs Lena Buckle Scott

**Deputy Chief Education Officer,**

**Curriculum and Support Services, Ministry of Education, Youth & Information**

# MESSAGE



The National Standards Curriculum (NSC) rests on the belief that all learners are endowed with the capabilities, gifts and talents to fulfil their divine purpose. These attributes are to be further enhanced or improved in a nurturing, inspiring and inclusive environment; one that caters to the whole person (soul, spirit and body - spiritual, emotional, social, physical and mental). As learners assume their roles and responsibilities individually and as communities of learning in such an environment, they become critical-reflexive thinkers, creative problem solvers, effective communicators and natural collaborators.

A curriculum design of this nature, calls for transformative change at the societal level (Elkind, 2004)[1] and not just at the school and classroom levels. This is a call for all stakeholders, as users of the curriculum, to adopt a critical -reflective and reflexive stance and join learners in the quest for meaning, purpose and stability as they help to shape the world. By integrating principles from various disciplines and their related methodologies, learners who interact with the curriculum are provided with enriching experiences, opportunities for creative expressions and authentic exploration of problems from a classical standpoint as well as in the context of workplace learning. This is due to the fact that the NSC recognizes the importance of each discipline in the problem solving process and in development.

Assessment as an element of the curriculum becomes primarily a learning process for charting progress through self-corrective measures that are informed by feedback from peers and teacher-facilitator. By providing assessment criteria statements in the curriculum, teachers are encouraged to facilitate learners functioning as self and peer assessors. This approach should see the learner developing self-direction with the support of mentors and coaches and forming an intrinsic desire to succeed. These attributes prepare them to face high stakes assessment as problems to be confronted with courage, a sense of readiness, insight and creative prowess.

These features of the NSC have the potential to influence learners' profile as Jamaicans who are gratified by an identity of cultural excellence that embodies moral obligations, intellectual rigour, innovativeness, environmental stewardship and productivity. The curriculum echoes the sentiments of our National Anthem, National Song and Pledge and serves as rich and credible source of the values and virtues that are woven together to convey the Jamaican identity. I wish for our school administrators, teachers, students and other stakeholders much success as they work with the document.

## Dr Clover Hamilton Flowers

**Assistant Chief Education Officer, Core Curriculum Unit, Ministry of Education, Youth & Information**

[1] Elkind, D. (2004). The problem with constructivism. The Educational Forum, 68(4), 306–12.

| TERMS | DEFINITIONS/MEANINGS |
|---|---|
| Range of Content | Provides an overview of the concepts, knowledge, skills and attitudes that will be developed in a unit of study. |
| About the Unit | Gives a brief overview of the content, skills that are covered in the unit and the methodologies that are used. As well as the attitudes to be developed. |
| Standards | Statements that explain what all students are expected to know and be able to do in different content areas by the end of a course of study e.g. by the end of period spanning grades 4 – 9. |
| Attainment Targets | An attainment target is a desired or expected level of performance at the end of a course of work, within a given/specified teaching- learning period. Attainment targets identify the knowledge, skills and understanding which students of different abilities and maturities are expected to have by the end of each Grade. It is the standard that we expect the majority of children to achieve by the end of the grade. |
| Benchmarks | Behaviours students are expected to exhibit at different stages of development and age/ grade levels. |
| Theme/Strands | Unifying idea that recurs throughout a course of study and around which content, concepts and skills are developed. |
| Prior Learning | It is what students are expected to already know through learning and experience about a topic or a kind of text. |
| Specific Objectives | Specific objectives state what the student is expected to know or understand as a result of the learning experience. The specific objective is usually framed in the areas of the knowledge, skills and attitudes that the students are expected to achieve. Specific objectives tell us what the children will learn or will be taught. |

| TERMS | DEFINITIONS/MEANINGS |
|---|---|
| Suggested Teaching/Learning Activities | A teaching/learning activity is an organised doing of things towards achieving the stated objectives. They are suggested activities that are crafted in a way to be an efficient vehicle which can move the student between what is to be learnt (objective) and what the student is to become (outcome). |
| Key Skills | Gives a brief overview of the content, skills that are covered in the unit and the methodologies that are used. As well as the attitudes to be developed. |
| Assessment | An assessment is a determination of whether intended results have been achieved. This section of the curriculum speaks to both the product that will be judged as well as the criteria against which it will be judged. It must be noted that this section does not introduce new activities. Instead, it speaks to the judging of the suggested teaching and learning activities.<br><br>Formal assessment may be conducted with the aid of instruments (e.g. via writen test, portfolio) or by requiring students to complete assigned tasks (e.g. performance), and is usually recorded against a predetermined scale of grading. Informal assessment (e.g. via observation or spontaneous student expression) may also reveal important evidence of learning. |
| Points to Note | This section provides technical information that must be considered in delivering the unit. It may also include information that provides additional explanation of key concepts that may be unfamiliar to the teacher as well as suggestions for infusion within the unit. |
| Extended Learning | These are opportunities for students to utilise the knowledge and skills they would have acquired in the unit in authentic situations/experiences. |
| Learning Outcomes | A learning outcome is a demonstration/ behavioural evidence that an intended result has been achieved at the end of a course of study. The learning outcome tells us if pupils have understood and grasped what they have been learning. |
| Links to other Subjects | Suggests opportunities for integration and transfer of learning across and within different subject areas. |
| Key Vocabulary | This section consists of a number of words/phrases that addresses the skills, topics and content that must be covered in the unit. |

The study of Science should enable students to become:

- Willing to embrace the rapidly changing worlds of knowledge and technology and be capable of managing information with understanding and confidence to meet the personal, social and vocational needs and challenges.
- Adept in participating in decision making processes and be competent in their role of contributing to social and economic development, while being mindful of sensitive moral and ethical concerns that impact ecologically-sustainable environment.
- Proud citizen of Jamaica by embracing values that impact increased productivity and economic prosperity, and promote equity and social justice for all.

## PHILOSOPHICAL STATEMENT

Science is a way of knowing about the structure and behaviour of the physical and natural world through observation and investigation.

Today's global societies have become significantly more scientific and technological, requiring an understanding of science in making many personal decisions and addressing various socio-economic, environmental and health issues. A course of study in science therefore offers students the ability to develop crucial skills and knowledge that equip them to understand the world around them, make informed decisions, and build positive life-long learning habits, behaviours and attitudes.

The Grades 1-9 Science Curriculum is predicated upon the constructivist approach to learning in that it creates, through a variety of learner-centred instructional methodologies, 'hands-on,' 'minds-on,' and 'real world' experiential opportunities for exploring, catering to multiple intelligences and, in the early years (Grades 1-3), makes the most of the pedagogy of play. The curriculum has been redesigned to have a greater emphasis on the integration and application of scientific concepts, principles and innovation. Fundamental to this new curriculum is the acquisition of the science process skills that will enable students to engage in scientific enquiry which forms a foundation for scientific programmes at advanced levels. The curriculum has also taken into consideration the national strategic objectives in education as well as the twenty first century desired outcomes which include the ability to communicate ideas, to collaborate on issues thereby building interpersonal skills, to create meaningful solutions to problems with real world applications and to exercise critical thinking skills which has implications for personal growth and development. As a result, students will become flexible and adaptable, information and technology literate, aware of health and wellness issues and globally competent.

The assessment of the science curriculum is also predicated on constructivism, and incorporates real life and performance based experiences that are student-centred and formative in nature. Learner-centred assessment relies heavily on formative assessment and requires the use of varied, multiple non-traditional assessment strategies and tools to measure students' achievement and progress throughout the school year. These assessment strategies actively engage students and promote the involvement of students through performance tasks and student self and peer assessments.

Based on the National Standards Curriculum (NSC) Framework, the curriculum emphasizes the need for balance between the acquisition of scientific knowledge, as against the learning process and attitudes. In addition, where applicable, the technological applications, social implications and the value aspects of science are also considered. The curriculum exposes students to

methodical approaches to investigation and problem solving, as the basis for evidence-based conclusions. Students will encounter the need for fair test and veracity in data derived through experimentation. They will build personal integrity and develop personal qualities such as perseverance, ingenuity, respect for the opinions of others and tolerance for diversity of opinions even when they contradict their personal beliefs. Acquisition of these qualities, along with the understanding of scientific principles and applications, when transferred to life beyond school, will not only produce astute scientists but will also impact the social, economic and political lives of graduates. Science in the curriculum also adequately equips students to choose relevant careers by making them knowledgeable about the diverse branches of science and technology and a growing number of other science-related professions; many of which have not yet been created.

In the NSC, science is linked with other subject areas such as Social Studies, Geography, Mathematics, Resource and Technology and the Arts within the context of integration through STEM. This interdisciplinary approach helps students recognize the relevance of each subject and that everything in our world is interconnected.

**Range of Activities**

Students should be inducted into the processes of science, engage in practical inquiry and plan and conduct investigations both in groups and individually. They should develop an appreciation for the range of flora and fauna in their locality and beyond and understand how they maintain the delicate balance in the environment. Students should learn the scientific basis of the structures and functions of their bodies. They should explore the range of materials and understand their physical and chemical properties. They should also explore the different forms of energy and forces and how these impact on everyday life.

## Themes, Standards and Attainment Targets

| THEMES | STANDARDS | ATTAINMENT TARGETS | | |
|---|---|---|---|---|
| | | GRADES 1-3 | GRADES 4-6 | GRADES 7-9 |
| **Science Exploration, Application and Design Practice** | Develop problem solving, decision making, and inquiry skills, reflected by formulating questions and hypotheses, planning experiments/investigations, conducting systematic observations, interpreting and analysing data, drawing conclusions, and communicating results.<br>Develop an understanding of technology as an application of scientific principles | Begin to explore the environment in order to relate everyday experiences to simple scientific concepts and processes.<br>Begin to understand and apply aspects of the scientific method. | Gain an understanding of and apply the engineering design process.<br>Gain an understanding of and apply aspects of the scientific method. | Apply scientific knowledge and processes to the solution of real world problems.<br>Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts. |
| **Living Things, Life Processes and the Environment** | Develop an understanding of the structure, characteristics and basic needs of organisms, the diversity of life, and how lifestyles determine health and well-being.<br>Develop an understanding of the environment as a system of interdependent components affected by human activity and natural phenomena. | Begin to explore selected life processes in humans, the interdependence between living things in the environment, and how lifestyles affect health and well-being in humans.<br>Begin to appreciate the impact of selected human activity and natural phenomena on the environment | Gain an understanding of some life processes in plants and animals, and how lifestyle choices impact health and well-being in humans.<br>Recognise the variety of living things, their interdependence and their inter-relationship with the environment. | Understand the importance of the life processes in plants and animals, their interdependence, their interaction with the environment, and how lifestyles determine health and well-being.<br>Gain an understanding of the components and structure of the universe, and how advances in science and technology have enabled space exploration. |

| THEMES | STANDARDS | ATTAINMENT TARGETS | | |
|---|---|---|---|---|
| | | GRADES 1-3 | GRADES 4-6 | GRADES 7-9 |
| **Energy, Forces and Matter** | Develop an understanding of the structure and behavior of matter.<br>Develop an understanding of natural laws as they apply to motion, forces, and energy transformations. | Begin to explore the properties of various materials, substances, selected forces and forms of energy through the use of the senses. | Recognise the importance of energy to life processes, everyday life, and the relationship between energy and matter. | Understand natural laws as they apply to motion, forces, and energy transformations.<br>Understand the importance of energy in our everyday life, the range of available energy sources and some environmental impacts of utilising these resources.<br>Understand the existence of materials such as solids, liquids and gases, the particulate nature of matter, and simple chemical reactions that change one material into another. |
| **Scientific Attitudes and Ethics** | Develop a spirit of scientific enquiry, open-mindedness and perseverance, and scientific literacy.<br>Develop creativity, integrity, responsibility, and value science and technology as important tools for exploring the environment. | Begin to demonstrate stewardship for living things and the environment.<br>Begin to demonstrate a positive attitude towards the use of scientific language.<br>Begin to demonstrate positive interpersonal skills in order to foster good working relationships. | Begin to appreciate the influence and limitations of science.<br>Demonstrate a positive attitude towards the use of scientific language.<br>Demonstrate positive interpersonal skills in order to foster good working relationships. | Appreciate the influence and limitations of science with consideration for ethical issues.<br>Demonstrate a positive attitude towards the use of scientific language.<br>Demonstrate positive interpersonal skills in order to foster good working relationships. |

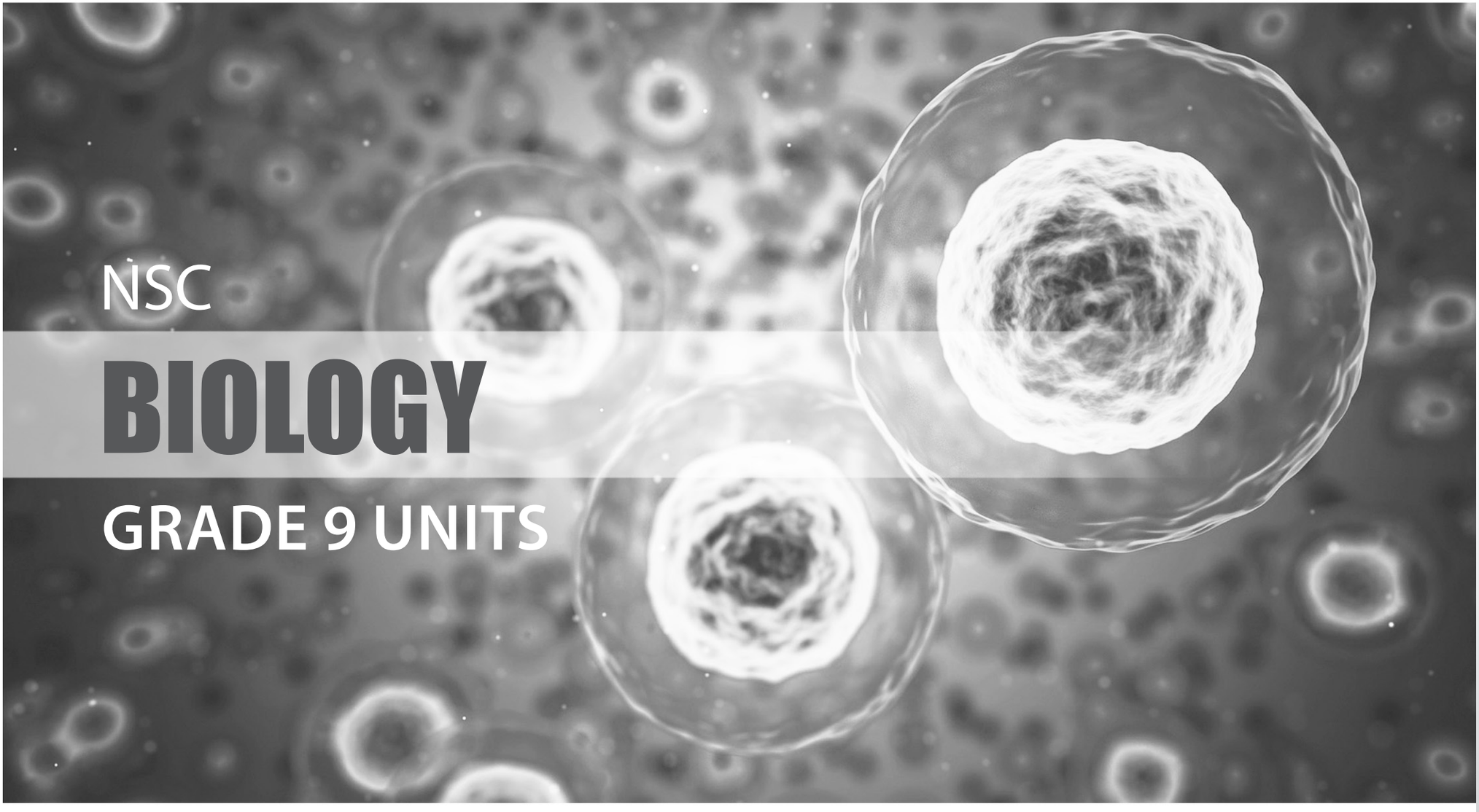
| THEMES | BENCHMARKS | | | | | |
|---|---|---|---|---|---|---|
| | GRADE 1 | GRADE 2 | GRADE 3 | GRADE 4 | GRADE 5 | GRADE 6 |
| **Science Exploration, Application and Design Practice** | Ask questions and contribute to discussions about how to seek answers.<br>Use the senses to observe objects/ events in order to describe/explain them.<br>Begin to share ideas in writing/orally using scientific language and illustrations such as simple sketches, drawings or models. | Use simple apparatus/ equipment to make observations and record information in a variety of ways and begin to compare one thing with another.<br>Share ideas in writing/orally using scientific language and illustrations such as simple sketches, drawings or models. | Measure quantities to make comparisons, identify simple relationships, draw conclusions from results, use scientific language and begin to use scientific knowledge to suggest explanations.<br>Communicate ideas in writing/orally using scientific language and illustrations such as simple sketches, drawings or models. | Devise and carry out fair tests in familiar contexts.<br>Predict the outcomes of events based on their knowledge.<br>Describe a simple design that addresses a specific challenge and indicate what defines success and what limitations exist. | Make predictions of what will happen based on scientific knowledge and understanding. Suggest and communicate how to test these predictions. Interpret data and decide whether results support predictions, and are sufficient to draw conclusions.<br>Generate and compare possible solutions to a problem based on how well each is likely to meet the criteria and limitations of the problem. | Use prior experiences and scientific knowledge to formulate and test hypotheses, and interpret results.<br>Make a series of measurements of quantities and make inferences from observations in order to draw conclusions.<br>Plan and carry out fair tests to identify aspects of a model or prototype that can be improved. |
| **Living Things, Life Processes and the Environment** | Recognise some important features of the environment.<br>Understand the functions of some external parts of the human body.<br>Appreciate that living things depend on each other. | Recognise the importance of the environment to living organisms.<br>Know the location and simple related functions of some internal parts of the human body (heart, brain and skeleton).<br>Understand the need for taking care of the body.<br>Recognise similarities differences between living and non-living things. | Know that some activities can harm the environment.<br>Understand the basic functions of the teeth, stomach and lungs.<br>Recognise that most foods originate from plants and animals and that some foods can be harmful to the body.<br>Recognise that living things have life cycles. | Know the characteristics of living things and recognise that all living things have similar basic requirements (air, water, nutrients).<br>Know the basic functions of the sense organs in humans and other animals.<br>Know some key structures of flowering plants and their basic functions. | Be familiar with weather instruments. Use and share observations of local weather conditions to describe patterns overtime.<br>Begin to understand the interdependence of living things in the environment.<br>Know that foods are produced in different ways (organic, non-organic and genetically modified). | Be aware of some environmental problems (climate change, solid waste disposal, soil degradation) and how to mitigate against them.<br>Know the structure and functions of the main parts of flowering plants.<br>Know the structure and functions of selected animal systems. |

| THEMES | BENCHMARKS | | | | | |
|---|---|---|---|---|---|---|
| | GRADE 1 | GRADE 2 | GRADE 3 | GRADE 4 | GRADE 5 | GRADE 6 |
| **Living Things, Life Processes and the Environment** | | | | Know some characteristics of water and understand its importance to life.<br>Know the effects of water pollution, and ways of reducing it.<br>Know some characteristics of air and its importance to life.<br>Know the effects of air pollution, and ways of reducing it. | Be aware of food nutrients and their importance to humans. | Realise that an unbalanced diet may result in disease *(obesity, malnutrition, diabetes) and be aware of the dangers of drug misuse.* |
| **Energy, Forces and Matter** | Explore different kinds of materials using observable characteristics.<br>Use the senses to explore the different forms of energy (heat, light and sound) in their immediate environment. | Explore the inherent physical properties of everyday materials (such as hardness, flexibility, durability).<br>Recognise that a push or pull is needed for movement and determines how fast an object will move and its direction. | Categorise materials in a variety of ways, and explain why some materials are suited to specific purposes.<br>Know that heating and cooling materials can cause them to change.<br>Explore non-contact forces using magnets | Know that materials can exist as solid, liquid or gas, and explore selected properties and the composition of everyday materials. | Understand the effects of forces and the concept of work.<br>Be aware of energy forms, their sources, and how heat is transferred.<br>Understand how machines make work and life easier. | Explore what happens when some materials are mixed and how they may be separated.<br>Explore the properties of light and sound, and how different materials affect their behaviour.<br>Know how to safely use, store and dispose of everyday materials, and how their properties determine their uses.<br>Recognise that some changes are irreversible and others are reversible. |

| THEMES | BENCHMARKS | | | | | |
|---|---|---|---|---|---|---|
| | GRADE 1 | GRADE 2 | GRADE 3 | GRADE 4 | GRADE 5 | GRADE 6 |
| **Energy, Forces and Matter** | | | | | | Understand the processes involved when a solid changes to liquid (and vice-versa) and a liquid changes to gas (and vice-versa). |
| **Scientific Attitudes and Ethics** | Show concern by being responsible towards the environment.<br>Demonstrate care and concern for living things and the environment.<br>Demonstrate concern for safety of self and others.<br>Display curiosity, objectivity and perseverance in their approach to activities. | Show concern by being responsible towards their bodies.<br>Value the need for personal hygiene as a means of maintaining good health.<br>Appreciate the importance of the environment to living organisms.<br>Display curiosity, objectivity and perseverance in their approach to activities. | Demonstrate care and concern for living things and the environment.<br>Display curiosity, objectivity and perseverance in their approach to activities. | Show concern for water as a limited natural resource and the need for water conservation.<br>Display curiosity, objectivity and perseverance in their approach to activities. | Show concern for man's impact on the environment.<br>Show concern for the need to conserve energy usage in our everyday life.<br>Display curiosity, objectivity and perseverance in their approach to activities. | Show responsibility in food choices.<br>Show sensitivity to others who make unhealthy eating choices.<br>Show concern by being respectful and responsible towards the environment and the organisms living in it.<br>Display curiosity, objectivity and perseverance in their approach to activities. |

| THEMES | BENCHMARKS | | |
|---|---|---|---|
| | GRADE 7 | GRADE 8 | GRADE 9 |
| **Science Exploration, Application and Design Practice** | Apply scientific skills, processes and methods in everyday situations and be aware of safety precautions involved in scientific work.<br>Use scientific principles in the design of solutions to a problem taking into account potential impacts on man and the natural environment. | Analyse and interpret experimental data to determine similarities and differences in findings.<br>Analyse several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success | Apply the principles of measurement in the solution of everyday problems.<br>Use scientific knowledge to select appropriate experimental methods.<br>Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge. |
| **Living Things, Life Processes and the Environment** | Understand the impact of climate change on living things and on the environment.<br>Know that the cell is the basic unit of structure and function of all living organisms and be aware of the differences between plant and animal cells.<br>Understand the hierarchical relationship from cells to organism.<br>Understand the process of sexual maturity, and reproduction, in plants and animals.<br>Understand the importance of maintaining a healthy lifestyle. | Know the properties, sources and uses of water.<br>Know the percentage composition of air and understand how carbon is cycled in the atmosphere.<br>Understand the intake, digestion and absorption of food in animals, and how energy is released through respiration.<br>Understand how plants make their food, and how this forms the basis of energy chains and webs.<br>Understand the importance of nutrients, their functions and food tests.<br>Be aware of the impact that diet, cleanliness, exercise and rest have in maintaining good health.<br>Understand the physical characteristics of the universe and how technology has enabled its exploration. | Understand the role of the key organs and systems in humans and animals in sensing and responding to the environment.<br>Demonstrate an understanding of transport systems in plants and animals.<br>Understand embryo development and birth, appreciate the importance of maintaining a healthy lifestyle during pregnancy, and be aware of birth control methods. |

| THEMES | BENCHMARKS | | |
|---|---|---|---|
| | GRADE 7 | GRADE 8 | GRADE 9 |
| **Energy, Forces and Matter** | Explore the various properties of matter and know that atoms are the basic unit of structure, and that atoms form molecules, elements and compounds.<br>Know that mixtures represent a physical change and are either heterogeneous or homogenous.<br>Be familiar with the nature of energy transformations, the various types of energy sources and the importance of energy.<br>Understand the importance of energy to society, and know how alternative energy sources are harnessed. | Understand physical and chemical changes and know that chemical changes take place through the re-arrangement of atoms.<br>Know that chemical symbols are used to represent one atom of an element which is represented on the periodic table, and how selected elements are grouped in the periodic table.<br>Know the structure of an atom.<br>Know how substances can be classified by their chemical nature and how this relates to the way they react.<br>Explore the relationships between forces and motion, and illustrate these relationships in the environment and living things. | Be aware of the types of currents and understand the effects of resistance and voltage on current flow.<br>Recognise the connection between electricity and magnetism.<br>Be familiar with the nature of electricity and understand the different types of electrical circuits.<br>Understand and apply the law of conservation of mass.<br>Understand how substances can be classified by their chemical nature and how this relates to the way they react. |
| **Scientific Attitudes and Ethics** | Appreciate the importance of scientific methods.<br>Demonstrate objectivity by seeking data and information to validate observations and explanations.<br>Demonstrate care and concern for living things and the environment.<br>Demonstrate concern for safety of self and others.<br>Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.<br>Demonstrate concern for the preservation of natural resources.<br>Demonstrate concern for man's impact on the environment.<br>Demonstrate sensitivity to others who are different. | | |



NSC

# BIOLOGY

## GRADE 9 UNITS

## TERM 1

**Unit 1**

**Working Like a Scientist 3**

Developing hypotheses
Planning and designing fair tests
Fundamental quantities and units
Derived units
Plotting graphs
Calculating gradients from graphs
Interpreting distance & velocity-time graphs
Determining significant figures
Writing numbers in standard form

**Unit 2**

**Transport in Humans and Plants**

Investigating Osmosis
Comparing Osmosis and Diffusion
Importance of transport system in multi-cellular organisms
Substances transported in animals
Annotate a diagram of the heart
Relate structure of the heart to its function
Tracing blood flow from heart to rest of the body
Relate structure of arteries, veins and capillaries to their functions
Main components of blood and their functions
Investigating rate of diffusion based on surface area
Substances transported in plants
Adaptations of roots for transport
Locating transport tissues in dicotyledons
Functions of xylem and phloem
Investigating movement of substances from soil to leaves

## TERM 2

**Unit 1**

**Sensitivity and Coordination**

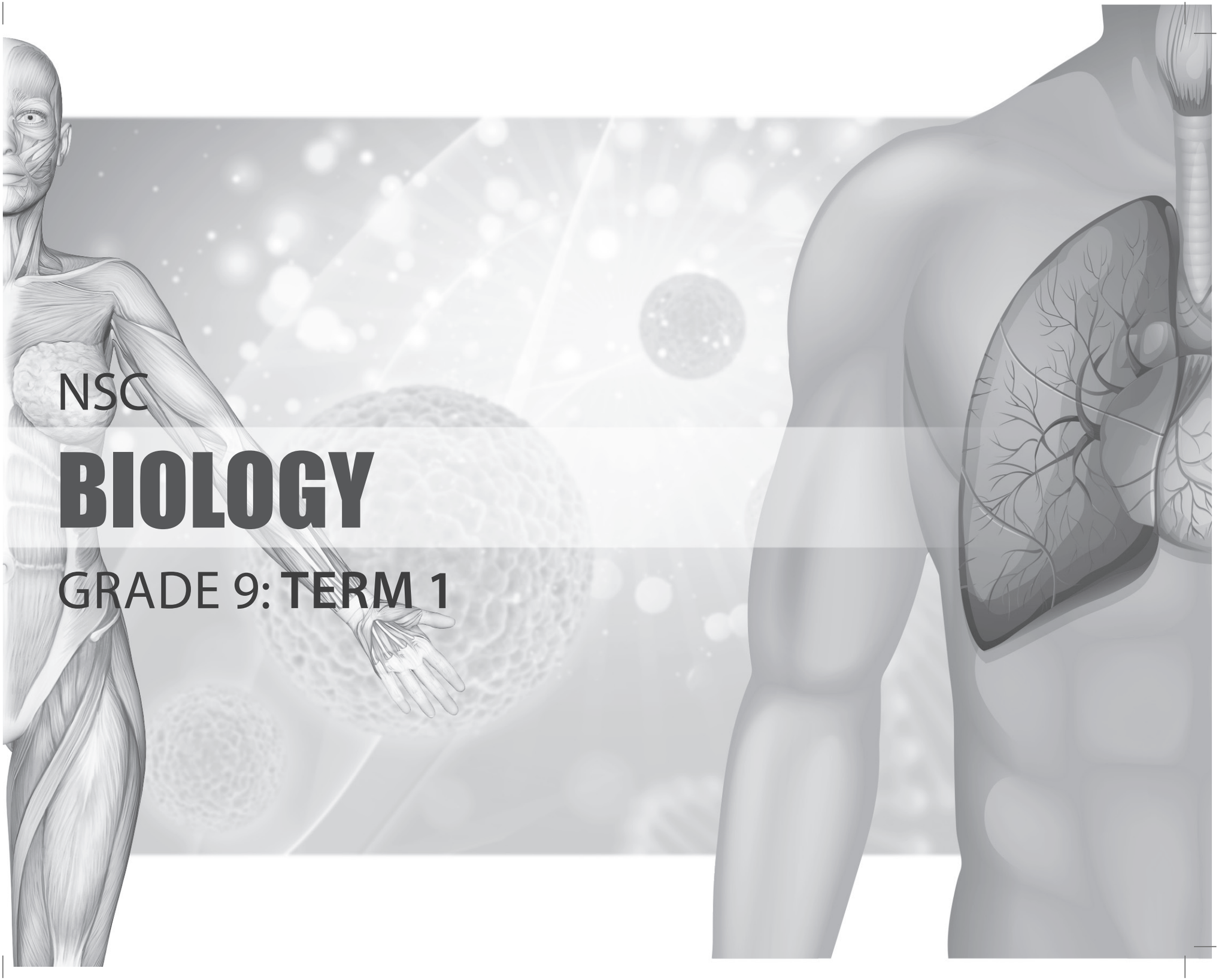
Importance of responding to changes
Linking sensory cells to sense organs and stimuli
Components of the central nervous system
Main parts of the brain and their functions
Distinguishing voluntary and involuntary actions
Importance of reflex actions
Importance of the endocrine system
Identifying selected endocrine glands and associated hormones
Comparing the nervous and endocrine system

## TERM 3

**Unit 1**

**Sexual Reproduction and Birth Control**

Identifying key structures in a pregnant uterus and their functions
Determining how embryo gets food, oxygen and eliminates waste
Effects of negative maternal behaviours on embryo development
Importance of prenatal care
Methods of birth control
Importance of family planning
Problems associated with teenage pregnancy



NSC

# BIOLOGY

## GRADE 9: TERM 1

**(This unit should be done first. It appears in Biology, Chemistry and Physics, and should be done only in one of these subjects.)**

### About the Unit

In this unit, students will learn about the processes involved in planning and designing fair tests in order to solve problems. Emphasis is on the development of measurement skills through hands-on enquiry. The students will learn about the importance of physical quantities and units in measurement. They will learn the correct and appropriate use of various measuring instruments while determining physical quantities associated with objects and events. They will learn how to record measurements and the results of calculations in standard form and to give the appropriate number of significant figures. They will acquire the skills involved in the construction and interpretation of graphs.

### Range of Content

- In developing hypotheses, previous knowledge or experience is used to put forward an idea of how or why something happens. Investigations of these hypotheses are then carried out using fair tests.
- The International System of Units (SI) or metric system is based on physical quantities that can be measured and expressed using specific units. These units are multiplied or divided by a set of prefixes representing a power of ten. Derived units such as area, volume and density are formed from the fundamental units.
- Line graphs describe the relationship between two quantities, with the independent variable on the horizontal (x) axis and the dependent variable on the vertical (y) axis. Best fit lines are drawn from scatter graphs and have approximately equal number of points on either side.
- In plotting distance-time and velocity-time graphs, the gradient (slope) of the line can be used to calculate velocity and acceleration which are affected by the steepness of the gradient.
- Significant figures represent the digits that carry meaning and contribute to the precision of a number. This can be determined by expressing the number in standard form (as a power of ten).

### Guidance for the Teacher

In physical measurement, the number of significant figures is crucial in indicating precision. Students normally have difficulty with the concept of significant figures particularly when expressing the results of calculations. The following are some rules that should be emphasized in the determination of significant figures:

1. All non-zero digits are significant (e.g. 2856 g has four significant figures)
2. Zeros that fall between significant digits are significant (e.g. 408 K has three significant figures)
3. Trailing zeros are significant (e.g. 3.100 cm has four significant figures)

Rules for determining significant figures in calculations:

1. **Addition or subtraction** – the result of the calculation should have the same precision of the least precise measurement (e.g. *45.24 g + 18.1 g = 63.3 g and not 63.34* g)
2. **Multiplication or division** – the result of the calculation should have the same number of significant figures as the measurement with the least number of significant figures (e.g. *40.96 kg ÷ 8.0 $m^3$ = 5.1 kgm-3 and not 5.12 kgm-3*)

## UNIT 1: Working Like a Scientist 3

**Theme:** Science Exploration, Application and Design Practice
**Topic:** Experimenting
**Duration:** 5 hours/2 weeks

### Prior Learning

Check that students can:

- Identify the steps in the scientific method
- Present data in a variety of scientifically acceptable ways
- Recall types of variables

**ATTAINMENT TARGET(S):**

- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**BENCHMARKS:**

- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**OBJECTIVES**

**Students will:**

- Identify and state problems
- Formulate hypotheses
- Plan and design experiments (fair tests) to solve specific problems

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>Create a flow diagram outlining the steps involved in the scientific method and then share and discuss their diagrams with the class. As a class discuss each step of the scientific method. | Communicate, collaborate | Flow diagram contains the steps of the scientific method in correct sequence |
| As a class, examine samples of scenarios, problem statements generated from them, and experiments which were carried out to solve the specific problems. Discuss the importance of controlling variables in the design and execution of fair tests. | Communicate, collaborate, think critically - analyse | Variables required for fair tests identified |
| In groups, generate a problem statement from a scenario provided by the teacher. Develop a hypothesis then plan and design an experiment to test the hypothesis.<br><br>Carry out the experiment then present a report to class in an exhibition format. | Collaborate, formulate, think critically –hypoth-esize, plan and design<br><br>Communicate, record, think critically – investigate | Problem statement acceptable,<br>Expected results linked to hypothesis<br>Experimental plan is plausible and follows expected steps<br>Suitable methods indicated for presenting data<br>Display meets agreed criteria |
| In groups, identify and specify a problem in their school/community. Discuss and formulate a hypothesis, then plan and design an investigation to test their hypothesis. Collect and record their observations/data and write a report on the investigation. Share and discuss findings and ideas with the class. | Writing problem statements, observe, record, communicate, think critically – analyse, interpret, formulate hypotheses, draw conclusions, plan and design, | Report reflects the scientific method,<br>Problem statement acceptable<br>Hypothesis acceptable<br>Investigation reflects fair-testing<br>Data/observations appropriately recorded,<br>Explanations/conclusions supported by data |

## Learning Outcomes

Students who demonstrate understanding can:

- Specify a problem
- Formulate hypotheses
- Design experiments (fair tests)
- Analyse data
- Draw conclusions that are supported by data

| Points to Note | Extended Learning |
| --- | --- |
| Use opportunities to reinforce the skills garnered in this unit throughout the course. | Identify an invention and research the processes that were involved in its development. |

**RESOURCES**

Samples of scenarios and experiment reports, scenarios for the planning and designing activities, materials for creating science exhibition display boards

**KEY VOCABULARY**

Hypothesis, problem statement, fair test, controlling variables

**LINKS TO OTHER SUBJECTS**

**Biology**

**Chemistry**

## UNIT 1: Working like a scientist 3

**Theme:** Science Exploration, Application and Design Practice
**Topic:** Quantities, Units and Graphs
**Duration:** 7.5 hours/3 weeks

### Prior Learning

Check that students can:

- Recall the five fundamental quantities and their base units

**ATTAINMENT TARGET(S):**

- Apply scientific knowledge and processes to the solution of real-world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**BENCHMARKS:**

- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**OBJECTIVES**
**Students will:**

- Formulate a definition for the term 'physical quantity'
- Recall five fundamental quantities and their base units
- Recognise a unit as a standard measure of a quantity
- Recognise that all other quantities and units are derived from fundamental quantities and base units
- Use prefixes: micro, milli, centi, deci, kilo, and mega appropriately and be able to carry out relevant calculations
- Recognise that quantities have effects on each other and that a graph is a pictorial representation of their relationship
- Plot graphs according to accepted standards
- Calculate gradients of graphs and determine their units
- Create and interpret distance-time and velocity-time graphs for uniform motion

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>In groups, be given a glass of water and various measuring instruments (e.g. balance, ruler, thermometer, measuring cylinder, micrometer, vernier caliper, stopwatch). Use the instruments to measure and record the values of as many things as is possible regarding water. List some things about the water that could not be measured (e.g. colour, smell, shape). State, giving reasons, which of the set of things (measured/not measureable) are physical quantities. Suggest a simple working definition of the term "physical quantity". Share and discuss their definitions with class. (A physical quantity is a measurable characteristic of anything.) | Collaborate, communicate, record, report, manipulate, measure, think critically – analyse, justify, draw conclusions | Measuring instruments used correctly<br>Acceptable justifications made<br>Acceptable definition of physical quantity |
| Recall five fundamental quantities of measurement and their base units. In groups, use a ruler to measure the length and width of a sheet of paper and calculate its surface area. Use a stopwatch to measure the time it takes for a small piece of tissue to fall from a height of 2 m to the ground and calculate speed (distance ÷ time). Identify the fundamental quantities in the calculation of the area and the speed. Share information with class. (Teacher should use the ensuing discussions to introduce the term derived quantity.) Answer the following question:<br>1. How are derived quantities formed?<br>2. How are the units of derived quantities found? | Collaborate, measure, manipulate, calculate, formulate, think critically – analyse | Fundamental units correctly identified<br>Correct calculations made |
| In groups, have each group member measure and record the length across a desk top using their hand-span. Compare the measurements obtained. Use rulers (each group member) to measure the length across the desk and compare results. Discuss the differences in measurement obtained from using hand-span and the ruler and suggest advantages of using the ruler. Discuss the need for standardization in measurement and present a scenario to illustrate the need. Share information with class. | Collaborate, communicate, measure, observe, manipulate, think critically - compare and contrast, create | Scenario illustrates the need for standard measurement |
| Determine the number of millimetre graduations on a metre rule and answer the following questions:<br>1. What fraction of a metre is a millimetre?<br>2. What does the prefix milli mean? | Observe, measure, formulate | Meanings of prefixes correctly determined<br>Quantities correctly converted |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| Repeat the exercise to determine the meaning of centi and deci<br>Complete the following for each of the prefixes:<br>Micro = $^{1}/_{000}$ milli; micro =<br>Kilo = 100,000 centi; kilo =<br>Mega = 10,000,000 deci; mega =<br>Measure the mass of a stone in grams then convert the mass to (a) milligrams (b) kilograms. Read the frequency of a radio station on a radio dial then convert the frequency to (a) Hertz (b) kilo-Hertz. | | |
| In groups, discuss and provide an answer for the questions, "What is a graph?" and "How are graphs useful?" Share information with class. (*Teacher should emphasize that quantities have effects on each other and that a graph is a pictorial representation of their relationship.*)<br>Observe as teacher demonstrates the important steps involved in plotting a graph:<br>1. Formulating a title for the graph<br>2. Labelling axes of the graph with quantities and units<br>3. Creating scales to ensure that more than half of the grid is used in either direction<br>4. Plotting points accurately<br>5. Representing points using a small "x" (×) or a circled dot (⊙)<br>6. Drawing a thin line of best fit<br>Use the guidelines to plot graphs from data provided by the teacher. | Construct graph, communicate, collaborate<br><br>Construct graph | Graphs plotted according to the standards taught |
| As a class, brainstorm to determine the meaning of the term 'slope'. Discuss how slope relates to graphs and the usefulness of slopes in analysing data. (*Teacher should introduce the term gradient as a synonym for slope.*) | Communicate, define operationally, calculate gradient | Gradient determined using the standards outlined |

## Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria

Observe as teacher demonstrates the important steps involved in calculating gradient/slope:

1. Selecting two points on the best fit line that would create a large triangle (do not use points in the table)
2. Reading off coordinates of selected points
3. Substituting coordinates of points in equation for gradient
4. Calculating the gradient with units

Use the guidelines for calculating gradient to determine the gradient of graphs plotted earlier.

## Learning Outcomes

Students will be able to:

- ✔ Determine derived units
- ✔ Convert from one unit to another
- ✔ Plot graphs
- ✔ Determine gradient
- ✔ Construct and use distance-time and velocity-time to determine speed, velocity and acceleration

## Points to Note

The unit of frequency on the radio dial is MHz.

For graphs, require that each student has a 30 cm transparent ruler.

## Extended Learning

Find out what are the fundamental quantities used to form the derived quantities density, acceleration and force. Determine the units for density, acceleration and force

**RESOURCES**

Metre rule, stopwatch, balance, radio, graph paper,

30 cm transparent rulers, computer, multimedia projector

**KEY VOCABULARY**

Quantity, derived quantity, fundamental quantities, units, micro, milli, centi,

deci, kilo, mega, standardisation

**LINKS TO OTHER SUBJECTS**

**Mathematics** – measurement, numbers, relations, functions and graphs

## UNIT 1: Working Like a Scientist 3

**Theme:** Science Exploration, Application and Design Practice
**Topic:** Significant Figures and Standard Form
**Duration:** 5 hours/2 weeks

### Prior Learning

Check that students:

- Understand decimals and place value

**ATTAINMENT TARGET(S):**

- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**BENCHMARKS:**

- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate concern for the preservation of natural resources.
- Demonstrate concern for man's impact on the environment.
- Demonstrate sensitivity to others who are different.

**OBJECTIVES**
**Students will:**

- Determine the number of significant figures in the expressed value of a quantity
- Determine the number of significant figures in a calculated value
- Express measurements and calculated values to the correct number of significant figures
- Express measurements and calculated values in standard form ($a \times 10^n$)

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>In groups, be given a small object (e.g. a rectangular block, cylinder, sphere) for which they will measure and record the same dimension using a ruler, a vernier caliper and a micrometer screw gauge. Compare the measurements obtained, identify which measurement gives more information, and justify their selection. Share information with class. As a class, discuss the term 'precision' as it relates to measurement.<br>Complete worksheet, provided by the teacher, on identifying the most precise value.<br>Example of worksheet questions:<br>*Identify the most precise value in each case:*<br>*a. 0.2 g, 1.6 g, 8.24 g, 20 g*<br>*b. 405 m, 879 m, 879.0 m, 870 m* | Collaborate, measure, record, manipulate, communicate, think critically – compare, | Measurements correctly taken<br>Measurement that gives most information identified<br>Correct answer provided on precision worksheet |
| As a class, discuss the meaning of the term 'significant figures'. (T*eacher should emphasize that the significant figures of a number are those digits that carry meaning contributing to its precision*.) Discuss the rules for *identifying significant figures in a given number*, as provided by the teacher, and observe the examples done by the teacher. Complete teacher provided worksheet on significant figures.<br>As a class, discuss the rules for determining significant figures in numbers obtained from calculations, as provided by the teacher, and observe the examples done by the teacher. Complete teacher provided worksheet on significant figures, or the significant figures worksheet on the e-Learning website (*http://www.cremja.net/moodle*). | Communicate, calculate, think critically – analyse, summarize | Correct answer provided on significant figures worksheet |
| In groups, find out the distance of the sun from the earth, in metres. Given the speed of light (in m/s) and the formula for calculating speed, determine the time it takes for light to travel from the sun to the earth, in seconds. As a class, discuss the level of difficulty in carrying out the task.<br>Discuss the rules for expressing numbers in standard form, as provided by the teacher, and observe the examples done by the teacher. | Research, calculate, communicate, observe, collaborate, think critically – analyse<br>Communicate | Acceptable value for distance sun from the earth given<br>Calculation of time for light to travel from sun to earth correct |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| In groups, carry out the same task using standard form. Discuss the advantages of this method (*standard form*) and share with class. Complete teacher provided worksheet on standard form. (*Teacher should point out that in expressing a number in standard form, the number of significant figures should be retained.*) | Collaborate, communicate, calculate, think critically – justify | Logical advantages given for using standard form-<br>Correct answer provided on standard form worksheets |
| Carry out similar tasks, for example finding the time for a text message to travel from Jamaica to London, performing calculations using numbers in standard form. (*Teacher should include other tasks relevant to students' experiences.*) | Calculate, communicate, think critically - analyse | Correct answer provided in standard form |

## Learning Outcomes

Students will be able to:

- Give the results of calculations to the correct number of significant figures
- Record measurements to the correct number of significant figures
- Represent numbers in standard form

## Points to Note

Opportunities for adequate practice must be provided for the students. In addition to worksheets, practical activities should be devised.

## Extended Learning

Develop a podcast/digital story/photo story demonstrating how significant figures are determined, giving examples.

**RESOURCES**

Various small objects (e.g. a rectangular block, cylinder, sphere), worksheets on significant figures and standard form

**KEY VOCABULARY**

Significant figures, standard form, precision

**LINKS TO OTHER SUBJECTS**

**Mathematics** – measurement, numbers

### About the Unit

In this Unit, students will learn that multicellular organisms require a transport system to move substances between the cells and the environment. They will learn that humans have an elaborate transport system consisting of a pump, the heart, and a system of blood vessels – arteries, veins and capillaries – that link all the tissues of the body. Students will demonstrate the double circulation of blood around the body and the impact of exercise on the rate of flow. They will learn that, compared to humans, there are two transport systems in plants – one that transports water and mineral salts and another for manufactured food. They will investigate the pathway of water and mineral salts up the plant using herbaceous plants.

### Range of Content

- A transport system is needed by multicellular organisms to move substances between the cells and the environment.
- The transport system in humans consists of the heart, blood vessels and blood.
- The heart pumps the blood around the body.
- Blood is a tissue.
- The transport system in plants consists of xylem and phloem.
- Water and mineral salts are absorbed from the soil by root hairs/roots and passed from them into the xylem to be transported up the plant to the leaves.
- Manufactured food is transported by the phloem from the leaves to parts of the plant that use or store them.

## Guidance for the Teacher

In preparing biological materials for investigation, **do not attempt to extract or handle fresh blood samples. Obtain permanently prepared slides of human blood smear from authorised source**. Care should be exercised in the handling of knives or other cutting tools. Students should be reminded to handle eggs gently and carefully, not to eat or taste any biological sample and to wash hands immediately after handling samples. Take care to dispose of eggs and acid (HCl) safely.

## UNIT 2: Transport In Humans and Plants

**Theme:** Science Exploration, Application and Design Practice

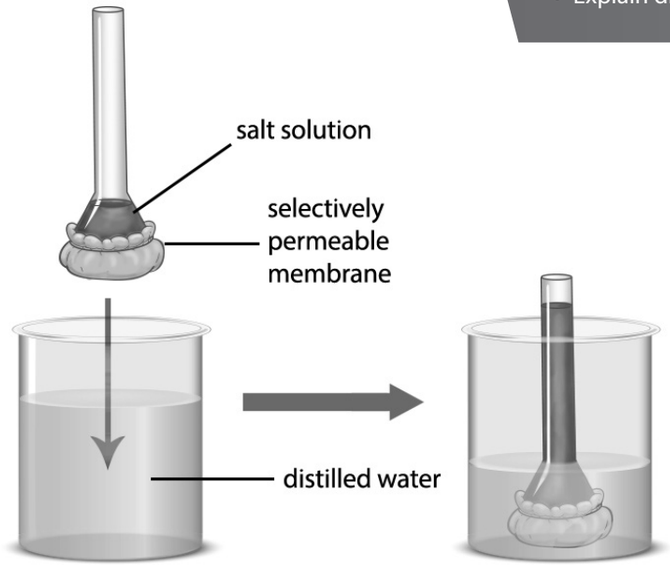
**Topic:** Osmosis

**Duration:** 5 hours/2 weeks

### Prior Learning

Check that students can:

- Recall the basic functions of the cell membrane, cytoplasm and vacuole
- Recall that the cell membrane is selectively permeable
- Explain diffusion




**ATTAINMENT TARGET(S):**

- Understand the importance of the life processes in plants and animals, their interdependence, their interaction with the environment, and how lifestyles determine health and well-being.
- Apply scientific knowledge and processes to the solution of real-world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**OBJECTIVES**

**Students will:**

- Investigate the process of osmosis
- Explain the process of osmosis
- Compare osmosis with diffusion
- Prepare biological materials for investigation
- Demonstrate interest in the outcomes of investigations
- Make predictions using scientific knowledge and understanding

**BENCHMARKS:**

- Demonstrate an understanding of transport systems in plants and animals.
- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**ICT ATTAINMENT TARGETS:**

COMMUNICATION AND COLLABORATION - Use technology to communicate ideas and information for a variety of purposes.

RESEARCH, CRITICAL THINKING, DECISION MAKING - use technology to develop a logical process for decision making and problem solving.

DESIGNING AND PRODUCING - Use technology to design and produce multimedia products to demonstrate their creative thinking.

DIGITAL CITIZENSHIP - Follow guidelines to promote healthy use of ICT tools

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>In groups, place one peg of grapefruit (or other citrus fruit) into a clean, dry, transparent plastic bag containing one tablespoon sugar or salt and shake. Place another peg of grapefruit into a similar plastic bag without sugar/salt. Leave the bags undisturbed for approximately ten (10) minutes. Observe and record what happens. | Manipulate, observe, communicate, collaborate, think critically - analyse, investigate | Satisfactory handling of apparatus and materials<br>Accurate record of observations |
| Share their observations with the class and suggest reasons for the changes. Guided by the teacher, relate their observations to the concept of osmosis and develop a simple definition of the process. | Define operationally | Acceptable definitions given |
| OR | | |
| In groups, cut a medium Irish potato in halves. Carve out a hollow in both halves of the potato. (*Be careful when using sharp instruments*). Cut the base of each potato cup so that it can stand on its own. Stand each potato cup in a separate dish containing the same volume of water. Place one teaspoon of brown sugar or salt into the hollow of one potato cup. Leave both potato cups for 30 minutes. Observe and record what happens. | Manipulate, observe, communicate, collaborate, think critically - investigate, analyse | Satisfactory handling of apparatus and materials<br>Accurate record of observations |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| Share their observations with the class and suggest reasons for the changes. Guided by the teacher, relate their observations to the concept of osmosis and develop a simple definition of the process. | Define operationally | Acceptable definitions given |
| Investigate the effects of pure water and strong sugar solution on raw, de-shelled chicken eggs. Make predictions about expected changes that will take place in the appearance of the eggs when submerged in pure water or in a strong sugar solution and left for some time. Take measurements of each egg – weight and circumference (use a string and ruler) then submerge one into the beaker of pure water and the other into the beaker of strong sugar solution. Cover the containers and set aside for 12 - 24 hours.<br>Construct a suitable table to record the measurements. After 12 - 24 hours remove the eggs and rinse in tap water. Measure the circumference and weight and add the results to the table.<br>Compare the eggs before and after placing in the liquids. Explain the changes observed in the eggs in terms of osmosis. | Manipulate, observe, communicate, measure, think critically – predict, investigate | Accurate observations and measurements recorded in the table<br>Results include reference to whether predictions are accepted or rejected<br>Explanation of changes to the eggs accurately relates to process of osmosis |
| Construct a table to show the similarities and differences between osmosis and diffusion. Share information with the class and through a teacher led discussion, complete a combined table of these similarities and differences. | Compare, tabulate, summarise, communicate | Table contains acceptable comparison of osmosis and diffusion<br>Acceptable table format – title, heading, neatness, lines etc. |

## Learning Outcomes

Students will be able to:

- Define and explain the processes of osmosis.
- Demonstrate osmosis using simple materials.
- Distinguish between osmosis and diffusion.

## Points to Note

- To prepare de-shelled eggs
  The shell of the eggs can be removed by placing them in 300-500 $cm^3$ dilute hydrochloric acid ($HCl_{(aq)}$) or vinegar (acetic acid) in a beaker/suitable container overnight or until the shell is fully dissolved. Ensure the eggs are fully submerged in the HCl or vinegar (acetic acid) (rest another small beaker of water over the eggs to prevent flotation). Carefully, using tongs/spoon, remove the eggs and rinse them several times in tap water. Dispose of the $HCl_{(aq)}$ safely. The eggs are now ready for use by students. Remind them to handle the eggs gently and carefully.
- Introduce the terms hypotonic, hypertonic and isotonic to explain osmosis.

## Extended Learning

Research the applications of osmosis in every-day life using the following examples:

- How do fish and other forms of marine life survive in a salt-water environment?
- The use of osmosis in food preservation – e.g. salting, pickling, sugar-curing.
- The effect of osmosis on red blood cells.

**RESOURCES**

Beakers or other suitable transparent plastic/glass containers, petri dishes, dilute Hydrochloric Acid or vinegar (acetic acid), eggs, Irish potato, salt, sugar, grapefruit or other citrus, plastic bags, ties

**KEY VOCABULARY**

Diffusion, concentration, concentration gradient, osmosis, dilute, selectively permeable, membrane, hypotonic, hypertonic, isotonic

**LINKS TO OTHER SUBJECTS**

**Chemistry, Food and Nutrition**

## UNIT 2: Transport In Humans and Plants

**Theme:** Science Exploration, Application and Design Practice

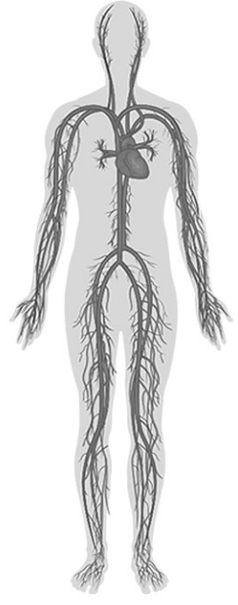
**Topic:** Transport in Humans

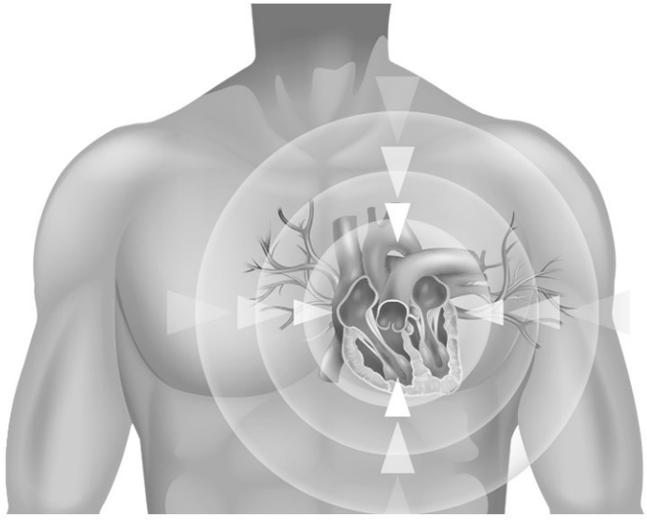
**Duration:** 7.5 Hours/3 weeks

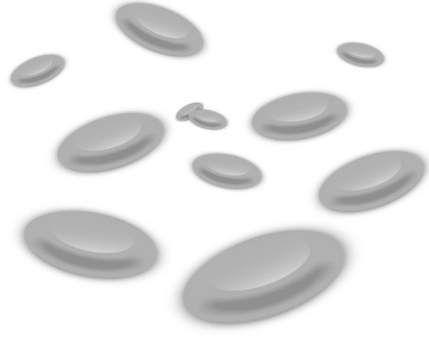
### Prior Learning

Check that students can:

- Recall that the transport system is responsible for moving substances around the body of the organism
- Identify the main parts of the transport systems of humans
- Explain diffusion and osmosis







**ATTAINMENT TARGET(S):**

- Understand the importance of the life processes in plants and animals, their interdependence, their interaction with the environment, and how lifestyles determine health and well-being.
- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**OBJECTIVES**

**Students will:**

- Investigate the need for a transport system in multicellular organisms
- Identify the types of substances which need to be transported in animals
- Annotate a simple diagram of the human heart
- Relate the basic structure of the human heart to its function
- Trace the flow of blood through the heart and around the body
- Relate the structure of arteries, veins and capillaries to their functions
- Identify the main components of blood and state their basic functions
- Use scientific vocabulary and/to articulate concepts clearly and precisely

**BENCHMARKS:**

- Demonstrate an understanding of transport systems in plants and animals.
- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**ICT ATTAINMENT TARGETS:**

COMMUNICATION AND COLLABORATION - Use technology to communicate ideas and information, and work collaboratively to support individual needs and contribution to the learning of others.

RESEARCH, CRITICAL THINKING, PROBLEM-SOLVING AND DECISION MAKING - use appropriate digital tools and resources to plan and conduct research, aid critical thinking, manage projects, solve problems, and make informed decisions.

DESIGNING AND PRODUCING - use digital tools to design and develop creative products to demonstrate their learning and understanding of basic technology operations.

DIGITAL CITIZENSHIP - Recognise the human, ethical, social, cultural and legal issues and implications surrounding the use of technology and practice online safety and ethical behaviour.

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>In groups, investigate how surface area influences the rate of diffusion in cubes of different sizes by carrying out the following activity. Measure the sides and calculate the surface area and volume of the cubes provided and record in a suitable table. Using forceps, place the coloured cubes into a 250 $cm^3$ beaker of dilute HCl and note the time. Record the time taken for each cube to become colourless. Determine the average time taken for each cube of a different size to lose its colour and plot a suitable graph of the results. As a class, discuss the results and complete the lab report. | Communicate, measure, calculate, record, observe, think critically – analyse, infer, draw conclusions, construct graph, investigate | Accurate measurements taken and recorded<br>Correct calculations<br>Correct relationship between surface area and rate of diffusion explained and supported by data<br>Construction of graph adheres to principles taught<br>Lab report adheres to the scientific method and uses scientific language to explain results |
| Peg or draw out a map of the human circulatory system on the school field or classroom floor. Label each area on the map. Take turns representing the blood, walk around the system explaining what happens at each point.<br>Guided by the teacher, infer that the human circulatory system is a double circulation, explain why it is given this name and discuss the advantages of such a circulation. | Collaborate, communicate, critical thinking – infer, create | Acceptable demonstration and explanation of blood flow |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| Demonstrate and explain what happens to the flow of blood if the rate of the heart beat increases. | | |
| Annotate simple diagrams of the human heart [external features and longitudinal section (L/S)].<br>Examine, in groups, the external and internal features of a pig's/ cow's heart and, with reference to the diagrams, identify the main parts. | Annotate, make observations, collaborate, think critically - make comparisons | Appropriate labels and annotations |
| View a chart / video/ interactive animation on how the heart pumps blood around the body. Use arrows on their labelled diagrams (from previous activity) to indicate the flow of blood through the heart. | Think critically - analyse, make comparisons, illustrate | Arrows indicate correct flow of blood through the heart |
| In groups, research, plan and design models of the different types of blood vessels, using available materials. Plans should include constraints. Present designs to the class, explaining how they will represent the blood vessels. Then, refine designs based on feed-back. Construct the model using the modified designs and display in the science corner. | Manipulate, communicate, think critically - create, plan and design, evaluate, research | Design plan includes constraints and redesign considerations<br>Models accurately depict blood vessels |
| View a prepared smear of human blood using a microscope, or a projected image or chart online/offline and, aided by the teacher, identify red and white blood cells and platelets.<br>In groups, make models of red and white blood cells and platelets by cutting shapes from cardboard, paper, plastic, foam, modelling clay/plasticine or rubber. Develop criteria to peer assess the models. Display models in the science corner. | Observe, collaborate, communicate, think critically – create, critique | Blood components and their functions correctly identified and represented by models<br>Appropriate criteria developed for peer assessment |

## Learning Outcomes

Students will be able to:

- Explain that multicellular organisms need a transport system.
- Describe the structure and functions of the human circulatory system

## Points to Note

Teacher led discussion for activity 1 should focus on surface area: volume ratio and how this influences the rate of diffusion.

To make good solid agar, stir 2 g of plain agar powder into 100 $cm^3$ of water. Heat in a water bath filled with boiling water, while stirring, until the agar solution boils. Colour the agar with potassium permanganate (add a few crystals and stir until the desired colour is obtained). Pour the coloured agar into straight-sided dishes or ice cube trays then allow to cool. Cut the agar cubes for the students – 0.5 $cm^3$, 1.0 $cm^3$ and 1.5 $cm^3$. Provide each group with two cubes of each size.

Mammalian hearts (complete with fat and major blood vessels), obtained from freshly slaughtered pig, cattle or goat can be sourced from public health inspectors, abattoirs and markets.

**Obtain prepared slides (human blood smear) from authorised source.**

Observe safety precautions when handling fresh specimens and sharp instruments. Students must wash hands using soap and water after the activity

## Extended Learning

- Research selected diseases of the circulatory system and state the possible causes and preventive measures.
- Research issues relating to the use of blood transfusions in medicine (e.g. ethical, religious).
- Explore the benefits of exercise as it relates to the heart and circulatory system.
- Research legal and illegal methods of increasing red blood cell concentration to improve athletic performance.

### RESOURCES

Videos, charts, posters, hearts (goat, cattle or pig), prepared blood smear slide, microscope, cardboard, foam, paper, plastic, modelling clay (e.g. Plasticine) or rubber, stop watch/clock, blunt needles (seekers), forceps, beakers, heating apparatus, agar, potassium permanganate, Hydrochloric acid, scalpel, straight sided containers or ice trays

Computers, Internet, speaker, multimedia projector, interactive video tutorials, CDs/DVDs

### KEY VOCABULARY

Arteries, veins, capillaries, valves, heart, lungs, blood, unicellular, multicellular, diffusion, osmosis, red blood cells, white blood cells, plasma, platelets, double circulation, transport system, haemoglobin, surface area, volume

### LINKS TO OTHER SUBJECTS

**Physical Education, HFLE, Mathematics** (Volume and Surface area)

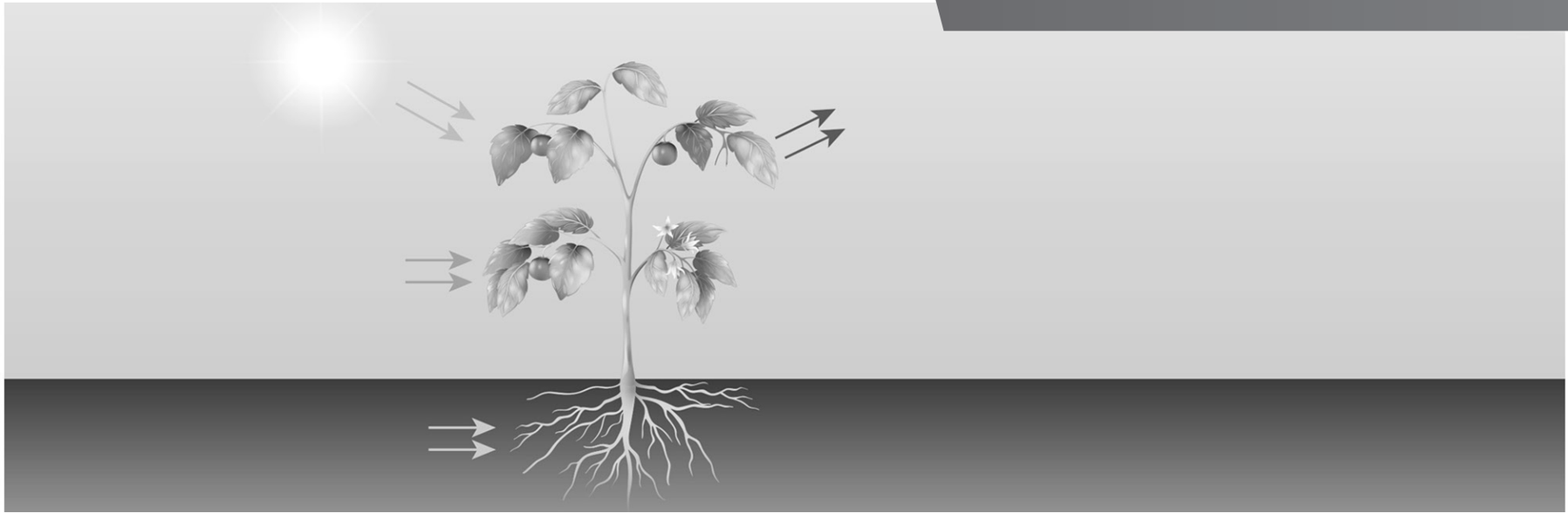
## UNIT 2: Transport In Humans and Plants

**Theme:** Science Exploration, Application and Design Practice
**Topic:** Transport in Plants
**Duration:** 5 Hours/2 weeks

### Prior Learning

Check that students can:

- describe the basic structure of plants, e.g. leaf, root, stem, flower
- recall that green plants take in water through their roots and that the leaf is important for photosynthesis
- Explain diffusion and osmosis



**ATTAINMENT TARGET(S):**

- Understand the importance of the life processes in plants and animals, their interdependence, their interaction with the environment, and how lifestyles determine health and well-being.
- Apply scientific knowledge and processes to the solution of real-world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**OBJECTIVES**
**Students will:**

- Identify the substances that are transported in plants
- describe how roots are adapted for taking in water
- Identify the location of transport tissues in a dicotyledonous plant stem and root sections
- Describe the basic functions of the xylem and phloem
- Investigate the movement of water from the soil to the leaves

**BENCHMARKS:**

- Demonstrate an understanding of transport systems in plants and animals.
- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**ICT ATTAINMENT TARGETS:**

COMMUNICATION AND COLLABORATION - Use technology to communicate ideas and information, and work collaboratively to support individual needs and contribution to the learning of others.

RESEARCH, CRITICAL THINKING, PROBLEM-SOLVING AND DECISION MAKING - use appropriate digital tools and resources to plan and conduct research, aid critical thinking, manage projects, solve problems, and make informed decisions.

DESIGNING AND PRODUCING - use digital tools to design and develop creative products to demonstrate their learning and understanding of basic technology operations.

DIGITAL CITIZENSHIP - Recognise the human, ethical, social, cultural and legal issues and implications surrounding the use of technology and practice online safety and ethical behaviour.

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>In groups, examine roots with root hairs, e.g. germinating peas or beans, or secondary sources such as prepared slides and animations, and brainstorm to identify the role of the root hairs. Share ideas with the class. | Collaborate, communicate | Acceptable role of root hairs identified |
| In groups, examine and record evidence of movement of a dye in plants using Balsam/'lady slipper' (*Impatiens*) plants which have been placed in the dye/food colouring for a few hours or over-night. Cut transverse sections from the stem and root of the plant and examine (using a hand lens) to show the location of the dye. View a prepared slide of the transverse section through a stem and root showing the vascular bundles and compare with the sections cut from the plant. Describe the movement of substances from the soil through the plant, and present their observations in a variety of ways. (*Teacher should emphasize that only the xylem will be stained by the dye and point out the association of the phloem with the xylem in the vascular bundle. Mention that food manufactured during photosynthesis is transported in the phloem. No further detail on the phloem is needed.*) | Observe, manipulate communicate, collaborate, think critically - investigate, compare | Accurate description of the movement of substances from the roots to the leaves<br>Accurate record of observations |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| In groups, draw two circles on the floor or on a poster sheet (one representing the stem and the other the root). Cut 20 discs of two different colours and sizes from card or paper (10 representing xylem and 10, phloem). Arrange the discs to demonstrate how the vascular tissues in a dicotyledonous root and stem are arranged. | Think critically - create | Arrangement of vascular tissues in the dicotyledonous stem and root accurately depicted |
| Investigate the uptake of dye/coloured ink by white flowers by placing the freshly cut flower stalks into a beaker/glass containing the dye/ink solution. Leave for 1-2 hours and observe what happened to the white petals. Suggest an explanation for their results. Suggest how this practice could be used commercially. | Observe, communicate, collaborate, think critically - investigate | Accurate explanations of movement of substances |

## Learning Outcomes

Students will be able to:

- Describe the adaptations of roots for absorption of water.
- Describe the location and basic functions of the xylem and phloem.
- Describe the route taken by substances from the soil up the plant
- Communicate information using discussion forums or social network

## Points to Note

Wash roots carefully before placing plant in the dye solution.

Sections of the parts of the plant may be projected for class viewing.

## Extended Learning

Research the adaptations of roots and leaves of plants in different environments (aquatic– brackish/freshwater; terrestrial– typical/desert)

**RESOURCES**

Microscope, prepared slides/posters/ of T/S stem and root, live seedlings, video clips, measuring cylinders, beakers, paper/cards, balsam/lady slipper, dye

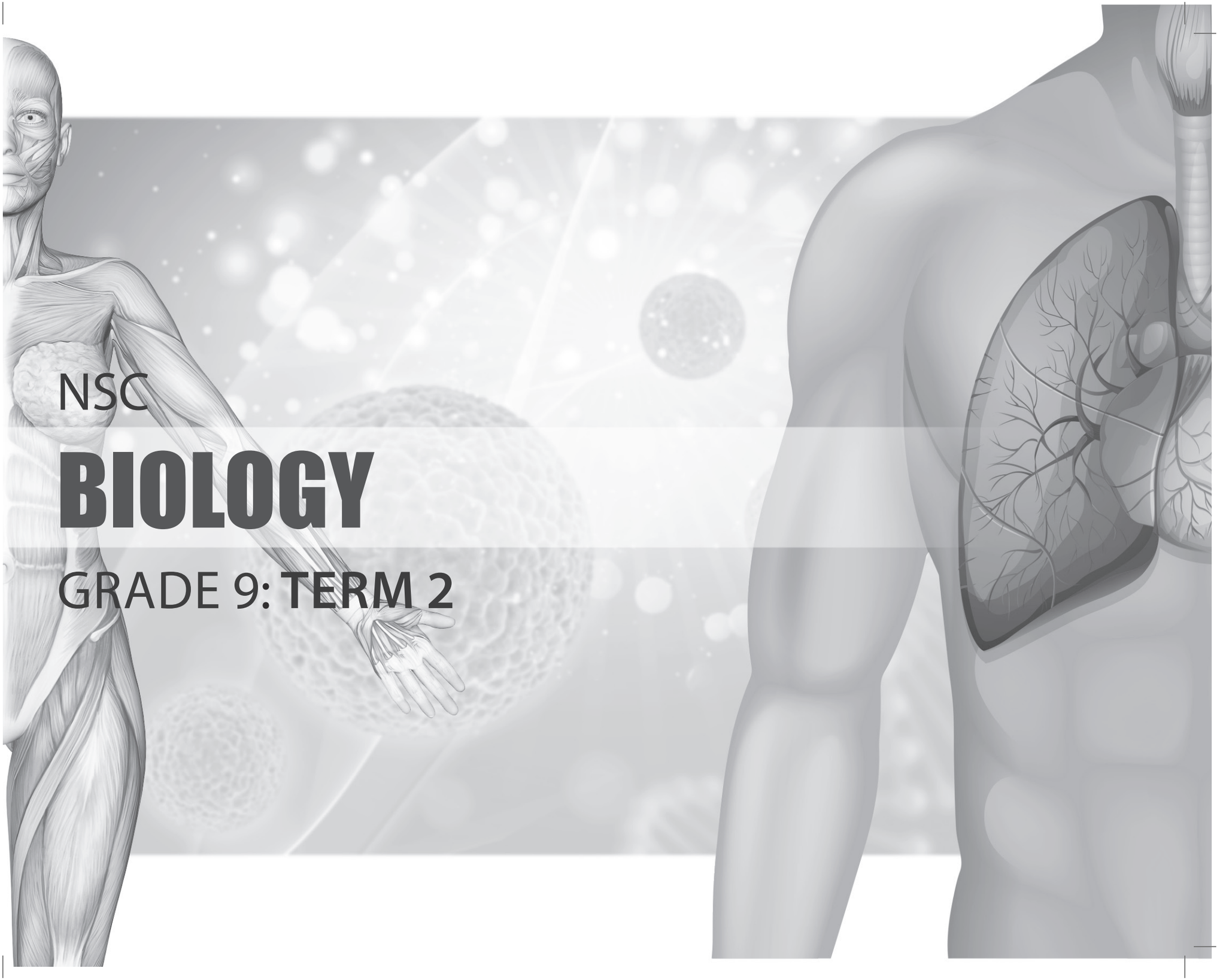
Computers, Internet, speaker, multimedia projector, interactive video

**KEY VOCABULARY**

xylem, phloem, vascular bundle, veins

**LINKS TO OTHER SUBJECTS**

**Agriculture**



NSC

# BIOLOGY

## GRADE 9: TERM 2

### About the Unit

In this Unit, students will learn about the importance of the body's ability to respond to external and internal stimuli. They will investigate a range of stimuli to identify the specific receptors/sense organs which detect them. They will learn that the brain and spinal cord constitute the central nervous system which coordinates all responses to stimuli. They will learn about the main parts of the brain and their basic functions. They will also appreciate that many processes in the body are controlled by chemical regulators called hormones and identify the location and specific functions of selected endocrine glands.

### Range of Content

- The nervous and endocrine systems enable us to respond to changes in the external and internal environment
- A variety of specific receptor cells detect stimuli in the environment and pass the information to the Central Nervous System (CNS)
- The CNS receives and sends information via nerve cells/neurones as it coordinates all the body's responses to stimuli
- Reflex actions are rapid, automatic responses to stimuli
- Hormones are chemical substances secreted by endocrine/ductless glands and are transported in the blood to the parts of the body where they work
- Hormones regulate the functions of many organs and cells.

### Guidance for the Teacher

Preview all videos to ensure they are appropriate in addressing the learning objectives.

## UNIT 1: Sensitivity and Coordination

**Theme:** Science Exploration, Application and Design Practice

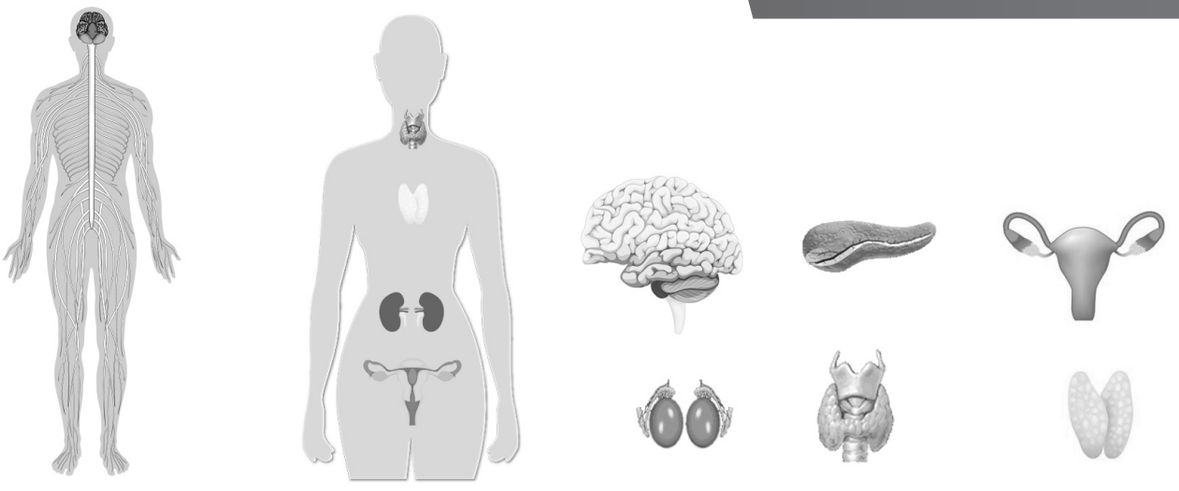
**Topic:** Sensitivity and Coordination

**Duration:** 10 Hours/4 weeks

### Prior Learning

Check that students can:

- Recall the definition of hormones
- Identify the sense organs of humans and the stimuli to which they respond



**ATTAINMENT TARGET(S):**

- Understand the importance of the life processes in plants and animals, their interdependence, their interaction with the environment, and how lifestyles determine health and well-being.
- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**OBJECTIVES**

**Students will:**

- Deduce the importance of responding to changes in the environment
- State that each sense organ contains sensory / receptor cells that detect a specific type of stimulus
- State that the brain and spinal cord comprise the Central Nervous System (CNS) which coordinates the body's responses
- Name the main parts of the human brain and state their basic functions
- Differentiate between voluntary and involuntary /reflex actions
- Explain the importance of reflex actions using examples
- Describe the endocrine system as consisting of ductless glands that respond to internal stimuli by producing hormones
- Identify selected endocrine glands, their location, the hormones they produce and their importance in maintaining the body's internal environment
- Compare the nervous system with the endocrine system
- Use appropriate scientific language to describe features of the nervous and endocrine systems

**BENCHMARKS:**

- Understand the role of the key organs and systems in humans and animals in sensing and responding to the environment.
- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate care and concern for living things and the environment.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate concern for the preservation of natural resources.
- Demonstrate concern for man's impact on the environment.
- Demonstrate sensitivity to others who are different.

**ICT ATTAINMENT TARGETS:**

COMMUNICATION AND COLLABORATION - Students use technology to communicate ideas and information, and work collaboratively to support individual needs and contribute to the learning of others.

RESEARCH, CRITICAL THINKING, PROBLEM-SOLVING AND DECISION MAKING - use appropriate digital tools and resources to plan and conduct research, aid critical thinking, manage projects, solve problems, and make informed decisions.

DESIGNING AND PRODUCING - use digital tools to design and develop creative products to demonstrate their learning and understanding of basic technology operations.

DIGITAL CITIZENSHIP - Recognise the human, ethical, social, cultural and legal issues and implications surrounding the use of technology and practice online safety and ethical behaviour.

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>View a video on the human nervous system. Participate in teacher led discussion to highlight the importance of responding to changes in the environment and identify the role the nervous system plays. | Communicate, collaborate | |
| In groups, review the sense organs and formulate definitions for stimulus, receptor, response and effector. Share definitions with the class in a teacher led discussion. Construct a table to list each sense organ, the stimulus which it detects and its corresponding function. | Collaborate,<br>define operationally,<br>communicate, tabulate | Acceptable definitions given<br>Accurate information linking sense organs to functions<br>Acceptable presentation of table |
| View diagram / picture / video or examine a model of the human brain then label the main parts on a teacher prepared hand out.<br>Construct a table to show the parts identified and their functions. | Label diagrams, tabulate | Diagram accurately labelled<br>Acceptable presentation of table with accurate information |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| Participate in a teacher-led discussion then formulate a definition of involuntary /reflex actions. In groups, generate and sort a list of actions into voluntary and involuntary. As a class, share their ideas from the lists and identify the benefits that can be derived from the involuntary/reflex actions cited. | Define operationally, collaborate, communicate, think critically - infer, classify | Acceptable definition of reflex actions given<br>Voluntary and involuntary actions correctly identified<br>Acceptable benefits of reflex actions identified |
| Work in pairs to demonstrate some reflex actions identified in the previous activity (e.g. blinking, knee jerk, pupil reflex etc.) then in a teacher led discussion, identify the common features involved in the reflex actions and the role each plays. | Collaborate, communicate, think critically - analyse | Acceptable identification of common features involved in the selected reflex actions |
| Work in groups to compare their reaction times. Hold ruler with forefinger and thumb. On a signal given by group leader, release ruler and try to grasp it with fingers before it hits the surface. Record the time taken to catch the ruler. Perform the activity two more times. Tabulate the results and calculate the average reaction time. Repeat the activity to determine the average reaction time for each member of the group.<br>Plot a suitable graph (reaction time/ students) using the group results. Share data with the class and compare reaction times of the students and discuss reasons for any differences.<br>Use interactive online reaction time monitor and compare values. *https://faculty.washington.edu/chudler/java/redgreen.html* | Collaborate, manipulate, communicate, tabulate, construct graph, think critically - analyse and interpret data, draw conclusions | Accurate presentation of data in table and graph<br>Acceptable comparisons of response times<br>Acceptable interpretation of the variation in reaction times |
| View video/power point presentation/poster or chart of the human endocrine system showing selected glands (pituitary, thyroid, adrenal, pancreas, ovaries, and testes) and in teacher led discussion identify the glands, their location, the hormones that they produce and their effects on the body. Record the information in a suitable table. Annotate a blank diagram of the endocrine system prepared by the teacher.<br>In groups, compare the nervous and endocrine systems and share findings with the class. Summarise the information presented. | Collaborate, communicate, tabulate, annotate | Acceptable presentation of table with accurate information<br>Accurate annotation of diagram<br>Accurate information presented in summary |

## Learning Outcomes

Students will be able to:

- Explain the role of sense organs in providing information on the external environment.
- Describe the central nervous system as comprising the brain and spinal cord.
- Identify the main parts of the brain and state their functions.
- Distinguish between voluntary and involuntary/reflex actions.
- Explain the importance of reflex actions using examples.
- Describe the endocrine system as consisting of ductless glands that respond to internal stimuli by producing hormones.
- Identify selected endocrine glands, their location, secretions and roles.
- Use appropriate scientific language to describe features of the nervous and endocrine systems

## Points to Note

Components of reflex action to include – parts that detect stimuli and parts that carry out responses.
**Details of components of reflex arc not required.**

Parts of the brain to include (cerebrum, cerebellum, medulla oblongata, pituitary gland)

Endocrine glands to include (pituitary, pancreas, ovaries, testes, thyroid, and adrenal)

## Extended Learning

Research and report on the effects of the malfunction of selected endocrine glands (e.g. thyroids, pancreas), the diseases which may develop and the methods of treatment available.

Research the work of Pavlov and his dogs in the context of the reflex action.

**RESOURCES**

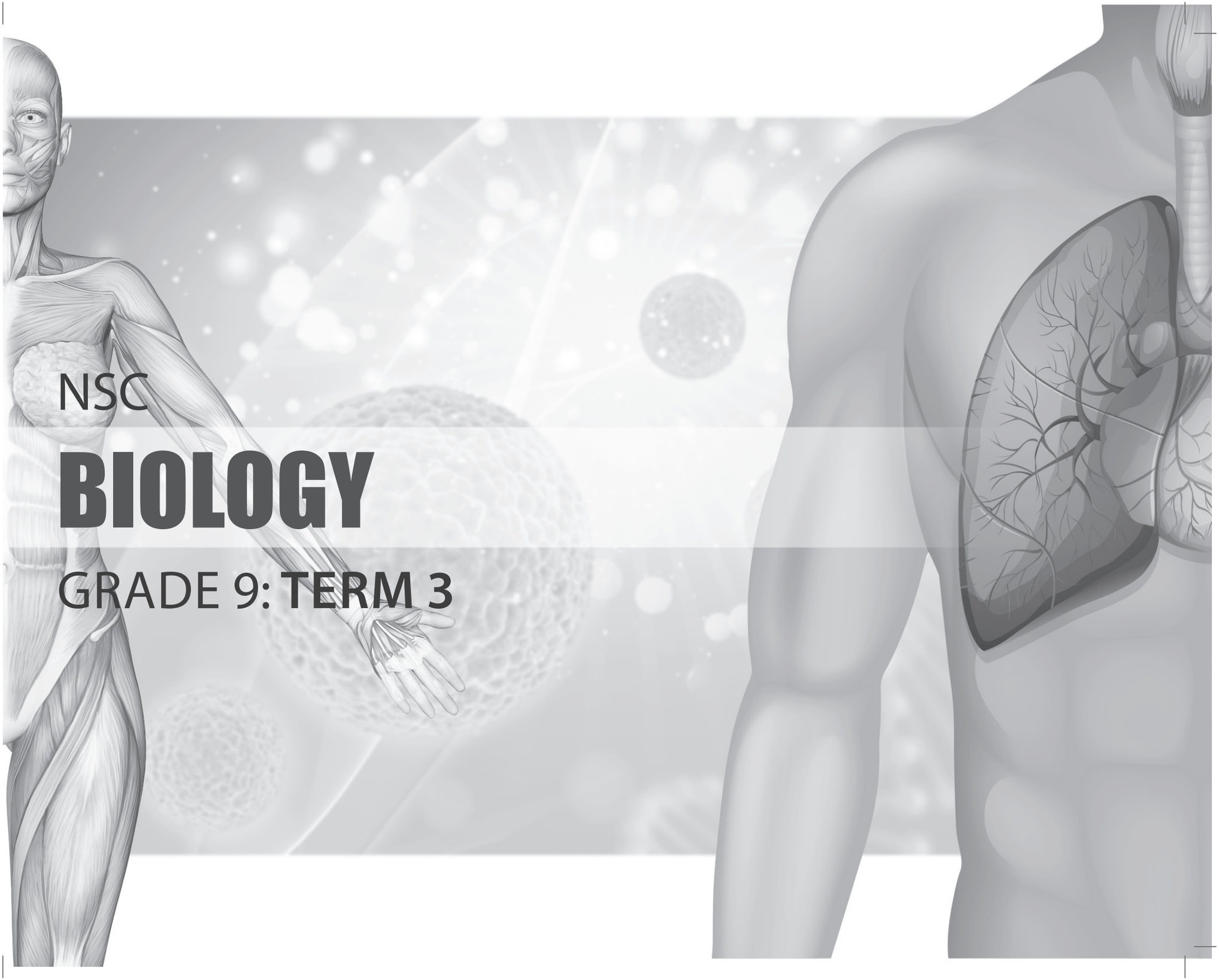
Charts, posters, videos, PowerPoint presentations on the nervous and endocrine systems; hand-outs and worksheets; stop watch, rulers

**KEY VOCABULARY**

Hormones, receptor, stimulus, spinal cord, brain, medulla oblongata, cerebrum, cerebellum, sense organ, pancreas, insulin, thyroid, pituitary, adrenal, adrenaline, thyroxin(e), voluntary , involuntary , reflex action , reflex arc, response, nerves, nervous system, central nervous system, endocrine, ductless gland.

**LINKS TO OTHER SUBJECTS**

**Physical Education**



NSC

# BIOLOGY

## GRADE 9: TERM 3

### About the Unit

In this Unit, students will learn about the changes that occur during pregnancy as the human zygote develops into an embryo, and then a foetus until it is born. During pregnancy the developing baby is supported by the placenta – all its oxygen and nutrient needs and all wastes are exchanged there. Students will appreciate that disease causing microorganisms and some drugs can also pass across the placenta and cause harm to the baby. It is therefore very important that the mother gets prenatal care and avoids practices such as smoking and drinking alcohol, which can harm the baby. They will learn about the importance of planning the family and explore the variety of methods of birth control used to prevent pregnancy. Students will debate issues related to teenage pregnancy.

### Range of Content

The key concepts, skills and knowledge students will learn in this unit are:

- The human zygote undergoes repeated cell divisions to produce an embryo.
- The embryo becomes implanted in the wall of the uterus and develops into a foetus/baby during the period of gestation.
- The placenta is the point of contact between mother and foetus.
- Nutrients, oxygen and wastes are exchanged across the placenta.
- Disease organisms and drugs can pass across the placenta.
- Maternal habits such as smoking, drinking alcohol, use of drugs and inadequate diets can have significant negative effects on the developing embryo/foetus.
- Prenatal care is vital for the health of mother and baby.
- Birth control methods prevent pregnancy in a variety of ways.

### Guidance for the Teacher

Preview all videos to ensure they are appropriate in addressing the learning objectives.

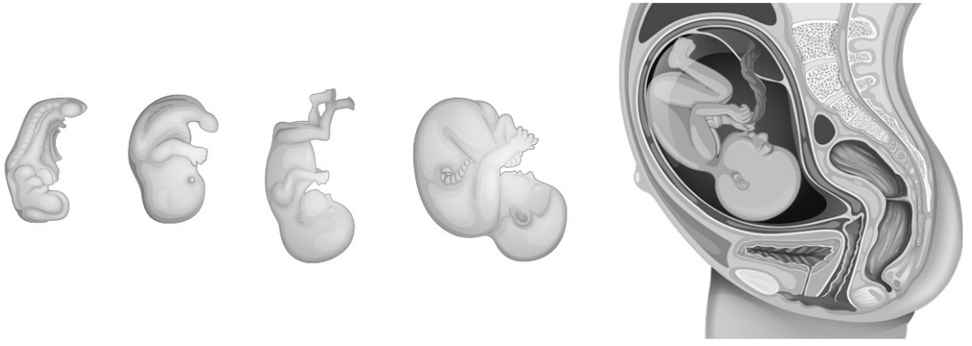
Be aware of students' religious and cultural backgrounds, and also their attitudes to sexual development and conception.

## UNIT 1: Embryo Development and Birth Control

**Theme:** Science Exploration, Application and Design Practice

**Topic:** Embryo development and birth control

**Duration:** 10 Hours/4 weeks



### Prior Learning

Check that students can:

- Identify the structure and basic function of the human reproductive system
- Define puberty and adolescence
- Explain the stages of the menstrual cycle
- Define ovulation and fertilization
- Recall that fertilisation involves the fusion of the nucleus of a spermatozoon (sperm) and ovum (egg)

**ATTAINMENT TARGET(S):**

- Understand the importance of the life processes in plants and animals, their interdependence, their interaction with the environment, and how lifestyles determine health and well-being.
- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**OBJECTIVES**

**Students will:**

- State that the fertilised egg (zygote) undergoes repeated cell divisions to produce an embryo which becomes implanted in the uterus
- Identify key structures in a pregnant uterus (placenta, amniotic sac, amniotic fluid, umbilical cord and uterine wall) and state their basic functions in the growth and development of the human embryo/foetus
- Describe how the embryo obtains nutrients and oxygen and eliminates waste
- Describe the effects of negative maternal behaviour during pregnancy on the development of the embryo/foetus
- Explain the importance of prenatal care during pregnancy
- Critique methods of birth control
- Assess the importance of family planning
- Evaluate problems associated with teenage pregnancy
- Show respect for each other's views

**BENCHMARKS:**

- Understand the role of the key organs and systems in humans and animals in sensing and responding to the environment.
- Understand embryo development and birth, appreciate the importance of maintaining a healthy lifestyle during pregnancy, and be aware of birth control methods.
- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate care and concern for living things and the environment.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**ICT ATTAINMENT TARGETS:**

COMMUNICATION AND COLLABORATION - Students use technology to communicate ideas and information, and work collaboratively to support individual needs and contribute to the learning of others.

RESEARCH, CRITICAL THINKING, PROBLEM-SOLVING AND DECISION MAKING - use appropriate digital tools and resources to plan and conduct research, aid critical thinking, manage projects, solve problems, and make informed decisions.

DESIGNING AND PRODUCING - use digital tools to design and develop creative products to demonstrate their learning and understanding of basic technology operations.

DIGITAL CITIZENSHIP - Recognise the human, ethical, social, cultural and legal issues and implications surrounding the use of technology and practice online safety and ethical behaviour.

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>View chart/ model/ video (online or offline) showing the development of the human embryo in the uterus.<br>Annotate a given diagram of the longitudinal section of the pregnant uterus. | Annotate | Correct annotation of diagram |
| Sequence prepared statements about the human life cycle (e.g. on cell specialisation, fertilisation, embryo development, birth etc.). | Sequencing | Acceptable sequence of stages of life cycle |
| In groups, create and annotate an album or a booklet to show the stages of growth of the foetus using pictures collected from the internet/posters/magazines. Display albums/booklets in the science corner. | Design, create, collaborate, annotate | Pictures accurately sequenced and annotated |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| Use suitable software (e.g., presentation or moviemaking) to create digital version of the album. | Navigate digital content<br>Use search engines safely | |
| In groups, research (online/offline) the effects of negative maternal behaviours (e.g., diet, drugs, alcohol and smoking) on the developing embryo/foetus. Discuss information and prepare related questions that could be used during a panel discussion/ press conference. Enact the panel discussion or press conference.<br>OR | Collaborate, communicate, think critically - research, critique, create | Questions adequately address the negative maternal behaviours<br>Authentic enactment |
| In groups, design and make a poster or movie/digital story to persuade pregnant mothers to give up negative behaviours during pregnancy. Display posters on the classroom, school's notice board or present movie to class, invited teachers, parents, other guests or post movie on class page. | Collaborate, communicate, think critically - create<br>Create and format document and multi-media presentation | Poster/movie/digital story adequately address the negative maternal behaviours<br>Accurate content, logical arguments, images convey message |
| Role play two pregnant women visiting a prenatal clinic, one who is taking good advice on prenatal care and the other who is disregarding it. | Communicate, think critically - critique, create | Role-play accurately depicts good prenatal care |
| In groups, investigate the views/opinions of a nurse, doctor, teacher, parent (single and/ married) and teenager on the importance of family planning, the effects of teenage pregnancy and the different methods of birth control/contraception, the use of technology in improving birth control methods in the twenty-first century. Present information in form of a project, scrapbook, journal or portfolio. | Communicate, collaborate, critical thinking – create, analyse, research | Presentation captures the variety, nature and importance of contraception<br>Includes a variety of methods for capturing and reporting data<br>Is attractively presented and reflects creativity<br>Evidence of thorough research |
| In groups, go on a field trip to the maternity ward of a hospital or children's home and complete survey checklist provided by teacher and, participate in a teacher led discussion. | Communicate, collaborate | |
| Debate on the moot "Be it resolved that condoms should be distributed in secondary schools." | Communicate, collaborate, think critically - critique, analyse, develop logical arguments | Arguments reflect understanding of teenage sexuality and the effects of teenage pregnancy<br>Evidence of collaboration |

## Learning Outcomes

Students who demonstrate understanding can:

- Explain that the fertilised egg (zygote) develops into an embryo which becomes implanted in the uterus.
- Describe the basic structure and function of a pregnant uterus.
- Describe the exchange of substances across the placenta.
- Explain the effects of negative maternal behaviours on the developing embryo/foetus.
- Value the importance of prenatal care.
- Evaluate methods of birth control in preventing pregnancy.
- Appreciate the problems associated with teenage pregnancy.
- Use digital story/movie to communicate information.

## Points to Note

Maternal behaviours to include diet, drugs, alcohol and smoking, responsible sexual habits.

Prenatal care to include maternal nutrition, exercise and immunisation.

Remind students of the following when using technology:

- Recognise and acknowledge the owners or creators of digital materials and encourage their peers to do so.
- Follow guidelines to promote healthy use of ICT tools

## Extended Learning

Collect and sequence ultra-sound pictures showing the stages of the developing foetus.

Visit the National Family Planning Agency or online, collect data from the different parishes in Jamaica and plot graphs to illustrate the incidence of teenage pregnancy.

Research in vitro fertilization (test-tube babies), fertility drugs and surrogate motherhood.

Explain how identical, non-identical and Siamese twins occur.

Research the rate of 'infant mortality' (death of new-born babies) in Jamaica.

Find out how different animals e.g., developing bird or reptile, meet their needs inside the egg.

**RESOURCES**

Charts, models, videos and movies of various aspects of human reproduction and family planning, resource personnel , samples of birth control methods, cartridge paper, markers, tape, glue

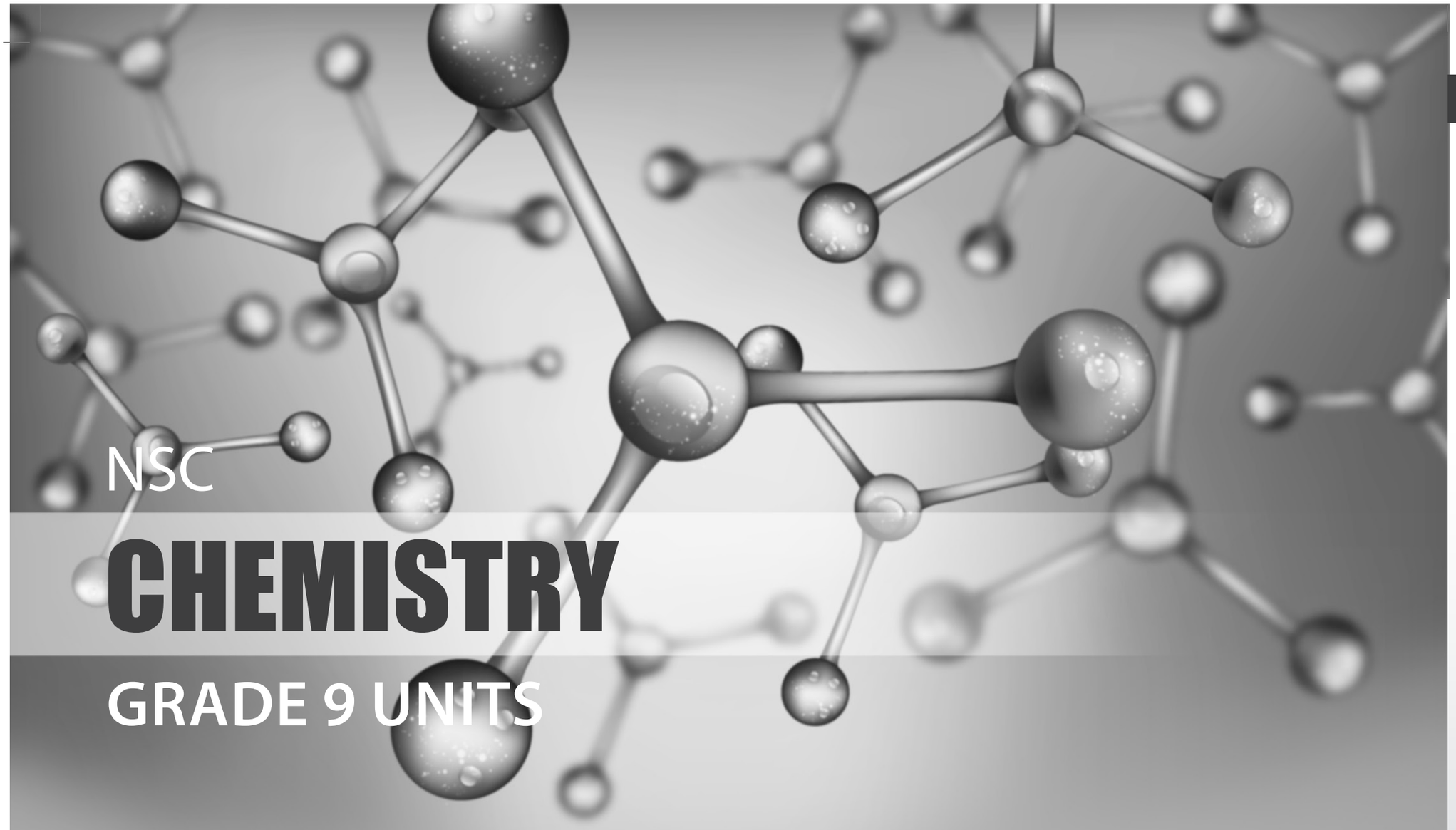
Computers, Internet, multimedia projector, speakers

**KEY VOCABULARY**

zygote, cell division, embryo, foetus, uterus, placenta, amniotic fluid, amniotic sac, umbilical cord, conception, implantation, gestation, labour, delivery, birth, family planning, contraceptives, prenatal care

**LINKS TO OTHER SUBJECTS**

**Social studies, Religious Education, HFLE**



NSC

# CHEMISTRY

## GRADE 9 UNITS

## TERM 1

**Unit 1**

**Working Like a Scientist 3**

Developing hypotheses
Planning & designing fair tests
Fundamental quantities and units
Derived units
Plotting graphs
Calculating gradients from graphs
Interpreting distance & velocity-time graphs
Determining significant figures
Writing numbers in standard form

**Unit 2**

**Introduction to Chemistry**

Defining Chemistry
Branches of Chemistry
Chemistry in daily life
Careers in Chemistry
Using basic chemistry apparatus

## TERM 2

**Unit 1**

**Energy, Forces and Matter**

Calculating number of sub-atomic particles in atoms and ions
Writing electronic configuration of 1st 20 elements
Defining ionic bonding
Forming ionic compounds
Physical properties of ionic compounds
Determining chemical formula of binary compounds
Writing word, symbol and ionic equations
Balancing equations
Investigating types of reactions
Identifying exothermic and endothermic reactions

## TERM 3

**Unit 1**

**Acids and Alkalis**

Classifying substances as acids and alkalis
Interpreting the pH scale
Measuring the pH of substances
Using and creating acid-base indicators
Investigating reactions of acids and bases
Testing for hydrogen, carbon dioxide and ammonia
Classifying salts
Preparing insoluble salts
Applications of neutralization reactions in daily life

NSC

# CHEMISTRY

## GRADE 9: **TERM 1**

### About the Unit

In this Unit, students will learn about chemistry as an important area of science which contributes significantly to all aspects of their everyday life. Additionally, students will be introduced to the safe use of some basic lab equipment through practical activities.

### Range of Content

- Chemistry is a branch of Science that focuses on the reactions of matter.
- Physical, organic and inorganic chemistry are the three main branches of chemistry.
- Chemistry is a central Science and forms an important part of many science-related careers.
- Regular use of chemicals requires the following of safety guidelines in Chemistry.
- Basic apparatus used in the Chemistry laboratory include Bunsen burner, tripod, beaker, measuring cylinder, test tubes, evaporating dish and filter funnel.
- Volume measurements are determined using beakers and measuring cylinders while the balance is used to measure mass. Temperature is determined using a thermometer.

## UNIT 1: Introduction to Chemistry

**Theme:** Science Exploration, Application and Design Practice
**Topic:** Introduction to Chemistry
**Duration:** 5 hours/2 weeks

### Prior Learning

Check that students can:

- Explain the steps involved in the scientific method.

**ATTAINMENT TARGET(S):**

- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**OBJECTIVES**
**Students will:**

- Define the term chemistry
- State the three main branches of Chemistry
- Identify at least five chemists and outline their contributions to the development of Chemistry.
- Identify basic laboratory apparatus and associate each with their correct functions
- Use appropriate apparatus to measure quantities such as volume, mass and temperature

**BENCHMARKS:**

- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate care and concern for living things and the environment.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate concern for the preservation of natural resources.
- Demonstrate concern for man's impact on the environment.
- Demonstrate sensitivity to others who are different.

**ICT ATTAINMENT TARGETS:**

COMMUNICATION AND COLLABORATION - Use technology to communicate ideas and information, and work collaboratively to support individual needs and contribution to the learning of others.

RESEARCH, CRITICAL THINKING, PROBLEM-SOLVING AND DECISION MAKING - use appropriate digital tools and resources to plan and conduct research, aid critical thinking, manage projects, solve problems, and make informed decisions.

DESIGNING AND PRODUCING - use digital tools to design and develop creative products to demonstrate their learning and understanding of basic technology operations.

DIGITAL CITIZENSHIP - Recognise the human, ethical, social, cultural and legal issues and implications surrounding the use of technology and practice online safety and ethical behaviour.

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>View video presentation on the importance of Chemistry to everyday life. Engage in teacher led discussion on the impact of Chemistry (areas such as pharmaceuticals, cosmetics etc). | Communicate, think critically – analyse, infer, draw conclusions | Actively participate in discussion<br>Inferences on the importance of Chemistry made |
| Create a chart, possibly **using appropriate software**, to show the link between Chemistry and all the other branches of Science. Chart to be displayed in the class. | Create, communicate, infer | Correct information displayed<br>Link between Chemistry and branches of Science made |
| In groups, **browse and search online sources and other media for information** on the contribution of named scientists to the development of Chemistry. **Prepare information for presentation to the class using suitable software (e.g., presentation, movie-making, and sound recording)** or other physical media. Present information to the class **in varied formats.** | Research, communicate, report<br>**Navigate digital content**<br>**Capture audio**<br>**Insert illustrations** | Correct information presented<br>Neat and concise |
| Identify and collect substances used in everyday life. Make a list of substances and their active ingredients. Tabulate information using the following headings substance, active ingredients, and uses. | Observe, think critically – analyse, classify, report, | Properly identifies active ingredients |
| View display/ read handout of basic lab apparatus and participate in a teacher led discussion on their names and uses Draw diagrams of common laboratory apparatus in laboratory books and indicate what they are used for. | Observe, draw, communicate, | Correct names identified<br>Properly labelled diagrams |
| In groups, use correct apparatus to measure the volume, mass and temperature of selected substances and record results in a table using appropriate units (such as ml/ $cm^3$ - volume, g - mass and °C – temperature).<br>***Teacher will decide the nature and amounts of substances to be used.*** | Manipulate, measure, report, think critically - analyse | Correct measurements taken<br>Correct equipment used<br>Appropriate units recorded |

## Learning Outcomes

Students who demonstrate understanding can:

- Define Chemistry
- State the branches of Chemistry
- Explain the contributions of five chemists
- Use apparatus for measuring volume, mass and temperature

## Points to Note

Safety measures to be explained when heating substances (e.g. in a test tube) and using the Bunsen burner

Safety gears when using the laboratory to be emphasized by teacher

**Remind students of the following when using technology:**

- **Recognise and acknowledge the owners or creators of digital materials and encourage their peers to do so.**
- **Follow guidelines to promote healthy use of ICT tools**

## Extended Learning

Research modern chemists who have made new contributions to the field (Nobel Prize winners in Chemistry could be a start)

**RESOURCES**

Measuring cylinder, safety chart, pipette, burette, balance, thermometer, Bunsen burner

Internet, computer with presentation, moviemaking, sound recording software, multimedia projector, device for playing audio clips

**KEY VOCABULARY**

Chemistry, organic, inorganic, physical, apparatus, measuring, volume, mass, temperature

**LINKS TO OTHER SUBJECTS**

**Biology and Physics** (Application of Science)

NSC

# CHEMISTRY

## GRADE 9: **TERM 2**

### About the Unit

In this Unit, students will participate in various activities aimed at helping them understand how chemical formulae are written. They also learn how to write chemical equations through the use of innovative activities.

### Range of Content

- In an atom, the mass (nucleon) number is the sum of protons and neutrons while the atomic number is the number of protons.
- Electronic configuration describes the arrangement of electrons in energy levels (shells). There are a maximum number of electrons that each energy level can hold.
- Atoms bond to achieve stability. In ionic bonding atoms transfer electrons: one atom loses and the other gains electrons.
- The number of protons and electrons are equal in a neutral atom. Ions are formed when an atom loses (cations) or gains (anions) electrons.
- Ionic compounds are soluble in water, conduct electricity (in aqueous or molten state) and have high melting points.
- A chemical formula shows the composition of atoms (elements) in a substance (compound). By using the charges (valencies) of ions, the chemical formulae of ionic compounds can be determined.
- A chemical equation shows the reactants and products in a chemical reaction. When an equation is balanced, equal numbers of each atom (element) appear on both sides of the equation along with the respective state symbols.
- The main types of chemical reactions are oxidation, combustion, synthesis, decomposition and displacement. In exothermic reactions heat is given off and heat is absorbed from the surroundings in endothermic reactions.

### Guidance for the Teacher

- The Law of Conservation of mass/matter states that matter cannot be created or destroyed.
- In the activity relating to the Law of Conservation, avoid using chemical reagents that will react to produce a gas or gases. This is for two reasons, firstly, if students are working with sealed jars the pressure build-up from the gas can cause explosions and secondly, if the gas escapes the students' final reading could be affected.

## UNIT 1: Introduction to Chemistry

**Theme:** Science Exploration, Application and Design Practice
**Topic:** Formulae and Equations
**Duration:** 12.5 hours/5 weeks

### Prior Learning

Check that students can:

- State the first 20 elements of the Periodic Table and their symbols
- State that compounds are formed from the combination of two or more different atoms
- Know the difference between atoms and ions

**ATTAINMENT TARGET(S):**

- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**BENCHMARKS:**

- Understand and apply the law of conservation of mass.
- Understand how substances can be classified by their chemical nature and how this relates to the way they react.
- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**OBJECTIVES-Students will:**

- Recall the symbols of the first twenty elements
- Calculate the number of each sub-atomic particle present in an atom/ ion
- Deduce the pattern for determining electronic configuration of first 20 elements
- Use the Octet Rule to explain why atoms bond
- Draw dot and cross diagrams to represent ionic bonding
- Formulate working definitions for ions, cation, anion and ionic bonding
- Investigate physical properties of ionic compounds
- Write the formulae of simple binary compounds using symbols and valencies
- Translate word equations for simple chemical reactions into symbol equation.
- Investigate main types of reactions
- Cite examples of exothermic and endothermic reactions
- State and apply the Law of Mass conservation to writing balanced equations
- Investigate the Law of Conservation of Mass using precipitation reactions
- Construct balanced symbol and ionic equations from given information
- Use appropriate scientific language
- Make sure they are working safely

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>Read handout/textbooks (online/offline) on the atomic/proton number and mass number of an atom. Use the formula A = Z + N (where A – Mass number, Z – proton number and N – number of neutron) to calculate the number of sub-atomic particles in selected atoms. Use the idea of balancing charges to determine the number of electrons. Discuss and complete worksheet given. | Calculate, communicate, think critically – analyse, infer, draw conclusions | Sub-atomic particles correctly calculated<br>Logical inference made about number of electrons<br>Worksheet completed |
| **Play online interactive games on electron configuration and deduce the trend in adding electrons to an atom. Or** In groups, view completed electron shell diagrams of selected atoms and deduce the maximum number of electrons that can be added to each shell. Present deductions to the class.(Guide students to appreciate that the distribution of electrons in shells/energy level follows a pattern/rule). | Observe, communicate, collaborate,<br>think critically – analyse, infer, draw conclusions | Electron configuration trend correctly deduced<br>Logical conclusions made |
| View a diagram of an atom without any electrons (nucleus and shells only) and place electrons correctly in shells/energy levels. Complete electron shell diagrams for the first 20 elements. | Record, calculate, think critically - analyse | Electron shell diagrams for first 20 elements correctly done |
| Determine the electronic configuration of selected atoms. Place the element/ atom on the Periodic Table. Note the position and group number of the atom on the Periodic Table. Compare the number of outer shell electrons and the group number and determine the relationship between the two. Discuss with the class. | Calculate, classify, communicate,<br>think critically – analyse, infer, formulate | Element/ atom correctly placed<br>Accurate electronic configuration<br>Relationship between outer shell electrons and group number correctly deduced |
| In groups, students will compare the electron configuration of two metals, two non-metals and two noble gases (avoid the element H). Participate in a teacher- led discussion to infer that an octet of electrons (or duplet in Helium) implies stability. | Compare and contrast, communicate, collaborate, think critically – calculate, infer | Infer that stability is a function of the number of valence electrons in an atom. |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| In groups, discuss how they think given pairs of atoms may combine in order to attain stability and share their responses with class. Calculate the changes in the number of sub-atomic particles. Discuss what happens when the atoms gain or lose electrons. (The terms ions, cations, anions and ionic bonds should be introduced at this point). Formulate working definitions for ions, cations, anions and ionic bond. Complete worksheet to show the ions formed when selected atoms gain or lose electrons. Use dot and cross diagrams to show how atoms can combine in order to have a noble gas structure by transfer of electrons. | Collaborate, communicate, calculate, create, think critically – (analyse, infer, draw conclusions), define operationally, draw | Diagrams correctly drawn to show transfer of electrons<br>Changes in number of sub-atomic particles accurately calculated<br>Logical conclusions drawn<br>Working definitions are accurate<br>Worksheet is completed with accurate information |
| Perform experimental activities to investigate the physical properties of ionic compounds with regards to melting, electrical conductivity and solubility (in water).<br>1. In groups collect materials for setting up a simple electrical circuit and assemble according to instructional sheet information. Test the conductivity of table salt and record information. Explain your observation.<br>2. In groups, add a few grams of table salt to a test tube of water. Note and explain observations.<br>3. In groups, place a few grams of table salt in a combustion spoon. Place in the hottest part of the flame. Record and explain observations. | Observe, record, manipulate, communicate, collaborate, think critically – analyse, draw conclusions | Successfully set up circuit<br>Provide plausible explanations for their observations |
| In groups, select from a set of flash cards with the names of simple ionic compounds sodium chloride, calcium fluoride and magnesium oxide. Determine the ions (with charges) present in the compounds. Formulate the chemical formulae of these compounds by adding the integers (charges) to get zero, forming a neutral compound. Share their answers with the class and participate in discussion. Students will use the charges on the ions to assign the valency of the element. | Collaborate, think critically – (analyse, calculate, formulate, infer), communicate | Correct formula given<br>Correct valency given |
| In groups participate in teacher guided instructions on how to write the formula of simple binary compounds including the 'swap' method (which uses the valency or combination power). *Swap method should only be used to reinforce and not to teach the concept initially. (Teacher must guide students to the use of subscripts in formulae and that the overall charge on a compound is zero)* | Collaborate, think critically – analyse, formulate, communicate | Formulae correctly written with subscripts where necessary |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| In groups, view a chart/handout of common ions and engage in an activity to write the formulae of ionic compounds (using one-atom ions). Complete worksheet on formation of binary compounds | Collaborate, think critically– analyse, formulate, communicate | Correct formula on completed worksheet |
| In groups, select two cards one from each colour and complete the following chart for the compound formed between the two ions selected. (Cards are pre-organised into two different colours, one with positive ions and the other with negative ions). | Collaborate, think critically– analyse, formulate, | Table correctly completed, neatly drawn up |
| In groups, construct models of the substances for which the chemical formulae was determined previously and present to the class. | Collaborate, create, communicate, think critically - analyse, formulate | Model correctly represents the structure of the compound |
| In groups, given examples of common chemical reactions, students will make observations noting the reactants and products. Students will participate in teacher-led discussions to formulate word and symbol equations for the chosen reactions. | Make observations, communicate, collaborate, think critically – analyse, formulate | Accurate observations noted<br>Correct word and symbol equations |
| **Combustion Reaction**<br>View **online or** teacher demonstration of the reaction of burning magnesium in air or a pinhead portion of sodium metal in water and write the word equations for the reactions. (Concept of energy loss (heat) from exothermic reactions should be mentioned where applicable) | Make observations, collaborate, think critically– analyse, formulate, communicate | Accurate observations noted<br>Correct word and symbol equations |
| Participate in brief teacher-led discussion on how to represent chemical reactions with equations. Identify reagents, products and yield arrow in sample equations. Write chemical equation for the reaction. | | |

| Positive ion | # of electrons lost | Negative ion | # of electrons gained | Formula of compound | Name of compound |
|---|---|---|---|---|---|
| $Ca^{2+}$ | 2 | F- | 1 | $CaF_2$ | Calcium fluoride |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Oxidation**<br>View online or burn a piece of carbon over a Bunsen flame and write the word and symbol equations for this reaction. | Make observations, collaborate, think critically – analyse, formulate , communicate, manipulate | Accurate observations noted<br>Correct word and symbol equations |
| **Decomposition (thermal)**<br>View online or heat copper or calcium carbonate over a Bunsen flame. Test the gas produced.<br>Determine the reactants and products and formulate word and symbol equations. | Make observations, collaborate, think critically – analyse, formulate , communicate, manipulate | Accurate observations noted<br>Correct word and symbol equations |
| **Displacement**<br>View online or add a small quantity of zinc (granulated) to copper sulphate solution in a test tube. Shake and observe after a few minutes. Formulate word and symbol equations for the reaction. (*Any loss of energy as heat should be noted and used to highlight exothermic reactions*)<br>Or<br>Add 5 $cm^3$ of a soluble salt solution A (e.g. barium chloride) to a test tube containing a second soluble salt solution B (e.g. zinc sulphate). Record observations. Write word and symbol equations . *Activity can also be used to introduce writing of ionic equations.* | Make observations, collaborate, think critically – analyse, formulate , communicate, manipulate<br>Make observations, collaborate, think critically – analyse, formulate , communicate, manipulate | Accurate observations noted<br>Correct word and symbol equations<br>Accurate observations noted<br>Correct word and symbol equations |
| **Synthesis**<br>Recall the reaction of iron and sulphur heated to produce iron sulphide (Elements Mixtures and Compounds, Grade 8) or demonstrate the reaction again. Observe and formulate word and symbol equations.<br>***Concept of endothermic reactions (energy taken in from the surroundings resulting in reaction vessel becoming cold) can be introduced by dissolving a few grams of potassium nitrate or ammonium chloride in water.*** | Make observations, collaborate, think critically – analyse, formulate , communicate, manipulate | Accurate observations noted<br>Correct word and symbol equations |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| In groups carry out the following activity<br>1. Determine the mass of an empty measuring cylinder<br>2. Measure 10 $cm^3$ of soluble salt solution A (e.g. lead nitrate) and record the mass of the solution.<br>3. Measure 10 $cm^3$ of soluble salt solution B (e.g. potassium iodide) in a second measuring cylinder and record the mass.<br>4. Pour solution A into solution B. Observe and record the new mass.<br>5. Calculate the mass of reactants and products.<br>6. Write the equation for the reaction. | Make observations, collaborate, think critically – analyse, formulate , communicate, manipulate | Accurate observations noted<br>Correct word and symbol equations |
| Discuss what information can be had by taking the mass before and after the mixing and share ideas with the class. (Teacher leads students to conclude that mass before reaction is the same as mass after – Law of conservation of mass). Balance the equation for the reaction with teachers' assistance. | Think critically – analyse, formulate, infer, communicate, collaborate | Law of Conservation of Mass correctly stated<br>Balanced equation given |
| In groups, collect a set of index cards with information for a given chemical reaction and complete the following activity.<br>1. Use the set of index cards to replicate the chemical equation onto work desk.<br>2. Label the reactant side and the product side.<br>**Create an appropriately labelled table and record the following information:**<br>3. Identify the elements on the reactant side.<br>4. Count the number of atoms for each element.<br>5. Identify the elements on the product side.<br>6. Count the number of atoms for each element on the product side.<br>7. Are the 2 sides equal? If not, the equation is not balanced.<br>8. Insert the whole numbers (**coefficients**) before given chemical formulae. ***They can ONLY be placed in front of the elements. You cannot change the subscripts in any of the formulae.***<br>9. Choose an element that is not balanced and add numbers before the formulae until the number of atoms of the element are equal on both sides of the equation. | Collaborate, communicate, think critically – analyse, formulate, calculate | Balanced equation given |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| 10. Continue until you have worked through all the elements.<br>11. Once they are balanced, count the final number of Reactants and Products.<br>12. Write the balanced equation.<br>13. Can your equation be simplified?<br>14. Exchange their set of index cards with another group and repeat the activity | | |
| View video and engage in computer simulation/web quest on writing chemical formulae and balancing equations and complete the activities given. | Collaborate, communicate, think critically – analyse, formulate | Self-evaluate using computer program |

## Learning Outcomes

Students who demonstrate understanding can:

- ✔ Construct electron shell diagrams for the first 20 elements
- ✔ Show how ions are formed from loss or gain of electrons
- ✔ Use diagrams to represent ionic bonding
- ✔ Write the chemical formulae binary compounds using valencies
- ✔ Write word and chemical equations for simple reactions
- ✔ State the Law of Conservation of Mass
- ✔ Balance given chemical equations
- ✔ Work cooperatively in groups

## Points to Note

- ✔ The focus is on writing the formula binary compounds only. Compounds formed from polyatomic ions can be derived once formation of binary compounds is fully understood
- ✔ Teachers must use simple chemical equations such as reactions of metals with oxygen, acids; simple non-metals such as hydrogen and chlorine and oxygen.
- ✔ Preparation of index cards can be very tedious and hence students' assistance maybe secured in preparing cards well before time.

## Extended Learning

Derive the formula of compounds from polyatomic ions or radicals.

Research other reaction types; redox and neutralization reactions

- ✔ The concepts of endothermic and exothermic reactions are only being introduced for reactions where there is a noted change in temperature.
- ✔ Teacher may treat the concept of exothermic and endothermic reactions, for all reactions.

**RESOURCES**

Periodic Table, sets of colour coded cards with anions and cations, flashcards with formulae of ionic and covalent compounds, cards with different parts of chemical equations (coefficient, formula of reagents and products etc), handouts with rules for writing formula and balancing equations, beakers, magnesium ribbon, sodium metal, barium chloride, zinc sulphate or other reagents that will react to form precipitates, potassium nitrate, ammonium chloride, iron, sulpur, copper carbonate, calcium carbonate, carbon, zinc, copper sulphate

**KEY VOCABULARY**

Symbols, chemical formulae, valency, chemical equations, reactants, products, coefficient, ionic equation, Law of conservation of mass, balanced, word equation, ions, cations, anions, ionic bonding, electronic configuration, mass number, atomic number, combustion, oxidation, decomposition, displacement

**LINKS TO OTHER SUBJECTS**

**Mathematics** (Equations)

**Physics** (Conservation of Energy)

NSC

# CHEMISTRY

## GRADE 9: **TERM 3**

### About the Unit

In this Unit, students will engage in activities to classify substances in their environment as acids and alkalis using different indicators and the pH scale. They will investigate reactions of acids and alkalis and represent these in balanced equations. Students will also investigate salts; their classification and preparation and note examples of neutralization reactions in daily life.

### Range of Content

- Acids have a sour taste and turn blue litmus red.
- Alkalis are soluble bases, have a soapy feel and turn red litmus blue.
- During neutralization reactions, acids and bases completely react to form neutral solutions.
- Indicators (e.g. litmus and universal indicator) are substances which change colour in acids and alkalis.
- The pH scale measures the acidity and alkalinity of a substance and runs from 0 to 14 - with acids less than 7, alkalis greater than 7 and neutral solutions at 7.
- Acids react with bases, metals and carbonates to produce salts. Bases react with ammonium salts to produce ammonia, an alkaline gas.
- Gases produced during acid reactions include hydrogen (which burns with a 'pop') and carbon dioxide (which turns lime water cloudy)
- Salts can be classified as soluble or insoluble. Insoluble salts can be prepared by precipitation – mixing two soluble salts.
- Neutralization reactions in daily life include using bicarbonate of soda toothpaste, antacids and baking power in cake making.

### Guidance for the Teacher

- Proper laboratory safety procedures should be stressed at all times.
- The tasting of all chemicals is prohibited, especially some household chemicals which can be corrosive.
- The unit should be used to reinforce concepts of writing and balancing equations for all reactions of acids and bases that are demonstrated.

## UNIT 1: Nature of Substances

**Theme:** Energy, Forces and Matter

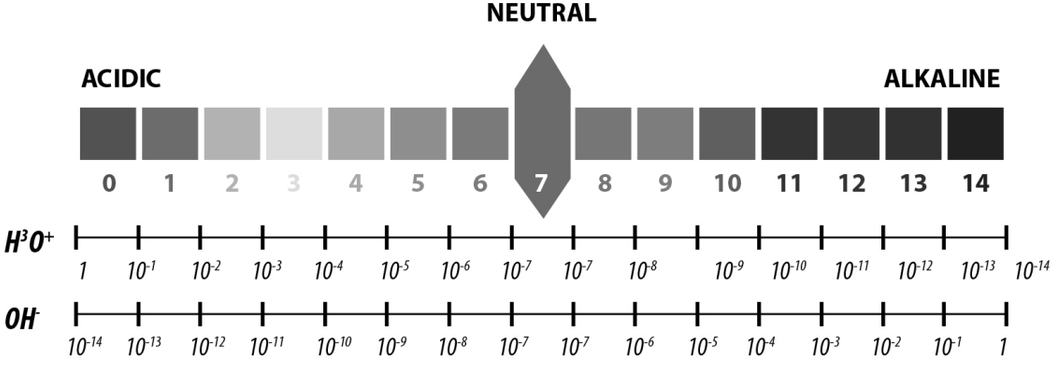
**Topic:** Acids and Alkalis

**Duration:** 7.5 hours/3 weeks

### Prior Learning

Check that students can:

- Classify materials based on identified properties




**ATTAINMENT TARGET(S):**

- Apply scientific knowledge and processes to the solution of real world problems.
- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**OBJECTIVES-Students will:**

- State that compounds can be classified as acids and alkalis
- Identify common acids, alkalis and salts
- Interpret the pH scale
- Use pH paper and universal indicator solutions to determine pH of different substances
- Show that acid-base indicators change colour in acids and alkalis.
- Analyze and synthesize information from multiple sources
- Synthesize homemade indicators using materials found in the kitchen and garden
- Investigate household chemicals using acid-base indicators
- Create individual pH scale from household substances`
- Investigate selected reactions of acids and alkalis
- Create a safety booklet dealing with the handling of acids and alkali.
- Distinguish between soluble and insoluble salts
- Prepare an insoluble salt
- Cite practical examples of neutralization in daily life
- Base conclusions and suggestions on evidence
- Show interest in the outcomes of experiments and investigations

**BENCHMARKS:**

- Be aware of the types of currents and understand the effects of resistance and voltage on current flow.
- Recognise the connection between electricity and magnetism.
- Be familiar with the nature of electricity and understand the different types of electrical circuits..
- Understand and apply the law of conservation of mass.
- Understand how substances can be classified by their chemical nature and how this relates to the way they react.
- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations..
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**ICT ATTAINMENT TARGETS:**

COMMUNICATION AND COLLABORATION - Students use technology to communicate ideas and information, and work collaboratively to support individual needs and contribute to the learning of others.

RESEARCH, CRITICAL THINKING, PROBLEM-SOLVING AND DECISION MAKING - use appropriate digital tools and resources to plan and conduct research, aid critical thinking, manage projects, solve problems, and make informed decisions.

DESIGNING AND PRODUCING - use digital tools to design and develop creative products to demonstrate their learning and understanding of basic technology operations.

DIGITAL CITIZENSHIP - Recognise the human, ethical, social, cultural and legal issues and implications surrounding the use of technology and practice online safety and ethical behaviour.

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>In groups, use KWL chart to say what they know and what they want to know about acids and alkalis. Participate in teacher led discussion and complete the KWL chart. (Teacher must clarify any misconceptions about acids e.g. all acids are dangerous substances that must be avoided). Discuss the physical properties of acids and alkalis (e.g. acids have sour taste, alkalis have soapy feel etc.). (Teacher could take the opportunity to define alkalis as soluble bases). Produce a presentation or class wiki/poster on the physical properties of acids and alkalis. | Communicate,<br>think critically- analyze,<br>collaborate, create | Correctly completed chart<br>Creative presentation contains accurate information on acids and alkalis |
| In groups, bring labels and samples of substances from the home that they think are acids and alkalis. Sort the samples as acids and alkalis based on the physical properties and the information presented on the labels. Report on their findings (using simple scientific language, drawings, labelled diagrams, bar charts or tables). Discuss the need for a more scientific method of determining acidity and alkalinity such as the pH scale and acid-base indicators. Students are guided to interpret the pH scale and use it to determine the pH of the household substances. Say what they think the function of an acid-base indicator is. Tabulate the results and make comparisons with initial classification made to draw simple conclusions. | Make observations, communicate, think critically – analyse, interpret, draw conclusions, collaborate, classify | Data presentation contains accurate information<br>Substances correctly sorted<br>Accurate observations noted<br>Comparison of initial classification and pH readings tabulated<br>Function of acid-base indicator formulated |
| In groups, use universal indicator (pH paper and solution) to determine the pH of different household substances. Construct individual pH scales based on the pH of the household chemicals measured (write the name of the chemicals instead of the numbers on the scale). Represent findings on an enlarged diagram of the pH scale posted on whiteboard or any suitable display surface. | Collaborate, think critically - analyse, draw conclusions, create, manipulate, communicate, make observations | Accurate pH and colour changes noted<br>pH scale displayed and labelled appropriately |
| In groups, perform a lab activity to determine the colour changes of litmus paper and methyl orange in different acid and alkali solutions and record their observations in a variety of ways (teacher provide instructions) Add their results to class data table for display. | Collaborate, think critically - analyse, manipulate, make observations, communicate | Accurate observations noted<br>Data suitably displayed |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| In groups, conduct research on homemade acid-base indicators. Plan and design a method of preparing an acid-base indicator from materials of their choice. Carry out procedures outlined for the preparation of the indicator. Use it on common household substances to sort them as acids and alkalis based on the colour changes observed. Use their results to suggest improvements and predictions for setting up further tests. | Manipulate, collaborate, think critically - analyze, classify, predict, infer, create, plan and design, communicate, make observations | Scientific method used<br>Hypothesis clearly stated and testable<br>Consideration for safety included<br>Acid-base indicator is functional<br>Substances correctly sorted using homemade indicator |
| In groups, investigate the properties of acids using simple test tube reactions of acids and metals (e.g. magnesium), alkalis (e.g. sodium hydroxide), bases (e.g. copper II oxide) and carbonates (e.g. calcium carbonate) and litmus. Test the gases (hydrogen and carbon dioxide) produced. Use the term neutralization to describe simple acid/base reactions. (Link – show that neutralization reactions are exothermic in nature). Write word and symbol equations for all reactions. | Collaborate, manipulate, think critically - analyse, make inferences, formulate, communicate, make observations | Accurate observations noted<br>Balanced equations given<br>Neutralization reactions identified |
| In groups, conduct research on the application of neutralization reactions to everyday life (e.g. indigestion tablets, treatment of bee and wasp stings). Perform laboratory investigations of common neutralization reactions in the home (e.g. reacting baking powder and lemon juice). Report findings (using simple scientific language, drawings, labelled diagrams, bar charts or tables). | Collaborate, communicate, investigate, manipulate, think critically - analyse, infer, draw conclusions, make observations | Accurate observations noted<br>Neutralization reactions identified<br>Suitable data presentation |
| In groups, investigate the properties of alkalis using test tube reactions of alkalis with acids, ammonium salts (e.g. ammonium chloride), and litmus. Test the ammonia gas produced with damp red litmus. (Students guided to identify ammonia as the only alkaline gas). Write word and symbol equations for all reactions. | Collaborate, manipulate, make observations, communicate, think critically - analyse, infer, draw conclusions, formulate | Accurate observations noted<br>Balanced equations given<br>Presence of ammonia linked to observations |
| In groups, view video and engage in computer simulation and web quest on acids and alkalis and their everyday uses. Complete the activities assigned. | Collaborate, think critically - analyse, communicate, | Completed Web Quest contains accurate information |
| In groups, conduct online/offline research and develop a safety booklet (electronic/non-electronic) on the correct ways of handling acids and alkalis. | Research, collaborate, create, think critically - analyse, draw conclusions, communicate | Safety booklet is creative and contains accurate information |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| In groups, investigate the solubility of salts. Be given samples of different salts such as sodium chloride, potassium nitrate, calcium sulphate, calcium carbonate) to test their solubility in water. Tabulate results grouping them as either soluble or insoluble. | Observe, manipulate, record, classify, collaborate, think critically - infer | Correct observations noted<br>Salts correctly classified<br>Table contains accurate information |
| In groups, make samples of insoluble salts (e.g. lead iodide) by combining solutions of two soluble salts (e.g. lead nitrate and potassium iodide). Record observations. Filter the precipitate formed then dry and collect the salt. Submit for grading. Write word, symbol and ionic equations of the precipitation reactions. | Create, collaborate, observe, record, manipulate, think critically – analyse, formulate | Correct observations noted<br>Dry sample of salt obtained<br>Balanced equations given |
| In groups, conduct research on the uses of salts in their everyday life, (include common names, chemical name and formula). Make presentations of findings in the form of a project. | Gather data, report, communicate, collaborate | Presentation is creative and contains accurate information |

## Learning Outcomes

Students will be able to:

- Classify substances as acids and alkalis
- Cite evidence to determine acidity or alkalinity of a substance
- Research for specific pieces of information
- Create homemade acid-base indicators
- Conduct investigations on acids and alkalis
- Work cooperatively in groups
- Navigate and manipulate digital content on websites and storage devices
- Use word processing and presentation software to collaborate and communicate information
- Collaborate and communicate by posting ideas/comments to, and responding to peers' posts in class wiki and blogs

## Points to Note

1. Teacher should warn students against tasting anything that is being investigated
2. Teacher can make this a competition in which the winning chart can be selected for display

## Extended Learning

Research how soil pH affects its ability to support plant growth and the use of substances (e.g. Lime) to counteract soil acidity

Plan and design an experiment to determine the pH of a sample of soil collected from either school or home garden.

Research different types of acids

## Points to Note

3. Navigate digital content on websites and storage devices, e.g., CDs, DVDs, etc (Examples of digital content, games, quizzes, simulation exercises, story, encyclopedias, etc)
4. Demonstrate safe, respectful, responsible and clear online communication when using class wiki and blog sites.
5. Participate in online discussions using resources designed for student collaboration and knowledge building

**RESOURCES**

Solutions of acids and alkalis, pH paper, red and blue litmus paper, universal indicator, magnesium, copper oxide, sodium hydroxide, ammonium chloride, aqueous ammonia, various household chemicals to include salts such as lead nitrate, potassium iodide, potassium nitrate, calcium sulphate, calcium carbonate, NaCl, Na2CO3, ammonia (cleaning solutions), bleach, vinegar, citrus fruits (juices) etc.

**Computer, Speakers, Internet, Multimedia projector, video CDs/DVDs, Class wiki site, Class blog site(s)**

**KEY VOCABULARY**

Acid, alkali, indicator, pH, neutralization, carbon dioxide, hydrogen, ammonia, pH scale, base, salt, soluble, insoluble, precipitation

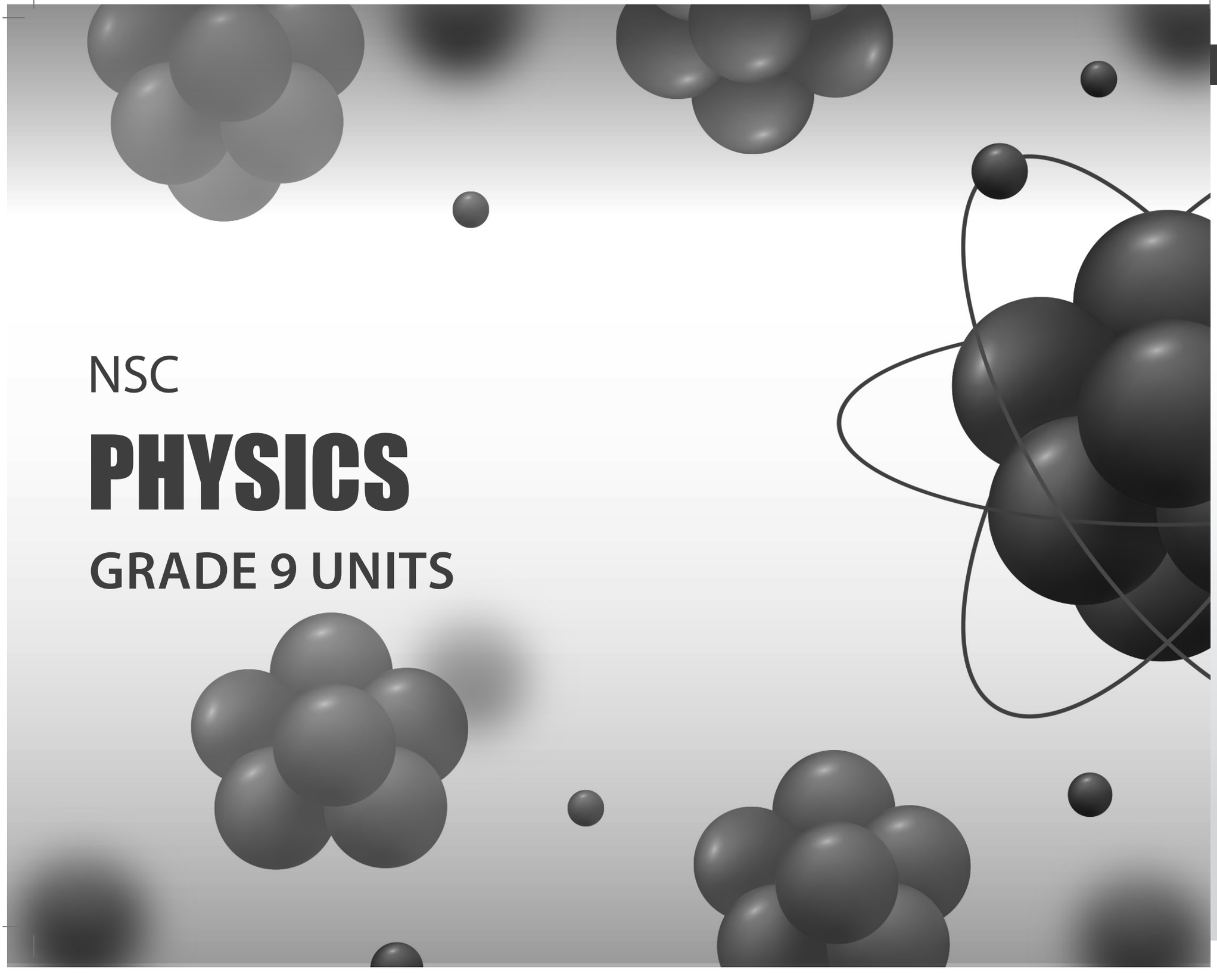
**LINKS TO OTHER SUBJECTS**

**Grade 7 Science** – Matter, Elements, Mixtures & Compounds**, Grade 9** – Formulae & Equations

NSC

# PHYSICS

## GRADE 9 UNITS



## TERM 1

**Unit 1 (Optional)**

**Working Like a Scientist 3**

Developing hypotheses
Planning & designing fair tests
Fundamental quantities and units
Derived units
Plotting graphs
Calculating gradients from graphs
Interpreting distance & velocity-time graphs
Determining significant figures
Writing numbers in standard format

**Unit 2**

**Measuring Length Derived Quantities**

Defining area and volume
Calculating area of regular and composite shapes
Determining area using the Grid Method
Calculating volume of regular shaped objects
Determining volume using the Displacement Method
Justifying the method used to calculate volume

## TERM 2

**Unit 1**

**Electricity and Magnetism**

Investigating static electricity
Applications and hazards of static electricity
Defining electric current
Classifying materials as conductors & insulators
Constructing simple circuits
Representing series and parallel circuits using diagrams
Preventing electrical hazards
Safety devices
Identify poles of a bar magnet
Demonstrating behaviour of like and unlike poles
Investigating relationship between voltage and current in simple series circuit
Constructing an electromagnet
Investigating properties of an induced current

## TERM 3

**Unit 1**

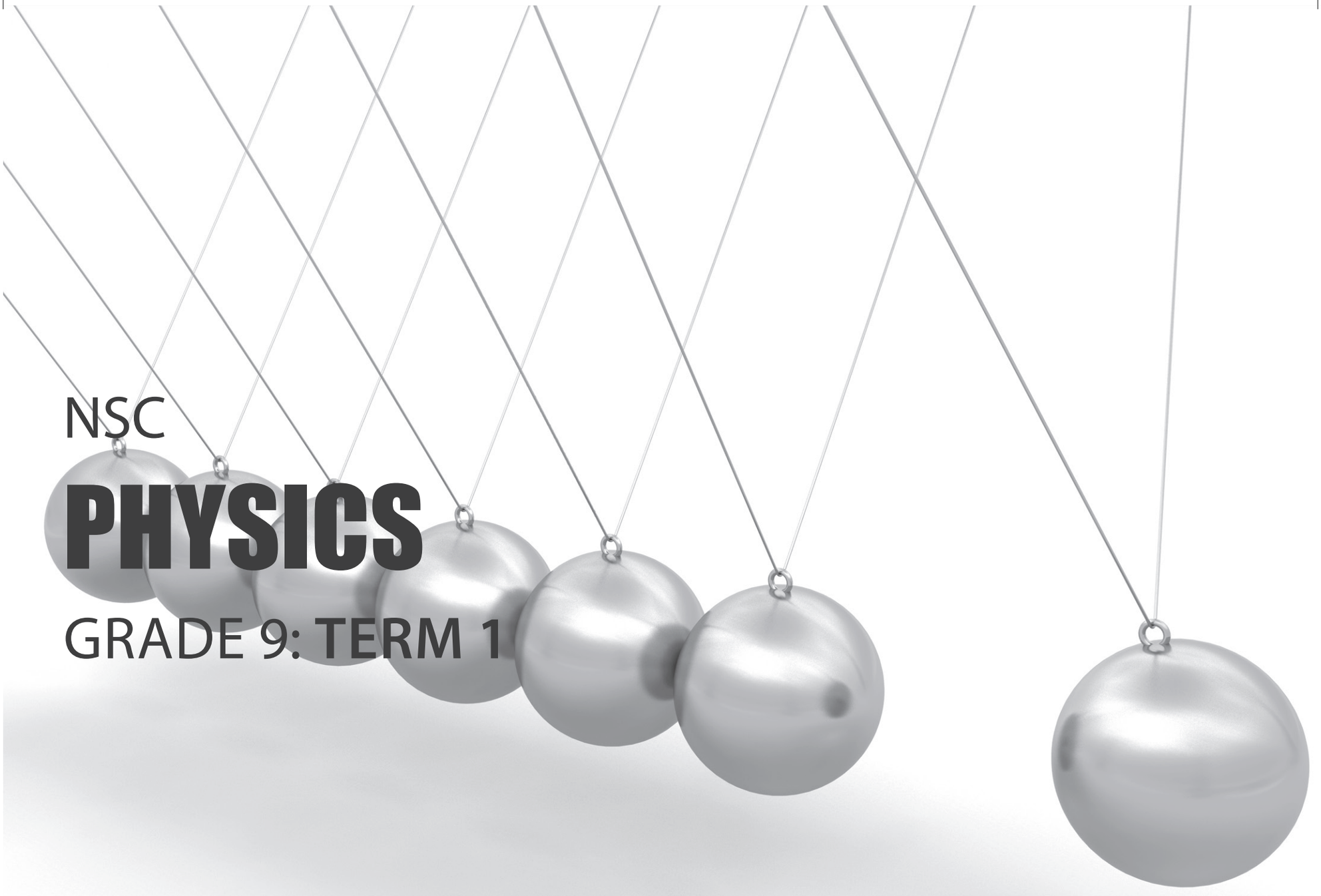
**Thermal Physics**

Defining temperature
Relating thermal energy flow and temperature
Investigating effect of temperature on physical properties
Comparing conduction, convection and radiation
Investigating the absorption and emission of thermal energy
Researching thermal energy transfer in selected devices
Constructing devices using principles of thermal energy transfer

NSC

# PHYSICS

## GRADE 9: TERM 1



### About the Unit

In this Unit, students will explore the various methods used to determine the area and volume of various surface areas and objects. They will assess particular situations to determine which method is most suitable to ascertain area and/or volume.

### Range of Content

- The area of a shape is a measure of the two dimensional space that it covers. Area is measured in square units, e.g. square metres ($m^2$).
- The area of regular shaped objects may be calculated using relevant formulae, e.g. the area of a rectangle = length x width. The area of an irregular shape, which is a composite of two or more regular shapes, may be found by dividing the composite shape into constituent regular shapes, finding the area of each and then combining them for the total area of the irregular shape.
- The area of irregular shapes can be estimated by tracing the shapes on a graph paper and then count the number of squares covered by the shapes.
- Volume refers to the amount of space that a substance or object occupies. Volume is measured in cubic units, e.g. cubic metres ($m^3$).
- The volume of regular shaped objects may be calculated using relevant formulae, e.g. the volume of a rectangular block = length x width x height.
- The volume of an irregular shaped solid may be determined by a displacement method..

### Guidance for the Teacher

It may be useful to revise perimeter to form the foundation for area and volume. Area should be looked at first as it forms the foundation for volume.

Pay close attention to the units.

## UNIT 1: Measuring Length Derived Quantities

**Theme:** Science Exploration, Application and Design Practice
**Topic:** Area and Volume
**Duration:** 7.5 hours/3 weeks

### Prior Learning

Check that students can:

- Differentiate between area and volume

**ATTAINMENT TARGET(S):**

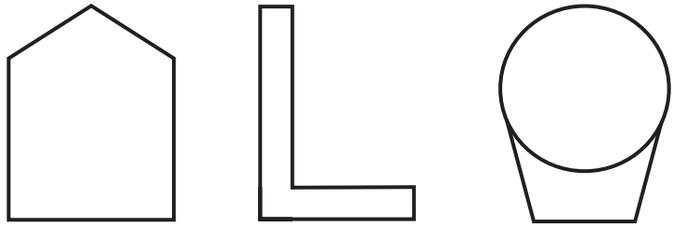
- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**BENCHMARKS:**

- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate care and concern for living things and the environment.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**OBJECTIVES-Students will:**

- Formulate a simple working definition for the term area
- Formulate a simple working definition for the term volume
- Use appropriate units for area and volume
- Calculate the area of regular shapes
- Estimate the area of irregular shapes
- Calculate the volume of regular shaped objects
- Determine the volume of irregular shaped objects
- Justify selection of methods used to determine area and volume in particular situations
- Work cooperatively in groups

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>In groups, given similar shapes of different sizes (see examples below), select the shape with the greatest area in each case, giving reasons for choices. Suggest a definition for area. Share selections, reasons and definitions with the class. (*Teacher should use class discussion to establish accepted definition for area.*)<br>  | Work in groups, infer, define operationally, communicate | Correct selections of greatest area.<br>Logical reasons given for selections. |
| Be given diagrams of composite shapes (such as below). Identify all the individual shapes that it is comprised of. Make appropriate measurements to determine the area of each shape identified. Determine the area of the composite shape.<br>  <br>For any of the composite shapes, determine the area by carrying out the following steps:<br>1. Cut out the shape<br>2. Place the shape on a grid (graph sheet) and draw its outline<br>3. Count the number of boxes/squares covered by the outline; only boxes that are at least half covered should be counted<br>4. Multiply the number of boxes by the area of one box<br>Compare the area obtained by the grid method with the calculated area. | Analyse, manipulate, calculate, compare | All shapes identified.<br>Appropriate and correct measurements made.<br>Area calculated correctly for shapes, and correct units given.<br>Steps correctly carried out. |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| In groups, be given at least two differently shaped leaves (or any flat irregular shaped object) and asked to determine the surface area of one side of the object. Present their results to the class and justify the method they used.. | Think critically, collaborate, communicate, measure | Appropriate method used to determine area.<br>Feasible reasons given for the choice of method used. |
| Half fill a container with water. Submerge a solid object into water and record observations. Repeat the procedure at least two times using a larger object on each occasion. Explain observations and share with class. Suggest a definition for volume. (*Teacher should use class discussion to establish accepted definition for volume.*) | Measure, record, investigate, infer, communicate, define operationally, observe | Correct procedures used in reading volume.<br>Correct reading of scale. |
| In groups, provided various solids (e.g. cube, rectangular block, sphere, cylinder), make appropriate measurements to determine the volume of each. For any of the objects, determine the volume by carrying out the following steps:<br>1. Half fill a measuring cylinder and note the volume ($V_1$)<br>2. Tie a string around the object and gently lower it into the water<br>3. Record the new volume ($V_2$)<br>3. Calculate the change in volume of the contents of the measuring cylinder ($V_2 - V_1$)<br>Compare the volume obtained by the displacement method with the calculated volume. | Analyse, manipulate, calculate, compare, record, infer, investigate, measure | Steps correctly carried out.<br>Correct procedures used in reading volume.<br>Correct reading of scale.<br>Correct method for determining volume of irregular object chosen. |
| Provided an irregular shaped object, select which method would be most appropriate for determining the volume, displacement or calculation method. Justify selection made with class. | | Logical justification offered for selection. |

## Learning Outcomes

Students who demonstrate understanding can:

- ✔ Explain the meanings of the terms 'area' and 'volume'
- ✔ Use appropriate methods to determine area and volume
- ✔ Apply methods of determining area and volume to everyday situations.

| Points to Note | Extended Learning |
|---|---|
| As an alternative to using the measuring cylinder for displacement activities, *the displacement/eureka can* may be used. | In groups, make appropriate measurements to calculate the area of a floor in the school (classroom/auditorium/library etc.) and determine the number of tiles of a specific dimension required to cover the area. |

**RESOURCES**

Sheet containing similar shapes of different sizes, diagrams of various composite shapes, rulers, measuring cylinder, scissors, graph paper, various regular and irregular shaped objects

**KEY VOCABULARY**

Area, volume, displacement method, regular shape, irregular shape, composite

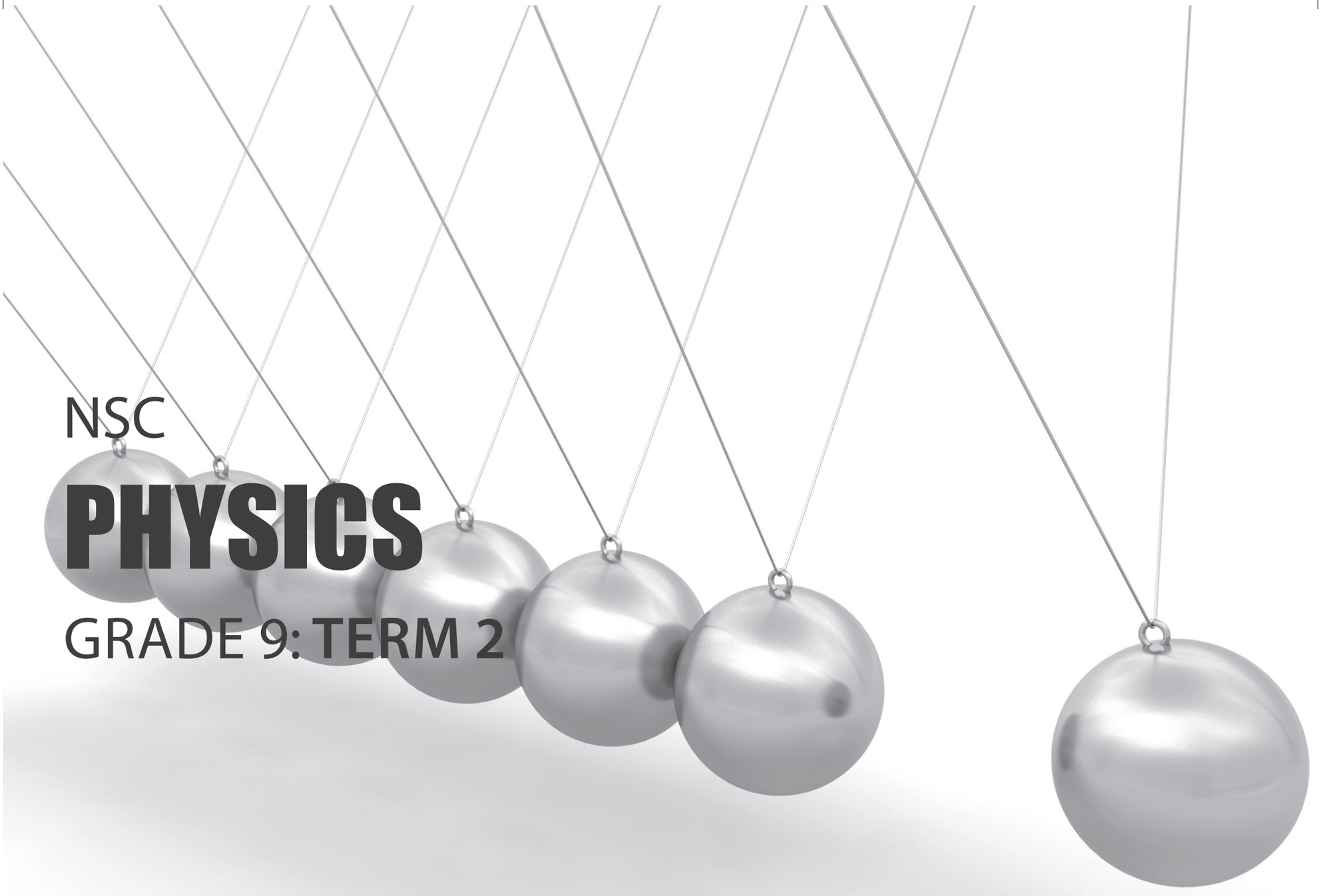
**LINKS TO OTHER SUBJECTS**

**Mathematics** – measurement, numbers

NSC

# PHYSICS

## GRADE 9: TERM 2



## About the Unit

In this Unit, students will develop an understanding of static electricity, and the mechanism by which it is produced, through hands-on investigations. They will explore useful applications as well as dangers associated with static electricity. They will learn to construct and diagrammatically represent electric circuits. They will explore series and parallel circuits through inquiry based learning.

Students will become familiar with the properties of magnets through simple investigations, and explore the relationship between electricity and magnetism. Additionally they will investigate the relationship between voltage and current in a simple series circuit, and represent this relationship graphically.

## Range of Content

- Objects can be positively charged, negatively charged or neutral (no charge).
- Matter is composed of atoms, and atoms consist of electrons (which are negatively charged), protons (which are positively charged), and neutrons (which are neutral). In their most stable state, atoms have equal numbers of electrons and protons and are therefore electrically neutral.
- Static electricity exists when there is a build-up of one type of charge on an object; i.e. there is an imbalance of positive and negative charge. A substance that gains electrons becomes negatively charged, while a substance that loses electrons becomes positively charged.
- One way of charging insulators electrostatically is by rubbing (friction). When some materials are rubbed, electrons are transferred causing a charge imbalance in both the material doing the rubbing and the material being rubbed.
- Static electricity can be very dangerous. For example, it can cause lightning, it can ignite the flammable gases thus causing explosions, and it cause electric shock to living organisms.
- Static electricity can also be very useful. For example, it is used in photocopiers and laser printers, in defibrillator machines, in electrostatic dust precipitators, in spray painting and insecticide sprays.
- An electric current is the flow of electric charge.
- Conductors are materials, e.g. metals, in which an electric current can flow freely. Insulators are materials, e.g. wood, that restrict the flow of an electric current.
- An electric circuit is a closed loop through which an electric current can continuously move. A simple circuit has conductors and a power source, however, other components such as a switch, a load (e.g. light bulb) are usually included. Circuit diagrams, or schematics, are line drawings that show how a circuit's components are connected together.
- There are two types of circuits: series and parallel. A series circuit is one that has only one path through which the electricity flows. In a parallel circuit there are more than two or more paths for electricity to travel.
- A magnet is any object that attracts iron, substances containing iron (e.g. steel), and some other metals such as nickel and cobalt.
- Magnets have north poles and south poles, which attract each other. However, two north poles will repel each other, as will two south poles. The poles of a magnet may be determined by suspending it or by using a plotting compass.
- Voltage is an electric force that causes an electric current to move around a circuit. When current flows through a conductor it creates heat because of resistance. Resistance measures how well a material or object conducts electricity. Low resistance means that an object conducts electricity well; high resistance means that an object does not conduct electricity well.
- If the voltage in a circuit is increased, then the current will increase. However, if the resistance is increased, then the current will decrease.
- When an electric current flows in a wire, it creates a magnetic field around the wire. This can be used to create an electromagnet. If the wire is wound into coils,

the electromagnet is stronger; the more turns on the coil, the stronger the electromagnet.

- An electric current is produced (induced) when a magnet is moved into a coil of wire in a circuit. The direction of the induced current is reversed when the magnet is moved out of the coil. The direction of the current will also be reversed if the other pole of the magnet is moved into the coil.

## Guidance for the Teacher

Ensure that proper safety practices are followed in the use of electrical equipment and operation of electrical circuits.

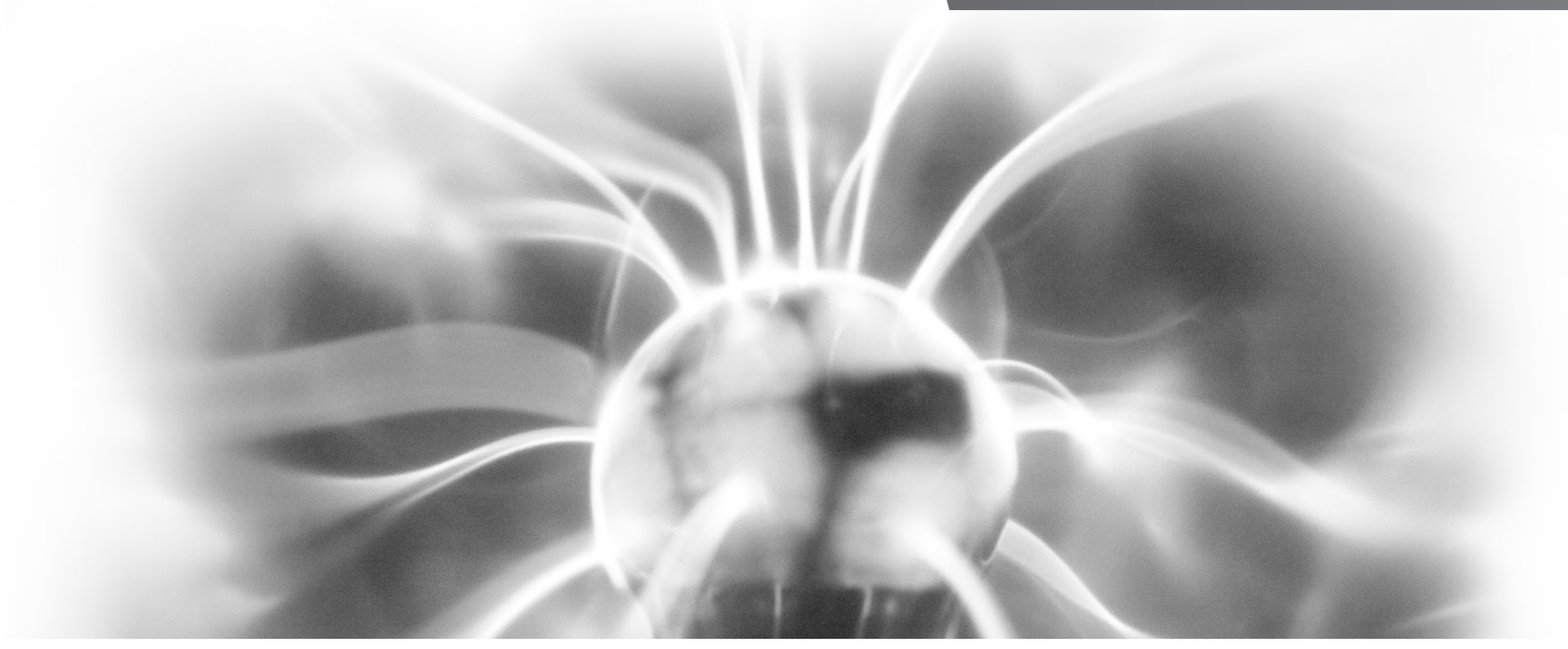
## UNIT 1: Electricity and Magnetism

**Theme:** Energy, Forces and Matter
**Topic:** Static Electricity
**Duration:** 5 Hours/2 weeks

### Prior Learning

Check that students:

- Can identify electricity as a form of energy
- Know that attractive and repulsive forces occur between magnets



**ATTAINMENT TARGET(S):**

- Understand natural laws as they apply to motion, forces, and energy transformations.
- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**OBJECTIVES**

**Students will:**

- Recall that atoms contain protons, neutrons and electrons and state their respective charges
- Investigate the production of static electricity
- Describe useful applications and hazards of static electricity
- Conduct investigations with due regard for safety
- Work cooperatively in groups

**BENCHMARKS:**

- Be familiar with the nature of electricity and understand the different types of electrical circuits.
- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**ICT ATTAINMENT TARGETS:**

COMMUNICATION AND COLLABORATION - Use technology to communicate ideas and information, and work collaboratively to support individual needs and contribution to the learning of others.

RESEARCH, CRITICAL THINKING, PROBLEM-SOLVING AND DECISION MAKING - use appropriate digital tools and resources to plan and conduct research, aid critical thinking, manage projects, solve problems, and make informed decisions.

DESIGNING AND PRODUCING - use digital tools to design and develop creative products to demonstrate their learning and understanding of basic technology operations.

DIGITAL CITIZENSHIP - Recognise the human, ethical, social, cultural and legal issues and implications surrounding the use of technology and practice online safety and ethical behaviour.

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>Review the sub atomic particles and their respective charges (Protons – positive, and electrons – negative and neutrons – no charge). | Communicate | |
| Carry out simple static electricity activities:<br>1. Tear off several small bits of paper and place them on a table/ desk. Vigorously rub a dry plastic object (e.g. a pen, comb) with a dry piece of cloth/tissue paper/in hair, and then bring the plastic object near to the paper bits. Observe and record what happens. Discuss and suggest reasons for observations. Share explanations with class. | Communicate, observe, manipulate materals, record, investigate, think critically | Accurate record of observations.<br>Suggestions logical and make reference to charges. |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| 2. Turn on the water so it is flowing from the tap in a narrow stream (just a few millimetres across but not droplets). Rub a plastic comb/balloon back and forth in their hair several times. Slowly move the comb or balloon towards the stream of water (without touching it) while watching closely to see what happens. Record and suggest reasons for observations. Share explanations with class. | Communicate, observe, manipulate materals, record, investigate, think critically | Accurate record of observations.<br>Suggestions logical and make reference to charges. |
| 3. Blow up a balloon and tie it off. Rub it several times across their hair and then press it against a wall. Record what happens. Leave the balloon in place for a while. Record how long it stays when left undisturbed. Suggest reasons for observations and share explanations with class. | Communicate, observe, manipulate materals, record, investigate, think critically | Accurate record of observations.<br>Suggestions logical and make reference to charges. |
| After teacher guided class discussion, explain with the aid of diagrams **using multimedia presentations tool**, the charging of materials by rubbing, in terms of the transfer of charges. | Communicate, draw diagrams<br>**Create and use multimedia to present information** | Diagrams meet criteria: neat, no shading, labels on one side.<br>Diagrams and annotations accurately depict process of charging by friction. |
| Research/ **navigate digital content on websites and storage devices** and report on:<br>1. some useful applications of static electricity;<br>2. Some possible hazards of static electricity. | Research, report, record, interpret<br>**Navigate and manipulate digital content** | Report reflects accurate knowledge of hazards and uses that can be applied |
| Research lightning and ways of reducing the dangers of lightning strikes. Create a poster/**digital story** etc. giving tips on safety practices that reduce the possibility of being struck by lightning. | Research, communicate<br>**Create and present digital content** | |

## Learning Outcomes

Students who demonstrate understanding can:

- ✔ produce static electricity through charging by friction
- ✔ explain how a body becomes electrostatically charged
- ✔ cite evidence of the usefulness and dangers of static electricity
- ✔ **Plan and conduct research, using a wide variety of electronic sources e.g. Internet and storage devices e.g., CDs, DVDs, etc.**
- ✔ **Create multimedia presentations**

## Points to Note

Static electricity should be explained in terms of stationary charges
useful application include: photocopier, dust extraction, painting car, crop spraying
possible hazard include: lightning,

**Create multimedia presentations which incorporate text, audio, images, videos and links to external resources to represent learning and original work**

**Follow guidelines to promote healthy use of ICT tools**

## Extended Learning

Research animals that generate static electricity (e.g. Electric Eel, Electric Ray).

**RESOURCES**

Plastic object, tissue paper, balloon, comb,
computer, speakers, Internet, multimedia projector, video CDs/DVDs, multimedia and graphic software tools

**KEY VOCABULARY**

static electricity, charge

**LINKS TO OTHER SUBJECTS**

**Technical and Vocational Education**

## UNIT TITLE: Electricity and Magnetism

**Theme:** Energy, Forces and Matter
**Topic:** Current Electricity
**Duration:** 5 Hours/2 weeks

**ATTAINMENT TARGET(S):**

- Understand natural laws as they apply to motion, forces, and energy transformations.
- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**BENCHMARKS:**

- Be aware of the types of currents and understand the effects of resistance and voltage on current flow.
- Recognise the connection between electricity and magnetism.
- Be familiar with the nature of electricity and understand the different types of electrical circuits.
- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**OBJECTIVES**
**Students will:**

- Formulate a simple working definition for the term 'electric current'
- Classify materials/substances as insulators and conductors of electricity
- Construct simple circuits using lamps, insulated wires, dry cells, switches to distinguish between series and parallel circuit
- Draw diagrams to represent series and parallel circuit
- Conduct investigations with due regard for safety
- Work cooperatively in groups

**ICT ATTAINMENT TARGETS:**

COMMUNICATION AND COLLABORATION - Use technology to communicate ideas and information, and work collaboratively to support individual needs and contribution to the learning of others.

RESEARCH, CRITICAL THINKING, PROBLEM-SOLVING AND DECISION MAKING - use appropriate digital tools and resources to plan and conduct research, aid critical thinking, manage projects, solve problems, and make informed decisions.

DESIGNING AND PRODUCING - use digital tools to design and develop creative products to demonstrate their learning and understanding of basic technology operations.

DIGITAL CITIZENSHIP - Recognise the human, ethical, social, cultural and legal issues and implications surrounding the use of technology and practice online safety and ethical behaviour.

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>In a teacher-led class discussion, review the phenomenon of lightning (Teacher should emphasize that a lightning strike is the movement of electric charges). With the aid of the teacher, derive a definition for an electric current (the movement of charges). | Communicate, operationally define, collaborate | |
| In groups, given each a box containing a D-cell battery, two 12-cm insulated wires, and a bulb, explore how the bulb can be made to light. Draw the setup used in their science notebook/journal. Share setup with class by drawing it on the board.<br>Participate in teacher-led discussion to deduce the reason for the lamp lighting. Create a definition for the term circuit and discuss the connection between current and circuit. | Manipulate, think critically, investigate, draw diagrams, collaborate, communicate | The bulb is made to light.<br>Students worked cooperatively. |
| Brainstorm to identify switches as a means of controlling the flow of current in a circuit. Observe as teacher demonstrates how a switch is attached in a circuit. In groups, create simple circuits with switches. Demonstrate to class how the switch works in the circuit **and/or watch and manipulate online/offline interactive video tutorials on switches and circuits**. In groups, identify various devices/situations in which switches are involved in circuits. In class discussion identify/describe the use of switches in everyday electronic equipment. | Observe, manipulate, investigate, collaborate, communicate<br>**Navigate and manipulate digital content** | Switch correctly attached in circuit.<br>Switches used in everyday electronic devices correctly identified/described. |
| In groups, investigate which material (paper, foil, cloth, aluminium, plastic, glass, water, salt water, etc.) will allow a lamp to light when used to complete a circuit. Observe and record result of the investigation in a variety of ways. Present findings to class using a multimedia presentation. Participate in teacher led discussion to deduce that some materials allow electric current to flow while others do not (here, teacher should introduce the terms conductors and insulators as relating to electrical conductivity) and/or watch and manipulate online/offline interactive video tutorials on electrical conductors and insulators | Investigate, manipulate, observe, record, think critically, classify, draw diagrams, collaborate, communicate<br>Create multimedia presentation<br>Conduct electronic search | Materials correctly classified as conductors and insulators |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| Be given a D-cell battery, four 12-cm insulated wires, and two bulbs, explore different ways in which both bulbs can be made light and draw the arrangements, using digital drawing tool. Identify the arrangement in which one lamp will not light when the other is removed. Identify the arrangement in which one lamp will remain lit when the other is removed. In groups discuss and outline the physical differences between circuits, record and share with class . (*Here, teacher should introduce the terms series circuit – single pathway, and parallel circuit – multiple pathways.*) | Investigate, manipulate, collaborate, communicate<br>Create digital drawings | Series arrangement constructed.<br>Parallel arrangement constructed.<br>Differences between series and parallel arrangements identified. |
| In groups, research online/offline the circuit symbols for connecting wires, lamps, cell, battery and switch. Use the circuit symbols to represent the series and parallel circuits created in previous activity. Draw circuit diagrams using digital drawing tool with additional lamps/cells/switches (e.g. a parallel circuit with a switch in each branch). Construct the circuits drawn. | Research, collaborate, draw circuit diagrams, manipulate | Correct symbols identified for components.<br>Circuit diagrams constructed correctly.<br>Circuits correctly constructed based on circuit diagrams drawn. |
| As a class, name electrical appliances that use varied electric current when operated. In groups create a simple circuit consisting of a battery and a 12 com bare wire. Place 5 ml of water in a container (e.g. a beaker) and record the temperature of the water. Place a section of the wire in the water for 10 minutes then record the temperature. Propose an explanation for observations and share with class (*teacher should emphasize that heat is a by-product of electric currents*).<br>As a class, discuss the need for safety devices to protect humans and appliances from electrical hazards. In groups view safety devices, or online/offline videos of safety devices used to prevent/mitigate electrical hazards (e.g. fuses, insulated wires, three pin plugs and circuit breakers). Research and describe the use of fuses, insulated wires, three pin plugs and circuit breakers. Present information to the class in a variety of ways. | communicate, investigate, manipulate, research, collaborate, think critically | Explanation of observations identify that heat is produced by electric currents.<br>Presentation contains correct information on safety devices. |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| Examine electrical hazards and suggest ways of preventing them. In groups create multimedia presentations with a list of electrical safety rules to create awareness of need to avoid the hazards. Also use class email/wiki/blogs to collaborate and share ideas/information on how to prevent electrical hazards | Communicate, formulating models, collaborate<br>Collaborate and communicate using class email/wiki and blogs | List comprises of at least six logical electrical safety rules. |

## Learning Outcomes

Students who demonstrate understanding can:

- Construct and diagrammatically represent series and parallel circuits
- Explain the meaning of the terms circuit and current
- Differentiate between conductors and insulators
- Create and manipulate multimedia presentation to communicate information
- Manipulate digital content from a variety technological devices
- Collaborate and communicate ideas and information through file sharing using class email/wiki and blogs

## Points to Note

Teacher should guide students in the construction of the series and parallel circuits and the differences between both series and parallel circuit connections in terms of current flow and pathway (series- all the current flows in the one path, parallel- current splits between the various paths)

Student would be guided to collaborate through file sharing (e.g., upload/download )

## Extended Learning

Identify applications of series and parallel circuits in the home (e.g. Christmas lights, house wiring)

Research the operation and application of fuses

Identify and list safety devices and hazards in the home and suggest ways in which you can make your home safer.

Highlight the dangers involved in the practice of illegal electrical connections

**RESOURCES**

Paper, foil, cloth, aluminium, plastic, glass, water, salt water, bulb, socket, insulating wires, switch, textbook, fuses, insulated wires, three pin plug, circuit breaker

computer, speakers, Internet, multimedia projector, video CDs/ DVDs, multimedia and graphic software tools

**KEY VOCABULARY**

Insulator, conductor, current, circuit, series, parallel, battery, switch, cell, wire, fuses, insulated wires, three pin plug, circuit breaker, electrical hazards

**LINKS TO OTHER SUBJECTS**

**Technical and Vocational Education**

## UNIT TITLE: Electricity and Magnetism

**Theme:** Energy, Forces and Matter

**Topic:** Electromagnets

**Duration:** 5 Hours/2 weeks

**ATTAINMENT TARGET(S):**

- Understand natural laws as they apply to motion, forces, and energy transformations.
- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**BENCHMARKS:**

- Be familiar with the nature of electricity and understand the different types of electrical circuits.
- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**OBJECTIVES**

**Students will:**

- Perform simple activities to identify the poles of a bar magnet
- Demonstrate that unlike poles attract and like poles repel
- Investigate the relationship between voltage (V) and current (I) in a simple series circuit
- Construct an electromagnet
- Investigate the properties of an induced current
- Conduct investigations with due regard for safety
- Work cooperatively in groups

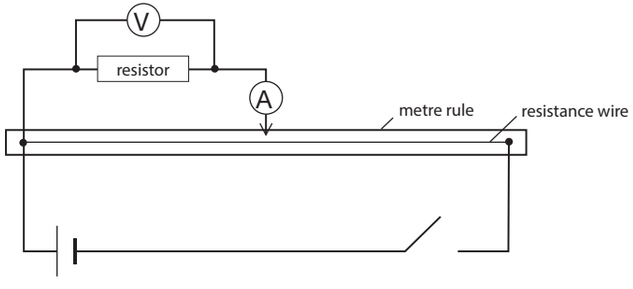
**ICT ATTAINMENT TARGETS:**

COMMUNICATION AND COLLABORATION - Use technology to communicate ideas and information, and work collaboratively to support individual needs and contribution to the learning of others.

RESEARCH, CRITICAL THINKING, PROBLEM-SOLVING AND DECISION MAKING - use appropriate digital tools and resources to plan and conduct research, aid critical thinking, manage projects, solve problems, and make informed decisions.

DESIGNING AND PRODUCING - use digital tools to design and develop creative products to demonstrate their learning and understanding of basic technology operations.

DIGITAL CITIZENSHIP - Recognise the human, ethical, social, cultural and legal issues and implications surrounding the use of technology and practice online safety and ethical behaviour.

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>Be provided with a magnet and various materials (including iron, iron alloys, non-magnetic materials etc.). In groups carry out an investigation to determine which of the materials are attracted by the magnet. Record results in a tabular form and share with class. | Investigate, observe, record, communicate | Materials correctly classified as magnetic and non-magnetic. |
| In groups, use a string to suspend a bar magnet and allow it to swing freely until it comes to rest. Record the direction in which the magnet comes to rest and share with class. (*Based on discussions, teacher should introduce the concepts of magnetic North-pole and South-pole.*) | Observe, manipulate materials, investigate | North-South pole correctly identified as the direction which the magnets comes to rest. |
| Place a magnet on a table and bring the like pole of another magnet towards it. Record observations. Repeat the process bringing the opposite pole towards the magnet on the table and record observations. Complete the following statements:<br>1. like poles of magnets _____<br>2. unlike poles of magnets_____ | Observe, infer, manipulate materials, investigate | Statements correctly completed. |
| Be given a dry cell 1.5 V, a one metre long resistance wire (e.g. constantan), three connecting wires, two thumb tacks and a metre rule. In groups, attach the wire along the metre rule and secure its ends with the thumb tacks, leaving one centimetre at each end for connections. Use the components provided to connect the circuit in the diagram below. Use the voltmeter to measure the voltage (V) across various lengths in order to obtain at least six readings. Set the length of wire, close the switch, take voltmeter and ammeter readings. Tabulate the results.<br>Individually, plot a graph of voltage against resistance and draw a line of best fit through the points. Based on the graph, identify the relationship between voltage and current.<br>  <br> | Manipulate materials, measure, experiment, interpret data | Circuit correctly connected.<br>Recorded values of voltages in table within reasonable limits of error from theoretical values.<br>Graph has title<br>Axes of graph labelled with quantities and units.<br>Voltage (y-axis) and resistance (x-axis)<br>Scales more than half length of grid.<br>Points plotted accurately.<br>Points represented using small "x" (×) or circled dot ( ).<br>Line of best fit drawn with thin line.<br>Large triangle for selecting points to calculate gradient.<br>Points on best fit line selected.<br>Read off coordinates of selected points correctly |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| In groups, close wrap a 80 cm length connecting wire around a 8cm (3 inches) nail and try to take up small paper clip. Connect the ends of the wire to a 1.5V dry cell and try to take up the paper clip again. Record and explain observations. | Manipulate materials, measure, experiment, infer | Logical explanation proposed for observation. |
| In groups, close wrap the 80 cm length connecting wire around a 2.5cm (1 inch) PVC pipe and slide the PVC pipe from between the wire so that the wire retains its helical form. Connect the ends of the wire to a voltmeter in the microvolt range or an ammeter in the microampere range. Insert one end of a strong bar magnet into the middle of the wire coil and rapidly withdraw it. Note what happens to the scale reading on the voltmeter/ammeter. Repeat the exercise with the other end of the bar magnet being inserted into the middle of the coil and withdrawn.<br>State whether the voltmeter/ammeter showed a scale reading when the magnet was stationary in between the coil.<br>State whether the voltmeter/ammeter showed a scale reading when the magnet was withdrawn from between the coil.<br>Answer the following questions<br>1. What does a scale reading on the voltmeter/ammeter suggest?<br>2. What can you conclude from the results of the exercise? | Manipulate materials, measure, experiment, infer. | Correct answers to questions |

## Learning Outcomes

Students will be able to:

- Locate the poles of a bar magnet
- use instruments to measure voltage and current accurately
- Demonstrate the relationship between electric current and magnetic effect.
- Make an electromagnet
- Demonstrate some properties of an induced current

| Points to Note | Extended Learning |
|---|---|
| Emphasize that magnets does not attract all metals<br>Constantly remind student to open circuit when they are not in use. | Research on the uses of magnets in everyday activities and state how it affects our lives.<br>Research on the effect of the speed at which the magnet is moved relative to the coil on the voltage/ current generated.<br>Research on the current conducted with different soil types (clay, sand and loam) and different conditions (wet soil and dry soil).<br>Design a simple device that uses an electromagnet |

**RESOURCES**

Short pieces of connecting wire, 80 cm length connecting wire, resistors, voltmeter, ammeter, switch, cell, short length of one inch PVC pipe, strong bar magnet.

**KEY VOCABULARY**

Voltmeter, resistor, ammeter, voltage, ohms

**LINKS TO OTHER SUBJECTS**

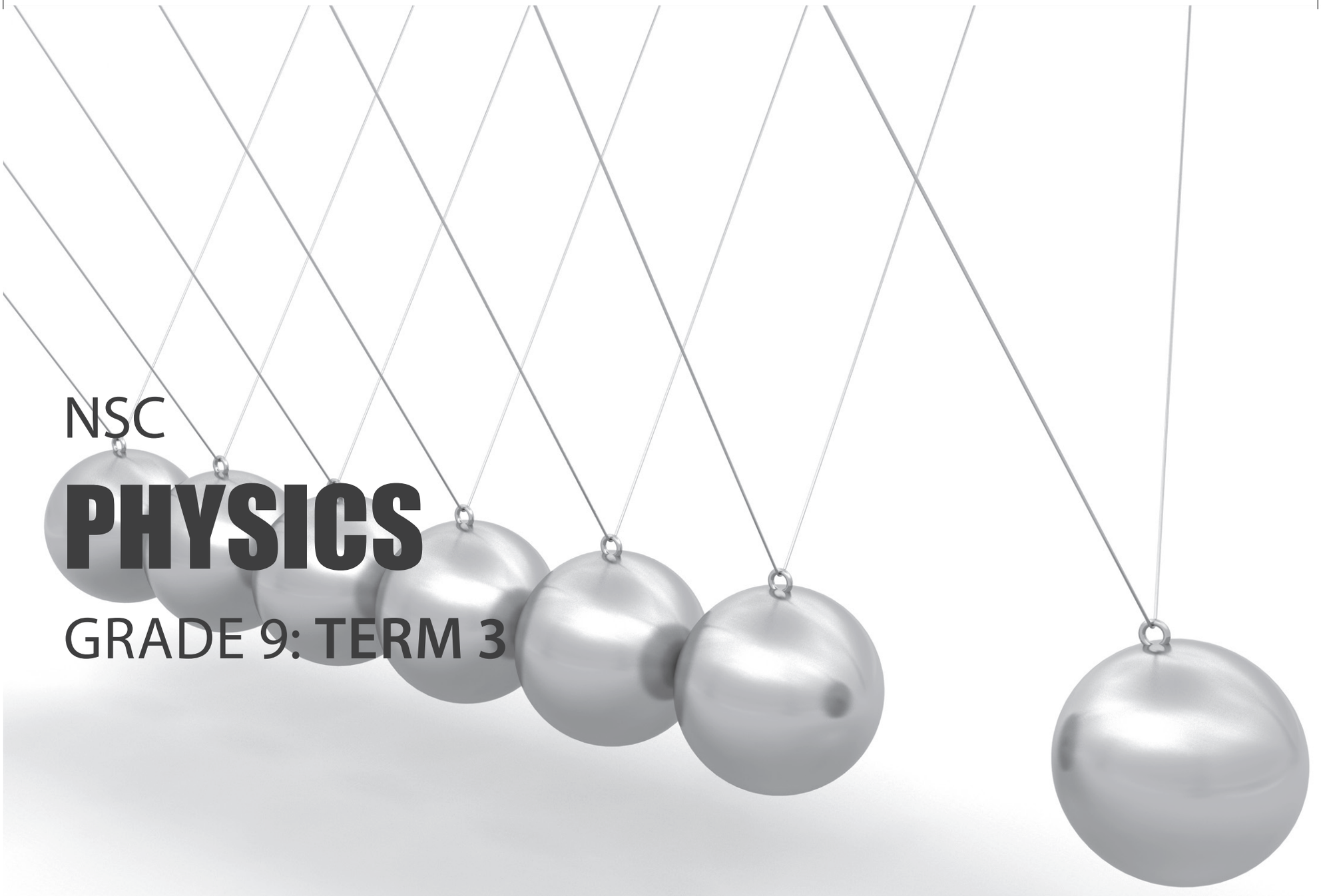
**Mathematics** – measurement; relations, functions and graphs

**Technical Vocational Education**

NSC

# PHYSICS

## GRADE 9: TERM 3



### About the Unit

In this unit students will learn about temperature and its relationship to heat transfer. They will investigate the thermal expansion of solids, liquids and gases, and the absorption and emission of thermal energy. Students will also use the concepts of thermal energy transfer to engineering solutions to a specific problem.

### Range of Content

- Temperature is a measure of how hot something is.
- Heat energy flows from an object at higher temperature to one at a lower temperature; i.e. from a hot object to a cooler one.
- All substances (solids, liquids and gases) expand when they are heated up, and contract when they are cooled down.
- Heat may be transferred from one place to another by conduction, convection and radiation. Conduction is a process in which transfer of heat takes place between objects by direct contact. Convection refers to the form of heat transfer in which energy transition occurs within the fluid (liquid or gas). Radiation refers to heat being transmitted without any physical contact between objects.
- Dark, dull surfaces are better absorbers and emitters of radiant heat.

### Guidance for the Teacher

Ensure that proper safety practices are followed by students in carrying out activities involving heat sources.

## UNIT 1: Thermal Energy

**Theme:** Energy, Forces and Matter

**Topic:** Heat Transfer

**Duration:** 12.5 hours/5 weeks

### Prior Learning

Check that students:

- Know that matter is made up of tiny particles in constant motion
- Know that thermal energy is transferred by conduction, convection or radiation;
- Know that thermal energy flows from objects at higher temperatures to objects at lower temperatures

**ATTAINMENT TARGET(S):**

- Understand natural laws as they apply to motion, forces, and energy trans formations.
- Apply scientific knowledge and processes to the solution of real world problems.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific concepts.
- Appreciate the influence and limitations of science with consideration for ethical issues.
- Demonstrate a positive attitude towards the use of scientific language.
- Demonstrate positive interpersonal skills in order to foster good working relationships.

**OBJECTIVES-Students will:**

- Formulate a simple working definition of temperature
- recall that temperature determines the direction of thermal energy transfer
- investigate physical properties which vary with temperature
- compare the transfer of thermal energy by conduction, convection and radiation
- investigate the absorption and emission of thermal energy by materials
- construct a device that utilises the principles of thermal energy transfer
- Work cooperatively in groups
- carry out investigations with due regard to safety

**BENCHMARKS:**

- Understand and apply the principles of thermal energy transfer.
- Apply the principles of measurement in the solution of everyday problems.
- Use scientific knowledge to select appropriate experimental methods.
- Construct explanations, design and evaluate solutions to complex real-world problems, based on scientific knowledge.
- Appreciate the importance of scientific methods.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.
- Demonstrate concern for safety of self and others.
- Demonstrate curiosity, objectivity and perseverance in their approach to scientific activities.
- Demonstrate sensitivity to others who are different.

**ICT ATTAINMENT TARGETS:**

COMMUNICATION AND COLLABORATION - Students use technology to communicate ideas and information, and work collaboratively to support individual needs and contribute to the learning of others.

RESEARCH, CRITICAL THINKING AND DECISION MAKING - Students use digital tools to design and develop creative products to demonstrate their learning and understanding of basic technology operations.

DESIGNING AND PRODUCING - Students use appropriate digital tools and resources to plan and conduct research, aid critical thinking, manage projects, solve problems and make informed decisions.

DIGITAL CITIZENSHIP - Students recognise the human, ethical, social, cultural and legal issues and implications surrounding the use of technology and practice online safety and ethical behaviour.

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| **Students will:**<br>Touch various objects on display, and list them in order of increasing/decreasing temperature. In groups, measure the temperatures to verify their listing. Suggest and record a simple working definition of temperature. Share and discuss their definitions with the class. | Investigate, collaborate, think critically, record, communicate | Acceptable definition of temperature provided. |
| In groups, predict what will happen when two objects of different temperatures are made to touch each other for several minutes in an insulated container, and then final temperature of each is measured. Carry out the investigation and record and explain their results. Share their findings with the class. As a class, discuss the relationship between temperature and the flow of thermal energy. | Collaborate, make predictions, think critically, investigate, record, communicate | Acceptable explanations of results. |
| In groups, carry out the following activities:<br>Fill a balloon with air and use a string to measure its maximum diameter. Warm up the balloon by rubbing it with their hands then use the string to recheck its maximum diameter. Repeat the investigation this time cooling the balloon with ice or cold running water. Record their observations and suggest reasons for their findings. | Collaborate, manipulate, think critically – analyse, draw conclusions, investigate, record | Acceptable explanations of results. |
| Fill a small glass/metal container with water and place a straw in it, ensuring that the straw stands vertically. Note the initial height of the water in the straw, and then gently heat the container for a few minutes while observing the height of water in the straw. Record and suggest reasons for their findings. | Collaborate, manipulate, think critically – analyse, draw conclusions, investigate, record | Acceptable explanations of results. |
| Test the tightness of a metal cap on a glass container. Gently heat the lid for a few minutes using hot water or other heating source. Re-test the tightness of the metal cap. Record their results and suggest reasons for the differences observed.<br>Share and discuss the findings of the investigations and their explanations with the class. As a class, summarise how physical properties vary with temperature. | Collaborate, manipulate, think critically – analyse, draw conclusions, investigate, record | Acceptable explanations of results. |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| Recap the ways in which thermal is energy transferred (conduction, convection and radiation). In groups, discuss the similarities and differences among them. Share and discuss their ideas with the class. As a class, finalise their findings in a summary chart. | Collaborate, communicate, think critically | Correct similarities and differences identified. |
| In groups, carry out the following activities.<br>Wrap four similar metal containers (e.g. condense milk tins) with paper of different colours (light and dark) and reflectivity (shiny and dull). Pour equal volumes on water in each container and measure their initial temperatures. Place the containers simultaneously in the Sun for the same period of time (e.g. 10 minutes) and record their final temperatures. Determine which containers had the largest and smallest temperature changes and suggest reasons for their findings. | Collaborate, investigate, manipulate, think critically-interpret, draw conclusions, conduct fair-tests | Investigations conducted with appropriate safety precautions.<br>Containers with largest and smallest temperature changes correctly identified. |
| Wrap four similar metal containers (e.g. condense milk tins) with paper of different colours (light and dark) and reflectivity (shiny and dull). Pour equal volumes on hot water in each container and measure their initial temperatures. Allow the containers to cool for the same period of time (e.g. 10 minutes) and record their final temperatures. Determine which containers had the largest and smallest temperature changes and suggest reasons for their findings. | Collaborate, investigate, manipulate, think critically-interpret, draw conclusions, conduct fair-tests | Investigations conducted with appropriate safety precautions.<br>Containers with largest and smallest temperature changes correctly identified. |
| Share and discuss their findings with the class. As a class, list materials in order of best to worst absorber and emitter of thermal energy. Draw conclusions about the thermal properties of the materials. | Communicate, think critically – analyse, draw conclusions | Acceptable conclusions drawn. |
| In groups, research how the device assigned by the teacher works (e.g. refrigerator, radiator, electric kettle, vacuum flask/thermos etc.). Discuss the information collected and summarise how the device uses the methods of thermal energy transfer in its operation. Present ideas to the class in a variety of ways (electronic/non-electronic). | Collaborate, research, communicate, think critically - analyse | Presentation contains correct information on how the device utilises thermal energy transfer. |

| Suggested Teaching and Learning Activities | Key Skills | Assessment Criteria |
|---|---|---|
| In groups, apply the Engineering Design Process to construct and test a device that either minimises or maximises thermal energy transfer (e.g. an insulated box, a solar cooker etc.). Present their device to the class and explain its operation, identifying the thermal energy transfer principles utilised. | Collaborate, investigate, think critically – plan and design, analyse, justify, create, communicate | Device performs intended function(s).<br>Device utilise thermal energy transfer principles. |

## Learning Outcomes

Students will be able to:

- describe the flow of thermal energy in situations where there is temperature change
- prove the expansion of all three states of matter on heating and contraction on cooling
- differentiate among conduction, convection and radiation
- prove that good absorbers are also good emitters of heat and poor absorbers are also good emitters
- use their knowledge about the thermal energy transfer to build devices that maximise/minimise heating/cooling
- work safely with various heat sources

## Points to Note

Where possible, use 'ball and ring' or other expansion demonstration apparatus to illustrate the effects of heating materials.

As much as is possible, use hot water and electrical heaters for heating rather than open flames.

**DO NOT include the calculation of thermal energy transferred.**

**Temperatures used for heating activities should not be too high.**

## Extended Learning

Explain why different clothes are worn at different times (e.g. why test/first-class cricketers wear white clothes when playing a four/five day match?).

Explain why houses and buildings are painted in light colours.

**RESOURCES**

Thermometers, electrical heaters, Bunsen burners, methylated spirit lamps, balloons, glass containers with metal lids, straws, milk tins, cartridge paper (assorted colours), aluminium foil, string, timers (e.g. stopwatches)

**KEY VOCABULARY**

Heat, thermal energy, temperature, conduction, convection, radiation, thermal expansion, reflective, thermal absorption, thermal emission

**LINKS TO OTHER SUBJECTS**

**TVET** – Energy**; Grade 7 science** – Energy forms

NSC

# SCIENCE

## GRADE 9: APPENDICES

## GLOSSARY OF SCIENCE TERMS

| TERMS | DEFINITIONS/MEANINGS |
|---|---|
| Analyse | To examine in order to explain and interpret data |
| Annotated diagram | a labelled scientific drawing with brief notes within the diagram |
| Annotate | to supply additional information to further explain elements in a diagram |
| Assess | to evaluate or make judgements to determine value or importance |
| Classify | to use observable characteristics to form groups |
| Conclusion | findings obtained through experimenting or research |
| Constraints | conditions that limit or restrict |
| Construct | to make or draw using data or material provided |
| Control (constant) variable | the variable that is not changed during the investigation |
| Criteria | pre-determined principles used to make decisions or judgements |
| Deduce | use information presented to reach a conclusion |
| Engineering Design Process | a problem solving method that consists of a series of steps used to design a product to meet certain criteria |
| Evaluate | to make judgements based on analysis |
| Evidence | data obtained during an investigation |
| Fair test | a scientific investigation in which one variable is changed while all other variables remain the same |
| Formulate | to develop a plan or strategy |

| TERMS | DEFINITIONS/MEANINGS |
|---|---|
| Findings | the results of a scientific investigation |
| Hypothesis | a part of the Scientific method in which a proposed explanation is given for an observed phenomenon. It is also a testable answer to a scientific question |
| Identify | name or point out specific features or structures |
| Illustrate | explain using examples or diagrams |
| Infer | make deductions based on observations |
| Inferences | a conclusion that is based on observation and reasoning |
| Investigate | to use a systematic inquiry to find answers |
| Investigation | the process of research and experimentation to find answers |
| Justify | provide reasons or an acceptable explanation of a phenomenon |
| KWL approach/ chart | determines what I **Know**, what I **Want** to learn and what I did **Learn** |
| Laboratory report | a record of the steps in an experiment |
| Line of best fit | a straight line that describes the general trend from a scatter of points on a graph. It is usually drawn through the middle of the points |
| Manipulate | a scientific process skill that describes handling and control of scientific apparatus |
| Manipulating variable | the independent variable in an investigation that is changed by the scientist |
| Model | 3-D representation of an object done on a smaller scale |
| Observe | to gather information in a scientific investigation through all the senses |
| Observations | information obtained through the use of all senses |

| TERMS | DEFINITIONS/MEANINGS |
|---|---|
| Operationally define | use a given scenario (what is observed or measured) to derive the meaning of a term |
| Plot | to mark a point on a chart or graph to show the relationship between two variables |
| Predict | suggest a possible outcome based on information given |
| Problem statement | the statement that outlines the problem to be investigated |
| Prototype | a small-scale model or example of the object to be built |
| Prove | to show using evidence or arguments |
| Responding variable | the dependent variable in an investigation that responds to changes and is measured or observed |
| Scientific drawings | line drawings done in pencil with no shading |
| Scientific method | a series of steps used to answer questions through observation, formulating and testing hypotheses and drawing conclusions |
| Suggest | to offer an explanation for observations |
| Test | to find out by investigating |
| Variable | a factor or condition that can be changed or manipulated in an experiment |

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## ALTERNATIVE PATHWAYS TO SECONDARY EDUCATION (ASPE)

The 21st century is a time of rapid technological growth and social change. The school curriculum must, therefore, ensure that young people are well prepared for the challenges and opportunities that they will meet as adults in this century. The MoEYI is making every effort to provide for the multiple intelligences of our children and cater to their diverse needs in order to fully maximize their capabilities. Hence, the MoEYI has created alternative pathways to receiving an education at the secondary level.

Providing alternative pathways will be far-reaching in carrying out the Ministry's mantra, "Every child can learn....every child must learn". Learning pathways will allow for an inclusive approach in which instruction is based on tailored curricula, enabling each learner to perform to his/her fullest potential based on aptitude, interest and ability. Alternative Pathways represent a new approach to secondary education. Secondary education in Jamaica is being reframed and re-positioned as customised, diverse, relevant, equitable, outcomes-based, and inclusive; and significantly, this approach will signal the introduction of a seven year (Grades 7-13) period of instruction for students on all secondary pathways.

### Goals of the APSE

- Design the school system to offer differentiated instructional programmes, informed by the National Standards Curriculum (NSC).
- Develop individualized intervention/learning plans based on students' performance profile.
- Provide special educators as Pathway Coaches to support subject teachers of students on Secondary Pathways II and III in the delivery of instruction.
- Facilitate a functional academic approach at the secondary level characterised by response to intervention (RtI) methodology, interactive, learner-centred, project-based and problem- based learning, reflection and alternative forms of assessment.
- Foster a system for ALL students to exit the secondary level with the knowledge, skills, competences and attitudes which will have them ready for the world of work or to access tertiary level education.

### Secondary Pathways I, II & III (SP I, II & III)

All students will access secondary education via the prevailing Grade Six examination. The exit examination will provide individual profiles to inform decisions for pathway access and standards for differentiation.

**SPI** is a 7-year programme with a curriculum based on the constructivist approach. At Grades 7-9 students will access the National Standards Curriculum (NSC), and at Grades 10, 11, 12 & 13, they will access the curricula/syllabi of the examining body.

**SP II** is a 2-year transitional programme with a curriculum based on the constructivist approach. Special educators/pathway coaches will work with teachers and students on this pathway. Students will be provided the required intervention and support to allow for transition. At the end of Grade 8 students will be re-evaluated through psycho-educational evaluation to determine their readiness for crossing over into either SP I or SP III.

**SP III** is a 7-year programme with a curriculum based on the constructivist approach. At Grades 7-9 students will access the National Standards Curriculum (NSC), and at Grades 10 & 11, they will access the curricula/syllabi of the examining body. At the end of Grade 11 SP III students will transition into the Career Advancement Programme.

At Grades 7-9 the NSC, will be modified to meet the needs of the SP III students. Students in SP III will be instructed through a functional academics curriculum in the core subjects- Mathematics, English Language, Communication, Social Studies and Science. Their instruction will be further enriched with Personal Empowerment, Technical and Vocational instruction, as well as the performing and creative arts. Pathway Coaches will collaborate with subject teachers to prepare content, ensuring differentiation in instruction for students on SP II and III. These students will also be supported through use of the Response to Intervention (RtI) methodology.

## PERSPECTIVES OF SCIENCE, TECHNOLOGY, ENGINEERING, MATHEMATICS & THE AESTHETICS (STEM/STEAM) IN RELATION TO THE NATIONAL STANDARD CURRICULUM (NSC)

### INTRODUCTION & BACKGROUND

The integration of theoretical principles that relate to STEM/STEAM Education in the NSC began in June 2014. This move was influenced by recommendations of the STEM Steering Committee that emphasized the need to develop learners who are not just productive, but who would also be innovative Jamaicans. STEM integration was also regarded as one of the strategic long term means of addressing the economic challenges being faced by Jamaica using education as a primary vehicle for the implied transformational change to happen, beginning from short term efforts.

Initial discussions and deliberations promoted an emphasis on STEM rather than STEAM Education. However, critical analysis of the conversations conveyed the perspective of STEM as a collection of related disciplines that all learners should have the opportunity of pursuing, to develop the competencies they offer and as a consequence be able to gain employment or become employers in STEM related areas. As stakeholders from different backgrounds processed their understanding of STEM, new meanings of the concept emerged from the discussions. One was the perspective of STEM as a methodology. There was, however, concern about the exclusion of “A” in STEM. This “A” component however, brought to the discussion, multiple meanings. In some Aesthetics as a field and was considered an important component to be included if educators are serious about issues of discrimination, holistic learning and current research on the iterative function of the brain that warrants attention to brain based learning and the role of the Arts in promoting knowledge integration to cater to multiple domains of learning. There was also discontent about neglecting the Performing Arts when related creative industries contribute significantly to economic development. The concern was that the role of the Arts to economic development was being trivialized.

The call for the integration of the Aesthetics or Art forms became more pronounced as STEM took on more national significance. This was supported by research that indicates the importance of the Aesthetics in developing values and attitudes, in promoting holistic learning and in serving as drivers of innovations. By integrating principles from STEM with those from the Arts/Aesthetics, the approach to problem solving would encourage greater appreciation for and reliance on the interdependent nature of knowledge when science and arts intersect. Additionally, STEAM as a methodology encourages the harmonizing of the cognitive and the emotional domains in the problem-solving process.

The concept of STEAM was adopted in 2015, as an integrative approach to education and a methodology that pays attention to the benefits to be derived from the inclusion of the Arts or Aesthetics with STEM related principles. These collective benefits are supported by Jolly (2014), Sousa and Pilecki (2013) and include divergent thinking; differentiated learning; Arts integration; focus on intrinsic motivation and informed decision-making.

## PERSPECTIVES OF STEM/STEAM IN THE CONTEXT OF THE NSC

In the context of the NSC, STEM/STEAM is used in a number of ways. These include:

STEM/STEAM as an integrative learning approach and methodology in facilitating learning. This perspective places emphasis on STEM/STEAM as a means of helping learners become creative or innovative problem solvers and lifelong learners who rely on scientific principles (laws and theories) to address issues/concerns or to deal with observed phenomenon that are puzzling for them or that inspire interest. As an approach, the focus is on solving problems based on principles. As methodology, the focus is on the system of practical procedures to be used to translate principles into the problem - solving processes or to choose from available problem- solving models.

STEM/STEAM as an Experiential-Vocational Learning Framework that is based on problem solving through the project-based approach. Emphasis is placed on solving real life problems in a context that requires learners and their facilitators to observe work-based principles. The primary purpose for this focus is for learners to: (i) become employable (ii) prepare for further education and/or for occupational or work readiness.

STEM as types of institutions in which learning is organized as a meta-discipline as described by Morrison and Bartlet (2009). Based on this perspective, STEM facilitates the demonstration of knowledge in a manner that removes the boundaries of each discipline for application to problem as would be practised in the real world.

### IMPLICATIONS OF PERSPECTIVES OF STEM/STEAM IN LIGHT OF THE NSC

Since the NSC is based on Constructivism principles, STEM/STEAM as an approach and methodology, has to be established on post-positivistic thinking. From this position, STEM/STEAM influences the kind of practice that promotes collaboration, negotiation of meaning and openness to scrutiny.

The NSC developers selected a Constructivist approach that included the deliberation, designing and development stages of the curriculum process. Evidence of the influence of Constructivism can be seen the NSC Framework Document that conveys the following emphasis:

(i) The element of objectives is presented in two forms; firstly as Learning Objectives to focus attention on process and experience rather than product. Secondly as Learning Outcomes that serve as some of the outputs of the process. They include the basic understandings, skills and dispositions anticipated from learners' engagement in the planned experiences.

(ii) The element of content is treated as contexts for learners to think critically, solve problems creatively while developing their identity as Jamaicans. Content is not expected to be treated as disciplines to be mastered but as areas that contribute knowledge, skill sets and attitudes that form the composite of competencies to be acquired from their integration in the learning situations.

(iii) The element of learning experiences (method) is presented as a set of learning activities that serves as a source of problems to be addressed as a part of the learning process. These real-life activities provide the scope of knowledge, skills and required dispositions or character traits for learners to make sense of that aspect of life or the world that they represent. They are the threads that connect all the other elements of the curriculum and allow for the integration of STEM/STEAM in the following ways:

- Identification of activities that are presented as problems to be solved using the STEM/STEAM approach based on contextual factors that include the profile of the learner, the learning conditions and the anticipated impact.
- Integrating activities to form a real problem to be solved as a short, medium or long term project to which the project based learning would be applied.
- The examination of learning activities by learners and teachers as co-learners through multiplelenses using content of science, technology, mathematics and the humanities that they have already explored to engage in the problem identification and definition processes.
- Extending learning in the formal setting to the informal by connecting co-curricular initiatives that are STEM/STEAM based that learners are undertaking at the institutional level through clubs and societies, as whole school projects or in partner ship with external stakeholders.
- Using the learning activities to review STEM/STEAM initiatives that form a part of the informal curriculum to and for reflection on action.

- Using activities as springboards for reflecting on career or occupational interest in STEM/STEAM related areas.

(iv) The element of evaluation is communicated in two major ways; firstly as prior learning which serves diagnostic purpose and secondly as an on-going developmental process. This formative focus is indicated by the inclusion of explicitly stated assessment criteria that are to be used alongside the learning activities. The use of assessment criteria as counterparts of the learning activities also indicates that assessment is learner centred since it is serving developmental rather than promotional purpose and as a consequence, allows learners to self-correct as they use feedback to develop feed-forward capabilities. Evidence of learning, based on the learning outcomes, can be collected from various types of assessment methods that emphasize the learner centred constructivist orientation. This brings to the fore the need for serious consideration to be given to differentiation in assessment for fairness and credibility of claims about learners' capabilities and to inform decisions that will impact their educational journey.

In general, this integrated approach, which is the context of STEAM, is aimed at improving the quality of the educational experience for learners while influencing the achievement of the aims of education that relate to productivity and creativity as part of the profile of the Jamaican learner.

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**The 5Es Overview: "The 5E Learning Cycle"**

What is a 5E Learning Cycle?

This model describes an approach for facilitating learning that can be used for entire programmes, specific units and individual lessons. The NSC supports the 5E constructivist learning cycle, as it places emphasis on the processes that may be used to help students to be personally involved in the learning situation as they are guided to build their own understandings from experiences and new ideas.

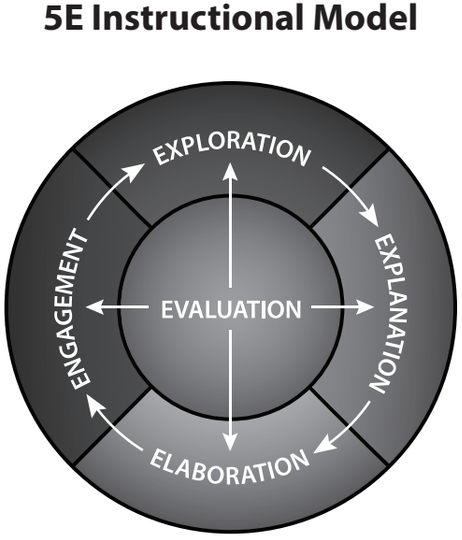


Figure 1. Illustrating one version of the 5E model that conveys the role of valuation as an interconnecting process that is at the core of the learning experience.


Figure 2, illustrating a cyclical perspective of the model with each process being given similar emphasis in contributing to the learning experience on a whole.

## EXPLANATION OF THE INSTRUCTIONAL MODEL

What are the 5Es?

The 5Es represent five key interrelated processes that provide the kind of learning experiences for learners to experience the curriculum or planned learning episodes: Engage, Explore, Explain, Extend (or Elaborate), and **Evaluate**.

ENGAGE: The purpose of the ENGAGEMENT dimension is to help students to be ready intellectually, socially, emotionally etc. for the session. Attention is given to the students' interests and to getting them personally involved in the lesson, while pre-assessing prior understandings, attitudes and/or skills. During the experience, students first encounter and identify the instructional task and their roles and responsibilities. During the ENGAGEMENT activity, students make connections between past and present learning experiences, setting the organizational groundwork for upcoming activities. The engagement activity may be used to (a) help student unearth prior knowledge (b) arouse their curiosity (c) encourage students to ask questions as a sign that they have wonderments or are puzzled.

EXPLORE: The purpose of the EXPLORATION dimension is to get students involved in solving a real problem that is based on a selected context. EXPLORATION provides them with a chance to build their own understanding of the phenomenon being investigated and the attitude and skills involved for arriving at a workable solution. In exploring the students have the opportunity to get directly involved with the phenomenon and materials. As they work together in learning teams or independently, the need to share and communicate becomes necessary from the experiences. The teacher functions as a facilitator, providing materials, guarding against obstacles to learning and guiding the students to operate based on agreements. The students become inquirers and co-owners of the learning process. In exploring, they also ask questions, formulate hypothesis, search for answers or information/ data, reflect with others, test their own predictions and draw conclusions.

EXPLAIN: The purpose of the EXPLANATORY dimension is to provide students with an opportunity to assess their thinking and to use intellectual standards as critical thinkers to communicate their perspectives and/or the meaning of the experiences. They rely on communication tools and their skills as Language users to: (a) organize their thoughts so that they are clear, relevant, significant, fair, accurate etc. (b) validate or affirm others (c) self-motivate. Reflection also occurs during the process and may cause students to adjust their perspective or justify their claims and summarise the lessons being learned. Providing explanations contributes to vocabulary building and self-corrective actions to deal with misconceptions that they become aware of from feedback of their peers and/or their facilitator.

EXTEND: The purpose of this dimension is to allow students to use their new knowledge and continue to explore its significance and implications. Students work independently or with others to expand on the concepts and principles they have learned, make connections to other related concepts and principles within and/or across disciplines, and apply their understandings in new ways to unfamiliar situations.

EVALUATE: The purpose of the EVALUATION dimension is for both students and facilitator to determine progress being made or the extent to which learning has taken place based on the stated objectives or emergent objectives. EVALUATION is treated primarily as an on-going diagnostic and developmental process that allows the learner to become aware of gaps to be treated and progress made from their efforts to acquire the competencies that were the focus of the session. Examples of competencies include understanding of concepts, principles and processes and demonstrating various skills. Evaluation and assessment can occur at different points during the learning episode. Some of the tools that assist in this diagnostic and formative process include rubrics, teacher observation log, self-inventories, peer critique, student interviews, reflective presentations, displays/expositions,

portfolios, performances, project and problem-based learning products. Analysis of reflections, video recordings are useful in helping students to determine the depth of their thinking and understanding and the objectives they have or have not achieved.

**Who developed the 5E model?**

The Biological Science Curriculum Study (BSCS), a team led by Principal Investigator Roger Bybee, developed the instructional model for constructivism, called the “Five Es”.

**The Link between the 5E model and Types of Learning Activities**

The five (5) types of Learning Activities purported by Yelon (1996) can be integrated with the 5E’s so as to enrich the teaching and learning process. He noted that every instructional plan should include the following learning activities

1. Motivation Activities: Intended to help learners to be ready for the session
2. Orientation Activities: Inform students of their roles and responsibilities based the purpose or objectives of a learning episode.
3. Information Activities: Allow students to manipulate current knowledge, access/retrieve and generate new ideas
4. Application Activities: Allow for the use of knowledge and skills in novel situations
5. Evaluation Activities: Allow for reflection, corrective actions and sourcing of evidence to confirm/refute claims about learning.

These activities can be planned to serve one of the purposes of each dimension of the 5E model. For example, ENGAGEMENT may be comprised a Motivation Activity and an Orientation Activity. EXPLORATION and EXPLANATION require an Information Activity, while EXTEND requires an Application Activity. EVALUATION requires the kind of activity that will contribute to the collection of data for assessing and arriving at a conclusion about performance based on stated or expected purpose for which learning is being facilitated.

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**Subject: Biology**

**Grade: 9**

**Duration: 5 – 6 hours, (one week for creation of digital presentation)**

**Resources: Plastic bags, containers, knives, grapefruit, salt, eggs, vinegar, Irish potatoes, hot water (for curly fries)**

**Lesson Topic: Transport in Humans and Plants – Osmosis**

**Attainment Target**

Understand the importance of the life processes in plants and animals, their interdependence, their interaction with the environment, and how lifestyles determine health and well-being.

**Objectives**

By the end of the lesson students should be able to:

1. Investigate the process of osmosis
2. Compare diffusion with osmosis
3. Make predictions using scientific knowledge and understanding
4. Plan and design an experiment to solve a specific problem

**Key Skills**

Activity 1: observe, analyse, draw conclusions, communicate, report

Activity 2: predict, observe, measure, analyse, compare, draw conclusions, problem-solve,report

***Challenge*** (assessment ): plan and design, problem-solve, create, apply, communicate

**Key Vocabulary**

Hypothesis, problem statement, fair test, controlling variables, isotonic, hypotonic, hypertonic, diffusion, osmosis

**Content Outline**: [*Brief notes on main points/concepts*]
For example, cite notes for: Simple description of osmosis with necessary diagrams and examples; definition of isotonic, hypotonic and hypertonic with illustrations. Include video description and link for videos to be used in lessons; reference texts and relevant page numbers.

**Prior Learning**
Check students' understanding of:

- the basic functions of the cell membrane, cytoplasm and vacuole and that they are able to recall that the cell membrane is selectively permeable
- diffusion

*Strategy***:** Students complete worksheet that requires them to label and annotate the plant and animal cells and, answer short questions about diffusion

**Learning Outcome:**

- Demonstrate an understanding of diffusion and osmosis as fundamental events which enable living organisms to carry out life processes.

**Assessment Criteria:**
*Activities 1 and 2*: Use a rubric to score investigation reports for students' ability to record accurate observations and in appropriate formats; analyse observations and data and draw logical conclusions that make reference to predictions and questions asked; communicate orally; measure accurately and make comparisons.
*Assessment activity (the challenge)*: Use a rubric to score the design plan for application of the engineering design process, application of the concept of osmosis and evidence of problem-solving strategies.

**Teaching Procedure**

**ENGAGE**

***How can I get students interested in this?*** **Use of an interesting picture, video, story etc. to hook students' attention**.

- Present the following story to the class.

Mrs. Gordon loves to take care of her vegetable garden. She is especially proud of the cabbage and lettuce plants with their sparkling colour and perfectly formed luscious leaves.

One day, Mrs. Gordon was alarmed to find that her lovely garden plants were covered with small, soft-bodied, brown creatures…'SLUGS!'…devouring those succulent leaves!

Quickly! Stealthily … like a soldier, (***'Mission Impossible'*** *sound track*), Mrs. Gordon crept up to the unsuspecting mulluscs and spinkles them with dry table salt. In a few minutes, the unfortunate slugs fell to the ground. No survivors …. they were all dead.

**What caused the death of the slugs?**

**EXPLORE**

***What tasks/questions can I offer to help students puzzle through this?*** **Use of a simple investigation**.

**Problem: Why do slugs die when table salt is sprinkled on them?**

Allow students to make predictions as to what the answer to this question might be.

Working in groups, students:

***Activity 1***

**Investigating osmosis in plant material**

- Place one peg of grapefruit (or other citrus fruit) into a clean, dry, transparent plastic bag containing one tablespoonful of salt and shake.
- Place another peg of grapefruit into a similar plastic bag without salt.
- Leave the bags undisturbed for approximately ten (10) minutes. Observe and record what happens.

***Activity 2***

**Investigating osmosis in animal material**

Students will:

- Label container with group's name
- Place 3 eggs in container and pour in sufficient vinegar to completely cover eggs
- Cover container loosely and leave in for two days
- After two days, carefully rinse de-shelled eggs and dry
- Measure mass and circumference of eggs (use a string and ruler) and record data in a table
- Pour 300 ml of pure water, strong salt solution and dilute salt solution separately into three different containers and label
- Place one egg in each container
- Cover containers and allow to soak for 12 - 24 hours
- Make predictions about the expected changes in the physical appearance, mass and circumference of the eggs during and after soaking them in the various liquids
- After 12 – 24 hours, remove eggs, rinse in tap water and dry
- Measure the mass and circumference of each egg and record data and observations in a table
- Compare the eggs before and after placing in the liquids and construct a simple bar graph to represent the data
- Explain the changes observed in the eggs in terms of osmosis

## EXPLAIN

***How can I help students make sense of their observations?*** **Class presentation and discussions.**

***Activity 1***

**Investigating osmosis in plant material**

Students share their observations with the class and suggest reasons for the changes.

**Facilitator:** Guides students in inferring from their observations that water particles move from an area where they are in greater amounts to an area where they are in smaller amounts.

**Guiding questions**

- What do you think the liquid in the plastic bag contain?
- Where do you suppose the water came from?
- What caused the water to move out of the grapefruit and into the plastic bag?
- What role, if any, do you think the membrane on the peg of grapefruit played in the process?
- Students draw a picture of how the membrane on the peg of grapefruit would appear if they were able to view it at the micro
- scopic level.

**Facilitator:** Show video of what happens to the peg of grapefruit at a molecular level and introduces, 'osmosis' as the term used to describe the phenomenon. Students are allowed to modify their drawing, if necessary, and annotate it.

- Students develop their own definition of osmosis and share with class.

**Guiding questions**

- In osmosis, what types of particles move from an area where they are plentiful to an area where they are in smaller amounts?
- What conditions must be present to facilitate osmosis?
- What major characteristic of the cell membrane makes it suited for osmosis?
- Do you think changes in temperature would affect the rate of osmosis?

**Facilitator:** Explains that 'an area where water particles are in greater amounts' is described as the area of 'high concentration' and that the 'area where water particles are in smaller amounts' is described as the area of 'low concentration'. The terms hypotonic, hypertonic and isotonic are introduced.

***Activity 2***

- Students share their observations with the class and suggest reasons for the changes.

**Facilitator:** Guides students in making the connection that osmosis takes place both in plant and animal matter and that the same conditions are necessary for the process to occur.
Students write a laboratory report and provide an answer to the question, **"Why do slugs die when table salt is sprinkled on them?"** Ensure that students make reference to the prediction they made earlier.

In addition, the report should include the answers to the following questions:

- How is the de-shelled egg similar to the body of the slug?
- Do you think osmosis occurred when salt was placed on the slugs? What evidence can you provide to support your answer? [Students research the body structure of the slug]
- What would be a better method of getting rid of the slugs?
- How is osmosis different from diffusion? (Students compare the processes of diffusion and osmosis.)

Students identify the fair test.

## ELABORATE

***How can my students apply their new knowledge to other situations?*** **Application of what was learned.**

**Facilitator:** With the aid of a video, introduces the students to dialysis and explains the role of diffusion and osmosis in the process.
Whole class discussion:
**Facilitator** leads discussion of the role of osmosis in life processes such as digestion and excretion. [A description of the processes is not required.]

## EVALUATE

***How can I help my students self-evaluate and reflect on the teaching and learning, and how can I evaluate the students learning of concepts and skills?***

**Challenge:** (class work) Students plan, design and conduct an investigation to make 'Curly Irish Potato Fries' using a given set of materials.
Note: Cooking of the fries is not allowed.
[Students may repeat the investigation at home under supervision of parents. Samples of fries may be displayed in class.]

Students' Reflection
Students record their thoughts/feelings about osmosis as a life sustaining process in both plants and animals in their journals.

**EXTEND LEARNING:**

It has been observed that when fruits, example mangoes and apples, are available in large quantities, much of these are wasted because of spoilage.

Create a digital presentation to explain how fruits might be preserved for a long time.

Differentiation Opportunities:

- Create a four-page brochure to explain how the process of dehydration is used in preserving grapes. Highlight the role of osmosis.
- Create a poster showing pictures of processed or preserved foods found around the home and indicate the role of osmosis in their preservation.

**Facilitator:** Schedules time for viewing of presentations by class.

**LINKS TO OTHER SUBJECTS**

Food and Nutrition, Chemistry, Mathematics, ICT

**POST-LESSON REFLECTION**

**Subject: Chemistry**

**Grade: 9**

**Duration: 60 minutes**

**Resources: modeling clay, peas (beans), blank paper, markers, electron shell diagrams, periodic tables, blank periodic tables**

**Lesson Topic: Arrangement of Electrons**

**Attainment Target**

- Understand the existence of materials such as solids, liquids and gases, the particulate nature of matter, and simple chemical reactions that change one material into another.
- Use mathematics as a tool for problem-solving, and as a means of expressing and/or modelling scientific theories.

**Benchmarks**

- Understand how substances can be classified by their chemical nature and how this relates to the way they react.
- Demonstrate objectivity by seeking data and information to validate observations and explanations.

**Objectives**

- Calculate the number of each sub-atomic particle present in an atom
- Deduce the pattern for determining electronic configuration of first 20 elements
- Relate the number of outer electrons to the group number on the Periodic Table
- Complete their own activity even if others have already finished theirs
- Work cooperatively in groups

**Key Skills**

Manipulate, predict, interpret patterns, create, communicate, collaborate, calculate, analyse, infer, draw conclusions

**Key Vocabulary**

energy levels (shells), electrons, electronic configuration, groups, periodic table, mass number, atomic number

**Content Outline**:

The atom consist of 3 sub-atomic particles; protons, neutrons and electrons. Protons and neutrons are found in the nucleus while electrons are found in energy levels (shells) around the nucleus. The number of sub-atomic particles can be calculated using the relationship Mass # - Atomic # (protons = electrons) = # neutrons. Electronic configuration describes the arrangement of electrons in energy levels (shells). There are a maximum number of electrons that each energy level can hold. The electrons are placed in the lowest energy first (shell K) then the next energy levels according to energy (L, M, etc). The arrangement of electrons follows a distinct pattern. Two electrons are placed in the first level, then 8 electrons in the second level, and a further 8 in the third level (for the first 20 elements only). The arrangement of electrons also influences the placement of the elements in groups of the Periodic Table.

**Prior Learning**

1. Draw the structure of an atom
2. Use symbol notation to locate the atomic and mass number of an atom
3. Identify the elements on the Periodic Table

**Learning Outcome**

Students who demonstrate understanding can:

1. Calculate the number of sub-atomic particles in a given atom
2. Identify patterns in the arrangement of electrons for the first 20 elements
3. Show the electronic configuration of the first 20 elements using electron shell diagrams
4. Relate the number of outer shell electrons to groups on the Periodic Table

**Assessment Criteria**

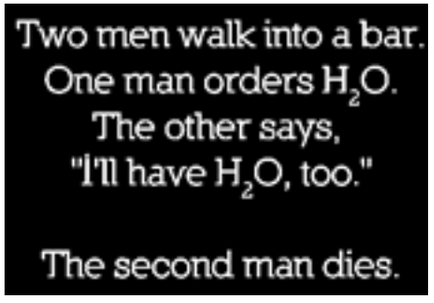
Number of sub-atomic particles correctly calculated
Logical inference made about number of electrons needed to balance charges in an atom
Electron configuration trend correctly deduced
Electron shell diagrams for first 20 elements correctly done
Element/ atom correctly placed in the Periodic Table
Relationship between outer shell electrons and group number correctly deduced

**Teaching Procedure/Activities**

**ENGAGE**

***How can I get students interested in this?*** **Use of an interesting picture. (3 min)**

- Students will be introduced to the brain teaser below and asked to make suggestions and/ or explanations. Teacher and students will discuss.




- *Teacher will clarify any misconceptions and direct students to form their own groups to carry out the next activity.*

**EXPLORE**

***What tasks/questions can I offer to help students puzzle through this?*** **Use of a simple investigation. (22 min)**

- In groups, students will be given modeling clay, wire, beans (peas) and asked to create a model of the atom. They will label the model using the words proton, neutron, electron, nucleus, shell. *Teacher observes the models created by students, then use the students' own depictions to discuss how the sub-atomic particles are arranged*.
- Students will view completed electron shell diagrams of selected atoms. *Teacher will direct students to use the following questions as a guide*:
- **Whole Class:** What do you notice about these diagrams of different atoms?
- Calculate the number of each sub-atomic particle in the shell diagrams.
- **Advanced group:** Why is the atom neutral (not charged)?; How could the identity of each atom be determined?
- **Whole Class:** Use the diagrams to deduce the maximum number of electrons that can be added to each shell. Identify the patterns and trends in the arrangement of electrons and present deductions to the class.
  *Teacher will assess how each group is carrying out the activity and offer guidance as needed.*

**EXPLAIN**

***How can I help students make sense of their observations?*** **Class presentation and discussions. (10 min)**

- Students will discuss and present answers to the questions asked. Students will be guided to see that the number of electrons and protons must be equal to make the atom neutral. The formula for determining the number of each particle (Mass # - atomic # (protons) = # neutrons) will be discussed. The trends and patterns in the arrangement of electrons will be presented by each group. Students will be guided to appreciate that the distribution of electrons in shells/ energy level follows a pattern/ rule with the lowest level (closest to the nucleus) filled first, then the next two energy levels having a maximum of 8 electrons (for the 1st 20 elements).
- Higher Tier – All 20 elements (periods 1-4)
- Middle Tier – Periods 1-3
- Lower Tier – Periods 1 and 2
- *Teacher will note students' deductions and misconceptions and offer clarifications.*

**ELABORATE**

***How can my students apply their new knowledge to other situations?*** **Application of what they learned. (12 min)**

- Students will be asked to use the completed shell diagrams and write the electronic configuration of selected atoms using the shortened form (2:8:8).
- Students will then note the position and group number of each element on the Periodic Table. Students will compare the number of outer shell electrons (in the highest energy level) and the group number and determine the relationship between the two.
- Students will present their deductions for discussion.
- *Teacher and students discuss the deductions and offer additional explanations, noting these on the board.*

**EVALUATE**

***How can I help my students self-evaluate and reflect on the teaching and learning, and how can I evaluate the students learning of concepts and skills?*** **Assessment (13 min)**

- Deductions given by each group will be assessed throughout lesson.
- Students will self-assess by comparing their model atom with a classroom model, noting why their model may look different.
- Students will view blank diagrams of atoms without any electrons (nucleus and shells only) and place electrons correctly in

shells/energy levels. Given the atomic number, students will complete electron shell diagrams for the first 20 elements.

- Students will use 'Think-Pair-Share' activity to share ONE thing learnt during the lesson.

**EXTEND LEARNING**

- Students will research ONE group of the Periodic Table, noting the special name, uses and reactivity of members of the group.

**LINKS TO OTHER SUBJECTS**

- Mathematics

**POST-LESSON REFLECTION**