Science

Lower Secondary

Syllabus

Papua New Guinea
Department of Education

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Contents

Secretary's message

This Science syllabus is to be used by teachers to teach Lower Secondary students (Grades 9 and 10) throughout Papua New Guinea. This syllabus builds upon concepts, skills, attitudes and values from Upper Primary and links to concepts, skills attitudes and values in Upper Secondary. It provides a sound foundation for further learning.

The role of Science is becoming increasingly important for the future development of Papua New Guinea. Science education provides the necessary skills and knowledge for young Papua New Guineans to contribute purposefully towards the development and economic growth of the country thereby improve their standard of living.

The Science syllabus conforms to the *National Education Plan's* vision which is that secondary education enables students to achieve their individual potential to lead productive lives as members of the local, national and international community.

The challenge for the teacher of Science is to shape the curriculum and learning experiences with the needs and interests of students in mind to support their development as independent, lifelong learners. All students require an understanding of the fundamental science concepts, processes, skills, attitudes and values in order to apply these meaningfully in daily situations. Contextual teaching, investigative and inquiry-based learning through rigorous intellectual challenge and the opportunity to explore issues in depth will enhance scientific literacy.

Science prepares students to engage intelligently in, meaningfully contribute to, and debate about important issues involving science and technology in real life. Science provides a foundation for a highly knowledgeable, skilled and responsible workforce. This is crucial to the needs of the industrial and technological advancement of a newly independent nation, in a modern world.

I commend and endorse this syllabus as the official Lower Secondary Science curriculum to be used in all schools throughout Papua New Guinea.

DR JOSEPH PAGELIO
Secretary for Education

Introduction

The *National Curriculum Statement* states that education in Papua New Guinea is outcomes based. All Lower Secondary syllabuses use an outcomes approach. The Science syllabus has been designed using learning outcomes which identify the knowledge, skills, attitudes and values that all students achieve or demonstrate by the end of Grade 10. It selects the essential knowledge and skills from syllabuses teachers have used in the past, and incorporates this with developments in Science to ensure that the syllabus provides relevant skills and knowledge for students. Science is one of the national curriculum learning areas and builds on the knowledge and skills students have learnt in primary school.

Assessment is an important component of teaching for learning and is integrated into the teaching and learning activities of Science. Continuous assessment in Science provides feedback to students and the teacher on students' progress towards achievement of the learning outcomes. It helps students improve their standards of achievement by knowing what they need to do well and where they need to improve. In Science, teachers will gather evidence from students' work during the course of the term and use those continuous assessments to improve their teaching and students' learning.

The Science syllabus has been designed to be relevant by providing topics that include knowledge, skills and values that are useful for all students. The syllabus provides students with the opportunity to study all units as these units provide the foundation for scientific learning for life after Grade 10 as well as for further studies. All units have topics and subtopics which emphasise the development of skills. The four strands which support the Science syllabus are the nature of science, life and living, matter and energy and earth and space. These strands provide the focus for Science and elements of them are included in the units.

This syllabus for the first time provides students with time and space to reflect on and learn about the diverse systems of indigenous knowledge development and skills transfer practised over thousands of years in Papua New Guinea. Students explore inter-relationships between contemporary models of science and traditional ways of constructing knowledge in order to value both systems that sustain resources and life.

The syllabus emphasises students working individually and in groups planning and conducting investigations. They evaluate issues and problems, identify questions for inquiry and draw evidenced-based conclusions from their investigations. Through this problem-solving process they develop their critical thinking skills and creativity. Students are provided with experiences in making informed decisions about the environment, the natural and technological world and in communicating their understanding and viewpoints.

The practical nature of the subject must be emphasised through hands-on activities that will occupy a substantial amount of time. All students will be required to undertake research projects, practical investigations and individual tasks.

Science is to be timetabled for five periods per week in Grades 9 and 10.

Rationale

The future development of Papua New Guinea depends on the sustainable management and use of its natural resources. Agriculture, forestry, fishing, mining and manufacturing sectors are still developing and require the skills of increasing numbers of scientists, technologists and tradespeople who are scientifically literate. A scientifically literate population, both rural and urban, is necessary to make both commercially viable and environmentally friendly decisions.

Science can develop knowledge, understanding and skills to explain and make sense of the biological, physical and technological world, enabling people to make informed choices and responsible decisions as individuals and community members. Science is highly valued by societies all around the world. Its methods and findings are internationally accepted as being an effective way to explain natural phenomena and predict future events or develop new products.

A modern education in Science helps connect students with the natural world, their culture, society and work, and most of all with themselves. Science enables students to develop an appreciation for the nature of scientific knowledge which evolves through repeated experimentation, minimising errors and on occasions through new ideas not related to previous theories. Through Science, students develop scientific literacy in the areas of life and health, earth and environment, space, and technology.

Science strengthens many skills that people use every day like solving problems creatively, thinking critically, working cooperatively in groups, using technology effectively and valuing lifelong learning while taking into account ethical and cultural issues. Students' future learning in subjects such as Agriculture and Design and Technology is very much dependent on a good grounding of basic science learned at the Lower Secondary level.

In Science students learn to evaluate issues and challenges, identify questions for inquiry, draw evidence-based conclusions from information available and communicate findings effectively. Preparing students for the world they will live in requires that more emphasis to be placed on developing the cognitive and meta-cognitive functions they will need: in particular to seek access to information and to organise information in ways that will be conducive to resolving the changing issues of life and living.

Achieving a better future for Papua New Guinea will become a reality through improved scientific literacy levels of everyone and a sound understanding of the nature of science; matter and energy; life and living; earth and space; and traditional and contemporary scientific knowledge. Scientific skills provide students with a foundation for a better living in their community, for further education or for entering into informal or formal employment.

Curriculum principles

The Science syllabus is based on the following curriculum principles taken from the *National Curriculum Statement* for Papua New Guinea. These curriculum principles should influence what teachers teach and how students learn Science.

Our way of life

Cultural relevance

Cultural relevance focuses on the richness and diversity of Papua New Guinean cultures and languages. Our traditional life is based on a holistic perspective that integrates the past, present and future. Papua New Guineans are the original inhabitants of Papua New Guinea and live in sophisticated, organised and self-sufficient societies. Our customs and traditions constitute a cultural mosaic, rich and diverse, and consist of different cultural groups. Our customs and traditions are unique. Science enables students to demonstrate recognition of the importance of the relationship between Papua New Guineans and the natural world. It also demonstrates recognition of the importance of Science as a universal language which enhances the relationship between Papua New Guinea and the world around it.

Maintenance of vernacular language

The Department of Education's *Language Policy in All Schools* states that at the secondary level, lessons will be conducted in English. However, teachers can use opportunities to further develop the students oral and written vernacular (or lingua franca) skills, for example when a concept is better explained using the vernacular or lingua franca. Students must be encouraged to learn and use English, but secondary and high schools should not discourage free communication in vernacular languages that students speak in and out of the school grounds for the purpose of enhancing their learning.

Cultural diversity

Papua New Guinea is fortunate to have so many languages and cultures. The diversity of our cultures is the source of our knowledge, skills, attitudes and Melanesian values. As a multicultural society, we must protect, promote and respect our many cultures and traditional knowledge. There are many people from our own ethnic groupings and from other countries with their own cultures, living and working together in Papua New Guinea. We must ensure that we promote and share our cultures and in this way, multiculturalism will be maintained and enjoyed whilst learning experiences will be enriched. Science recognises and promotes cultural diversity through contextual learning of scientific knowledge and skills.

Ethics, morals and values

Papua New Guinea is striving to create a society in line with democratic, liberal traditions. The citizens of Papua New Guinea should recognise appropriate social relationships based on sound human and religious ethics, morals and values. These are required for interaction with families, villages and wantoks, and other groups, and people from other provinces and nations. The process of socialisation requires a belief in the ethics, morals and values of the Melanesian extended family, dialogue with and respect for others and a willingness to conserve and promote those aspects of our traditions, which are consistent with integral human development. Socialisation also requires an awareness of the interdependence of individuals, societies and nations in the modern world. It requires involvement with family, church, school, community and the world beyond. The Science syllabus emphasises ethical decision making in regard to the preservation of Papua New Guinea environments and resources.

Integral human development

Facilitating integral human development

The Science syllabus contributes to integral human development which is described in the *National Curriculum Statement* as follows:

- *integral* in the sense that all aspects of a person are important;
- *human* in the sense that social relationships are basic
- *development* in the sense that every individual has the potential to grow in knowledge, wisdom, understanding, skills and goodness.

Science enables students to develop their potential so that each individual can solve his or her own problems, contribute to the common good of society and maintain, promote and improve earning and living opportunities.

Sustainability

The natural environment of Papua New Guinea is as diverse as its cultures. This diverse natural and physical environment is threatened by issues such as rapid population growth, mismanagement of resources like over logging-without replanting, abuses associated with mining, over fishing, dynamiting reefs and dumping toxic wastes. Our diverse cultures are also threatened by over exploitation and commercialisation of sacred cultural practices. Unfortunately, some of our cultural traditions, which promoted sustainability, are not being handed down from generation to generation. Science guides students to further appreciate, respect and value their natural environment, cultures, customs and traditions. It gives them the skills and knowledge to identify problems and issues and to take action to sustain these aspects of life in Papua New Guinea for the national and global benefit.

Catering for diversity

Gender

All Lower Secondary syllabuses are designed to cater for the educational needs and interests of both girls and boys. The Department of Education *Gender Equity in Education Policy* recommends that no student in the education system of Papua New Guinea will be disadvantaged on the basis of gender. There is a need for sensitivity to local cultural practices and values, with respect to traditional roles for males and females. The policy aims to prepare students for satisfying lives beyond school where:

- equal, non-violent relationships exist between females and males
- rights to personal respect and safety are reflected in everyday life
- positive cultural values and individual differences are acknowledged and respected.

To implement the policy, teachers have the responsibility to use and promote gender equity practices in their classrooms and with the wider community. This means teachers:

- use teaching and learning strategies that meet the needs and rights of all female and male students
- use gender inclusive language, content, methodology and assessment
- respect positive cultural values and challenge unfair cultural practices
- respect the contributions of men and women to society
- promote positive attitudes and behaviours of social responsibility, empathy and sensitivity.

In Science, students will be given equal opportunities to participate in all practical learning and assessment activities regardless of gender.

In gender sensitive classrooms:

- there is a safe, challenging learning environment which is socially and culturally supportive
- boys and girls have the right to equal power
- students take turns in being the leader and reporter
- students share and participate in activities
- students show respect for other students and their contributions
- teachers encourage students to challenge stereotyped gender roles.

Students with special needs

Many students have special needs. This includes students who are gifted and those who are disadvantaged. Gifted students should be given opportunities to extend their learning. Students who are disadvantaged need special support in the classroom. Teachers have a responsibility to ensure that the learning needs of these students are met. All students are individuals and all have the right to quality education in order to reach their full potential.

Teaching and learning

Science is a subject where practical activities enhance learning. Teaching and learning must reflect that students learn by problem solving and doing.

Student-centred learning

The Science syllabus uses a student-centred approach as a vehicle to guide and facilitate students' learning. A student-centred approach provides students with the opportunity to practice and develop critical thinking, problem solving and decision-making skills, as well as a range of practical skills and knowledge.

A student-centred approach means that teaching and learning approaches need to be flexible to cater for individual differences and learning should be relevant and meaningful to the experiences and needs of the students. A student-centred approach allows teachers to be more flexible in determining the most effective ways to help all students achieve Science learning outcomes. Students learn best through being actively involved in their learning through observation, experimentation and reflection.

In Science, students are encouraged to think critically about what they are learning and to take responsibility for their learning. They learn to teach each other and to learn from each other, to work cooperatively in groups and to work individually. They know that learning has a serious purpose. They enjoy using a wide range of resources and developing a wide variety of skills and techniques. Students learn how to communicate well with others, how to work things out for themselves and how to get the information they need. They become confident through being given the opportunity to use their knowledge and skills to solve problems and make decisions.

Inclusive curriculum

All students are individuals and all have the right to quality education in order to reach their full potential. An inclusive curriculum uses content, language and teaching methods that take account of all students. The Science syllabus values the experiences and knowledge of all students, regardless of gender, ability, geographic location, religious and cultural background, or socioeconomic status.

When interpreting and implementing syllabus learning outcomes, teachers must ensure that learning and assessment activities are inclusive of all students. The following statements identify important requirements of an inclusive curriculum.

- All students have fair access to resources such as time spent with teacher, space in the classroom, books and equipment, outside space.
- All students have equal opportunity to participate fully in teaching, learning and assessment activities.
- The curriculum includes and addresses the needs and interests of all students; girls as well as boys, gifted students, students with disabilities and students from different cultural and religious backgrounds.

- The experiences and knowledge of all students are valued by teachers and are reflected in classroom practice.
- Teaching and learning methods cater for different learning styles by allowing students opportunities to learn in different ways.
- Teachers use a variety of assessment methods that give students opportunities to demonstrate achievement of learning outcomes.

Teachers have a responsibility to ensure that the curriculum they teach, and the classroom practices they use, give all students the opportunity to reach their full potential.

Relevance

The Science syllabus is relevant to the social, spiritual and resource development needs of communities. A key focus of Science is to provide all students with real life and relevant learning experiences. There is a clear emphasis on the development of practical skills and knowledge that ensure students are able to achieve and maintain a sustainable way of life beyond their school years. Learning in Science provides students with opportunities to make connections with, and draw from, their cultural, linguistic and everyday knowledge, skills and attitudes and apply this to what is being learnt in their classrooms. It is essential that students are aware of and value community and local knowledge and realise that learning takes place inside and outside the school context.

Most people in Papua New Guinea work in the informal economy. Students who leave at the end of Grade 10 may need to find work in the informal economy. Students are skilled and prepared to work both in the informal and the formal economy or undertake formal education when there are opportunities. Science encourages independent learning so that all students are nurtured with qualities to become self reliant, adaptable and respectable people.

The Science syllabus enables teachers to support students' learning by encouraging teaching in real-life contexts. This means relating the skills and knowledge of topic to real life situations through the study of the unit Indigenous Knowledge and Practices. People from the community may be involved in learning activities to help teach skills and traditional and contemporary knowledge where appropriate.

Lifelong learning

Science lays the foundation for learning to continue throughout life. The experiences that students gain in Science are critical in encouraging them to continue learning after formal education. Students already know many things when they come to school. They learn many things outside of school and continue to learn after they leave school. The science curriculum builds on what students already know and this learning continues throughout life.

Integration

Relevant and meaningful teaching and learning of Science can be provided by integrating knowledge and skills from a range of subjects such as

Business Studies, Agriculture, Design and Technology and Social Science so that practical activities and projects mimic real life situations.

Taking relevant skills and knowledge from other subjects and using them in Science can make the subject more meaningful. Likewise, skills gained in Science such as measuring, experimenting and problem solving skills can be used to enhance other subjects.

Safety

The Department of Education requires all teachers to have a duty of care, and all students have a duty to act responsibly and safely at all times. Teachers and students must follow appropriate safety instructions and procedures at all times. Safety is always an essential component in Science because of the practical nature of the subject. Thus, teachers and students are required to observe all safety requirements when handling live animals, chemicals, and other hazardous materials both in science rooms and on field trips. Schools must observe all safety requirements as instructed by the Secretary for Education.

Resources

This syllabus requires some standard science equipment as well as resources from the local environment and community. Resources required include text books, basic tools, materials (some electrical), chemicals and physical apparatus.

Schools will require a basic science kit including the standard laboratory equipment to complete many of the learning and assessment tasks.

Aims of Science

The aim of the Science syllabus is to provide relevant learning experiences through which students gain knowledge, develop appropriate attitudes and values and develop process skills and general skills.

The focus of the Science curriculum at Lower Secondary is in areas of conceptual understanding and the development of scientific thinking. It looks at use and application of tools and technologies, processes of investigation and communication. The overall focus is to develop a scientifically literate student.

Knowledge

- develop critical thinking and skills to make decisions based upon supported and reliable evidence
- recognise the significance of the purposeful contribution science can make in the changing society of Papua New Guinea and the world
- develop an awareness of, interest in, and curiosity about phenomena in the environment, and a commitment to seek scientific explanations of these phenomena
- acquire a level of scientific understanding which enables students to recognise and solve problems in any environment
- develop an understanding of a selection of significant scientific concepts, and the ability to apply them in relevant situations
- develop an understanding and appreciation of the methods and application of Science, and the past, present and future contributions of science to life on earth and beyond
- develop an ability to analyse scientific findings and make logical interpretations
- live as productive citizens, caring and contributing responsibly towards sustainability.

Attitudes and values

- questioning
- being both sceptical and open minded
- caring and respecting
- questioning but respecting others opinions; accepting and questioning criticisms
- caring and respecting the environment
- being healthy and safe
- encouraging others to practice healthy habits in a systemic way
- being honest, reliable and punctual
- being enthusiastic.

Process skills

- observing
- classifying
- measuring especially identifying sources of the error
- inferring (deducing or drawing conclusions)
- predicting (guess the future using facts and observations)
- estimating (guess the size or measurement)
- hypothesising (give reasons for an event happening)
- experimenting and investigating.

General skills

- communicating
  - reading for understanding
  - explaining a science concept to other groups or class members
  - exchanging information with others
- cooperating in groups
  - working together to complete an investigation
  - collecting data individually and combining with other group members' data
- organising and interpreting data/graphs
  - presenting data in appropriate form
  - providing different possible interpretations of the same data
  - demonstrating simple technical drawings skills
- analysing, thinking critically, solving problems, making decisions
  - searching for patterns in data
  - presenting problems in diagrammatic form
  - discussing the usefulness and validity of an experiment
  - knowing that there are many different types of problems
  - looking critically at explanations
- researching
  - using other data to support a point e.g. class debate on logging
  - locating data quickly using indexes and skimming
- being creative or innovative or imaginative
  - describing what an unfamiliar situation might be like e.g. the surface of Pluto, the future
  - using creativity in problem solving
- self and peer assessment and evaluation
  - assessing other's work
  - assessing one's own work
- planning
  - planing an investigation

- transferring skills and knowledge from one context to another
  - using mathematical skills to quantify simple scientific descriptions
  - using scientific skills and knowledge to suggest solutions to simple everyday problems
- model building
  - being aware of the development of models through history, for example flat earth
  - using models as a simple way to provide explanations for more complex and abstract ideas/concepts
- recalling facts
  - learning blocks of information
- motor skills
  - handling standard apparatus, design functioning apparatus, and improvise.

Content overview

Science broad learning outcomes

The Science broad learning outcomes are statements that identify the knowledge, skills, attitudes and values all students should achieve or demonstrate at the end of Grade 10. The broad learning outcomes are linked to the unit learning outcomes.

Students can:

1. demonstrate an understanding of fundamental scientific principles and models
2. apply scientific thinking, process and motor skills to ask questions, investigate and find solutions
3. compare traditional and contemporary science methods used to generate and verify knowledge and explain natural phenomena
4. communicate findings of scientific investigation in a variety of ways
5. analyse past, present and future scientific developments and their socio-economic and environmental impact, and make informed decisions.

Strands

The strands describe the dimensions of the subject. They are broad, organising structures that define ways of approaching learning in Science. They incorporate cross-curriculum learning and skills and are woven through the units within Science.

The Lower Secondary Science curriculum is structured under four conceptual strands. The four strands link with the Upper Primary Science strands and sub-strands.

The strands for Science are the nature of Science, life and living, matter and energy, and earth and space.

Strand descriptions

The nature of Science

The nature of Science is an active or ongoing process of seeking new knowledge and verifying existing knowledge. Science is a powerful way of generating understanding and solving problems. This strand helps students develop an understanding of what science is and how it works.

It enables students to be aware of the history and origins of contemporary science, and the history and origins of the indigenous knowledge of Papua New Guinea. It allows students to compare similarities and differences between traditional practices, values and observations and scientific views, principles and assumptions in order to value both.

In this strand students reflect on and appreciate the processes of science and the factors that influence them. It enables students to focus on solving problems and issues through scientific processes and become creative and innovative in a socially responsible way. It develops an appreciation of the tentative nature of scientific knowledge and how it evolves over time.

Life and living

The life and living strand is about the diversity of living things and their interactions with each other and the physical world. It considers the functions of various parts of living things and compares these in different ecosystems.

This strand considers the way in which living things adapt to environments and change. It examines ecological habitats, roles of plants in ecosystems, life processes, and social and biological issues surrounding the survival of species. The study of the interdependence of living things includes consideration of relationship of organisms within ecosystems. It also explores the effects of human activity on these systems.

This strand provides students with an understanding of the interdependence of different life forms and the need to conserve the balance of nature.

Matter and energy

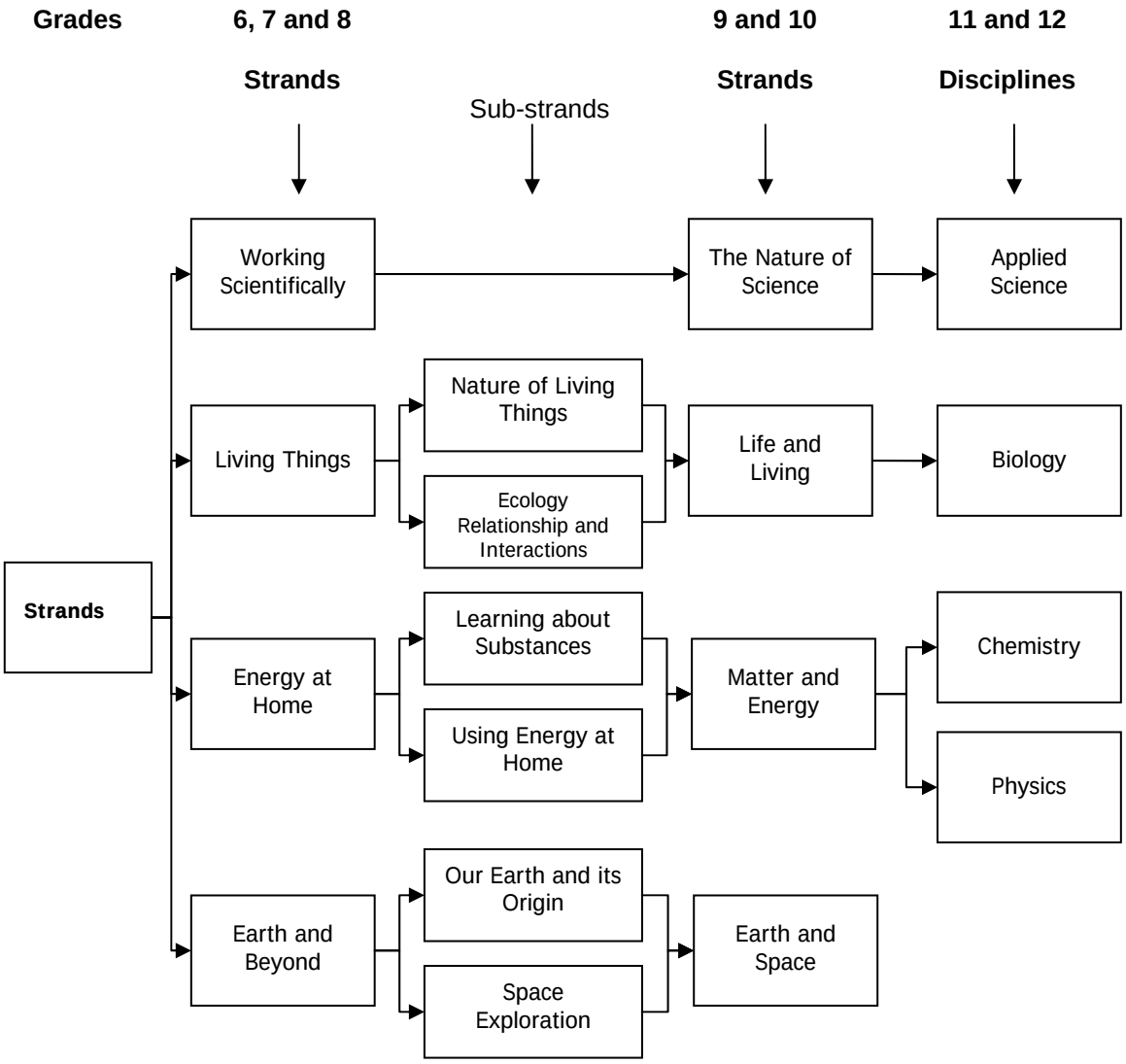
This strand relates to the structure of matter and its behaviour leading to reactions, and using these reactions for practical purposes. It relates to the vital role of energy in our lives as individuals and as a society. It focuses on the sources, conversion and transfer of energy and its application to the home and industry. The strand helps students become knowledgeable about rapidly changing technology and its implications for the world.

Earth and space

Our lives depend on air, water and materials from the ground. The way we live depends on our landscape, weather and climate. This strand considers a diverse range of issues related to geology and the atmosphere. It provides an opportunity for students to explore the structure of the earth and natural phenomena that bring about changes.

This strand includes the various layers of the atmosphere and the important roles they play. It looks at the nature and effect of rotations and revolutions of planets including the Earth. It also includes the active atmosphere and effects of radiation on land and water and related issues.

Overview of Science from Upper Primary to Upper Secondary



Units

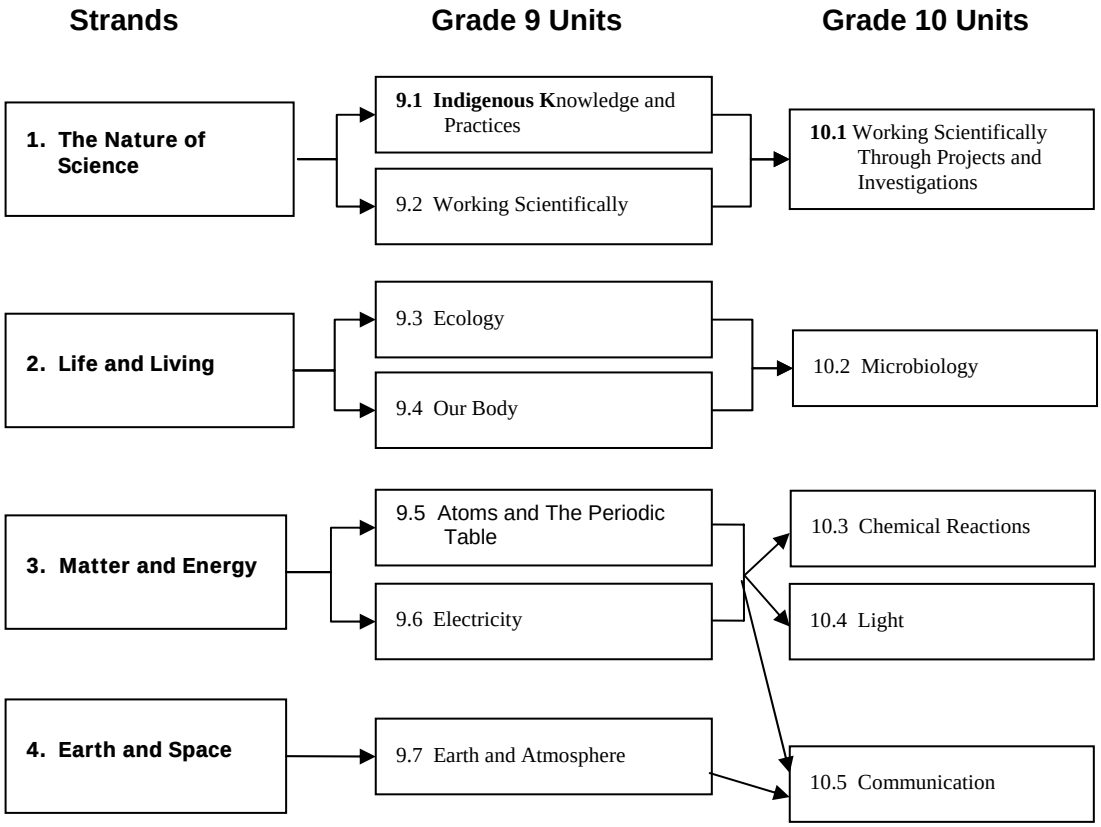
There are twelve units in this syllabus; seven Grade 9 units and five Grade 10 units. All units are core units. All units have both an academic focus and a practical/skills based focus. Each unit has a number of specific learning outcomes which link with the broad learning outcomes of the subject.

The description of each unit is in three parts. The first part is the context which establishes relevance of the scientific concepts, knowledge, skills, attitudes and values studied in the unit to real world situations. Teaching topics in a realistic context will provide motivation for meaningful science learning.

The second part describes the essential subject matter for the unit stated as topics and subtopics. The third part is scientific process, the specific techniques to be studied and used in the unit.

By setting the context, following the content prescribed and using appropriate processes, all units can be taught meaningfully benefiting all students with different needs, interests and aspirations. Most of all learning science should be fun.

The diagram below shows how the units are sequenced in this syllabus, but teachers do not necessarily have to follow the syllabus sequence.



School developed units

If particular topics or contexts are not available within the syllabus, then schools can develop units to meet their local requirements. Units are developed within the nationally accredited curriculum framework and use the broad learning outcomes of the subject. Once accredited by the Secondary Board of Studies (SBOS) a school developed unit can be offered to students.

This Science syllabus is designed so that there is flexibility in time allocation. Schools are encouraged to develop units according to their own local situations and time they have available, particularly in Grade 10. For example, schools near the coast may write and teach a unit on Marine Biology while schools near a mining centre might want to develop and teach a unit on Mining.

Unit learning outcomes mapped against broad learning outcomes

Broad learning outcomes		1. Demonstrate an understanding of fundamental scientific principles and models	2. Apply scientific thinking, process and motor skills to ask questions, investigate and find solutions	3. Compare traditional and contemporary science methods to generate and verify knowledge and explain natural phenomena	4. Communicate findings of scientific investigation in a variety of ways	5. Analyse past, present and future scientific developments and their socio-economic and environmental impact, and make informed decisions
Strand 1: The Nature of Science	**9.1**	9.1.1 Demonstrate an understanding of traditional knowledge and practices	9.1.2 Investigate the scientific principles underlying in some traditional practices	9.1.3 Show how traditional knowledge and practices provide sustainable living	9.1.4 Present Science as a human endeavour with contributions from around the world	9.1.5 Analyse interactions between scientific development and traditional beliefs
	9.2	9.2.2 Demonstrate mastery in the use of equipment and handling of data	9.2.1 Assess the nature of a particular procedure or instrument and take responsibility for its safe and accurate use	9.2.4 Identify work done by Papua New Guinea scientists	9.2.3 Identify information needed to undertake a scientific project in order to make an informed decision.	
Strand 2: Life & Living	**9.3**	9.3.1 Demonstrate understanding of the natural processes that are essential for the survival of biotic life in an ecosystem	9.3.2 Investigate natural and human-made changes on eco-systems and make suggestions to preserve the natural environment for all living things			9.3.3 Identify how ethical application of knowledge can contribute to economic growth as well as sustainable different ecological systems
	9.4	9.4.1 Describe the basic structures and functions of systems in the body	9.4.2 Investigate how the structure of organs enables them to perform their functions			9.4.3 Examine how proper diet, habit and exercise keep the body healthy

Unit learning outcomes mapped against broad learning outcomes

Broad learning outcomes		1. Demonstrate an understanding of fundamental scientific principles and models	2. Apply scientific thinking, process and motor skills to ask questions, investigate and find solutions	3. Compare traditional and contemporary science methods to generate and verify knowledge and explain natural phenomena	4. Communicate findings of scientific investigation in a variety of ways	5. Analyse past, present and future scientific developments and their socio-economic and environmental impact, and make informed decisions
Strand 3: Matter & Energy	**9.5**	9.5.1 Demonstrate understanding of the basic structure of atoms	9.5.2 Investigate the relationship between the properties of atoms and their structure using their location in The Periodic Table		9.5.3 Use combining power concept of atoms to write chemical formulae of compounds leading to chemical equations	9.5.4 Explain how and why the atomic model has evolved over centuries
	9.6	9.6.1 Demonstrate an understanding of electricity and electromagnetism	9.6.2 Construct different types of circuits and recognise their application in household electricity 9.6.3 Investigate and explain energy transfers and efficiency of devices			9.6.4 Compare different methods of generating electricity and their environmental impacts
Strand 4: Earth & Space	**9.7**	9.7.1 Describe the structure of Earth and its atmosphere and their role on life on Earth.	9.7.2 Investigate factors affecting weather, weathering and rock formation	9.7.3 Compare the traditional and contemporary scientific methods of predicting and explaining natural phenomena		9.7.4 Set up and use weather equipment to record and describe local weather patterns
Strand 1: The Nature of Science	**10.1**		10.1.1 Apply scientific skills competently to carry out integrated projects or investigations	10.1.2 Assess implications of the findings of a project in relation to people, their environment and ethical considerations		
Strand 2: Life & Living	**10.2**	10.2.1 Describe and explain the role of microbes in the living world	10.2.2 Safely and correctly use a microscope to observe, measure and show the characteristics of micro-organisms	10.2.3 Demonstrate how useful and harmful activities of microbes can be utilised for food processing and healthy living		

Unit learning outcomes mapped against broad learning outcomes

Broad learning outcomes		1. Demonstrate an understanding of fundamental scientific principles and models	2. Apply scientific thinking, process and motor skills to ask questions, investigate and find solutions	3. Compare traditional and contemporary science methods to generate and verify knowledge and explain natural phenomena	4. Communicate findings of scientific investigation in a variety of ways	5. Analyse past, present and future scientific developments and their socio-economic and environmental impact, and make informed decisions
Strand 3: Matter & Energy	**10.3**	10.3.1 Demonstrate understanding of the characteristics of chemical change and factors influencing change in materials	10.3 2 Investigate specific reactions of acids and bases and write balanced equations		10.3.3 Present an investigative report on at least one chemical process involved in industries in Papua New Guinea	
	10.4	10.4.1 Demonstrate understanding of the particle model and wave model of light energy in its propagation and effects	10.4.2 Investigate and explain the properties of images formed by optical devices		10.4.3 Use wave model of light to explain its place in the electromagnetic spectrum	10.4.4 Analyse the impact of optical inventions and associated major discoveries
Strand 4 Earth & Space	**10.5**	10.5.1 Demonstrate an understanding of the wave motion and wave nature of sound	10.5.2 Investigate the effect of wave characteristics on volume and pitch		10.5.3 Present an investigative report on development of communication means over the ages	10.5.4 Analyse the importance of science in communication technology for improved socio-economic development

Unit sequence and structure

Grade 9 Core Units	Grade 10 Core Units
9.1 Indigenous (local) knowledge and practices 4-5 weeks ▪ Types of knowledge • Practice in passing on knowledge • Sustaining our resources and knowledge systems • Usefulness of knowledge systems	**10.1 Working scientifically through projects and investigations 5-6 weeks** • Working safely • The scientific approach • Undertake a scientific project (in groups and individually)
9.2 Working scientifically 5-6 weeks • Measurement • The scientific approach • Papua New Guinea scientists	**10.2 Microbiology 5-6 weeks** • Introduction to microbiology • Useful microbes • Harmful microbes
9.3 Ecology 4-5 weeks • Ecology • Ecological issues • Maintaining balance	**10.3 Chemical reactions 5-6 weeks** • Chemical changes • Analysing matter • Corrosion
9.4 Our body 5-6 weeks • Skeletal and muscular system • Circulatory system • Respiratory system • Excretory system	**10.4 Light 6-7 weeks** • Light energy • Reflection and refraction of light • Images • The eye • Dispersion of light and colours • Useful inventions and applications of light
9.5 Atoms and The Periodic Table 4-5 weeks • Introducing atomic theory • The Periodic Table	**10.5 Communication 5-6 weeks** • Methods of communication • Sound waves • Making waves • Telecommunication
9.6 Electricity 6-7 weeks • Types of electricity • Circuits • Uses of electricity • House hold electricity • Generating electricity	**10.6 School developed unit**
9.7 Earth and atmosphere 5-6 weeks • Structure of earth • Rock cycle and weathering • Structure of atmosphere • Active atmosphere • Weather	

Grade 9 core units

9.1 Indigenous (local) Knowledge and Practices

Strand: The nature of science 4-5 weeks

This unit is a new inclusion to the Lower Secondary Science curriculum. It is recommended that this unit be taught in term 4 after Unit 9.7 Earth and Atmosphere when students have greater understanding of scientific knowledge and approaches.

Context

Did you know that many of the medicines we now use such as aspirin were used by the ancient Greeks and the Romans? Did you know the Ancient Chinese invented gunpowder? Did you know that the Ancient Mayan's had incredible records of medical cures and still probably lead the world in the diagnosis and treatment of diarrhoea. The Ancient Egyptians used impressive construction techniques and were also great astronomers *(Huff, 1995). What about here in PNG? Where do our traditional skills and knowledge come from? How can we be sure the knowledge we use is reliable? Can you think of something your elders used to know about, or something they were skilled at doing? Have these skills or knowledge been passed on to you? Why don't you try and find out more about your shared traditional knowledge by asking questions at home? Who owns the knowledge? How is it shared?

Content

This unit provides opportunities for students to review and value traditional knowledge and practices sustained over thousands of years and recognise that this knowledge has a place in contemporary society. It builds on from the elementary and primary where students began to explore the local area and the environment noting the different things available for events and occasions. The challenge for students at this level is to revisit their communities, to investigate, recognise, compare and identify the types of knowledge, skills and values, and *learn about* traditional knowledge systems and processes of passing on knowledge.

Process

Most students will have some knowledge of their own traditions and on a wider level, their own cultural experiences. Reconstruction of their experiences began at the elementary and the lower primary levels through Community Living and Environmental Studies. At Lower Secondary, students are provided with further opportunities to investigate traditional knowledge systems and practices. They can discuss and debate their usefulness in the past and present, and find means and ways to sustain Papua New Guinea's cultural and traditional knowledge. Activities such as

finding a book that describes ‘what Science is!’ and comparing this with the way they have learnt knowledge at home or in school will enable and empower students to ask questions and begin to value what is truly their own, passed on through generations for thousands of years.

Unit learning outcomes

Students can:

9.1.1 demonstrate an understanding of traditional knowledge and practices

9.1.2 investigate the scientific principles underlying in some traditional practices

9.1.3 show how traditional knowledge and practices provide sustainable living

9.1.4 present Science as a human endeavour with contributions from around the world

9.1.5 analyse interactions between scientific development and traditional beliefs.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Topic 1: Types of knowledge

Introduction

Reflect on the traditional knowledge and skills of:

- historical importance
- processing and sustaining resources.

Classification/taxonomies

Investigate indigenous classification/taxonomies and compare with contemporary science for:

- medicines
- good health
- farming/fishing/hunting
- construction
- entertainment
- basic technologies.

Natural processes, phenomena (the way things happen)

Investigate the local understandings of:

- 'natural' processes
- relationships involving plants/animals
- various supernatural and environmental factors of Papua New Guinea produced knowledge
- how it promotes sustainable living.

Ecological management (techniques of looking after the environment)

Explore the:

- ecological management knowledge
- decision-making processes
- responsible harvesting and hunting - getting just what is needed from the environment.

Topic 2: Practice in passing on knowledge

Processes of passing knowledge

Explain and demonstrate how different types of knowledge and skills, are passed on through generations in Papua New Guinea:

- oral exchange
- imitation
- experience, trial and error.

Testing knowledge

Discuss ways the testing of knowledge was done to confirm its reliability:

- scientists
- traditionally over very long periods of time, sometimes over generations.

Topic 3: Sustaining our resources and knowledge systems

Sustaining of resources

Explore and reflect on:

- traditional resource rights
- changes in the last 100 years
- intellectual property rights.

Local initiatives

Research local initiatives available to promote the sustainability of local knowledge and practices in terms of:

- self-demarcation of territory
- community recording of local knowledge and biodiversity
- community controlled research.

Contracts and agreements

Examine what legal agreements; contracts, covenants, material and information transfer agreements are in place at these levels:

- local
- provincial
- national.

Topic 4: Usefulness of knowledge systems

Identify and compare:

- usefulness of traditional knowledge systems
- contemporary knowledge systems.

Skills

The specific skills and attitudes practised and gained through this unit.

Attitudes and values:

Being healthy and safe; caring and respecting; self organising; being open-minded; being appreciative; being sceptical or questioning.

Process skills

Observing, classifying, estimating, predicting, researching.

General skills

Communicating, reading for understanding, analysing, thinking critically, problem solving, making decisions, cooperating and collaborating, organising and interpreting data, graphing.

Resources

Elders, written stories, story boards, text books

Assessment

Assessment task one

Oral presentation about traditional knowledge

Assessment criteria

Assessment task one will be assessed on the extent to which students can:

- show an example of locally produced knowledge or process
- demonstrate how this knowledge was generated and tested for its reliability
- identify any scientific principles evident in the knowledge
- explain how this knowledge was passed on from generation to generation
- argue for the usefulness or otherwise of this knowledge.

Marks 25

Assessment task two

Written reflection on traditional knowledge against contemporary science

Assessment criteria

Assessment task two will be assessed on the extent to which students can:

- show that some traditional knowledge and practices are more friendly to the environment
- demonstrate that contemporary science may produce fast economic growth but not sustainability for the environment
- recognise the limitations of traditional knowledge
- recognise the usefulness of contemporary science in areas such as health or communication
- make choices and decisions that are ethical and sustainable
- identify the effects of contemporary science on traditional societies.

Marks 25

Total marks 50

*Huff, T. E. (1995) *The Rise of Early Modern Science Islam, China and the West*. Cambridge University Press

9.2 Working Scientifically

Strand: The nature of Science 5-6 weeks

Context

Do you know how tall you are? Or how hot the cup of tea you drank this morning was? How much hot water you have used to make your cup of tea? How much a tea spoon of sugar weighs? Can you imagine the world today without accurate and reliable measurements of length, volume, mass, time and temperature and its implications on everyday life? How do scientists carry out their work? How does a vulcanologist at the Rabaul Observatory know there will be an earthquake? How will a medical researcher at the Institute of Medical Research find a cure for HIV/AIDS?

Content

This unit builds on basic measuring skills developed through the strand, Working Scientifically at Upper Primary. Measurement is important in the modern world today. The accuracy and reliability of instruments used to measure objects and the measurements made are vital. In this unit students learn about the basic use and handling of instruments, how to use measuring instruments correctly, the systems of units and how to work safely either in a science room or when carrying out fieldwork. Understanding of working scientifically is extended when students carry out simple investigations using scientific approaches. Students carry out an investigation or a project work to demonstrate, consolidate and enhance the mastery of these life skills. They look at the work scientists undertake in Papua New Guinea and the scientific methods and processes they use.

Process

The need to use scientific processes and techniques in this unit is important. Students learn about and apply specific techniques that make up the scientific process. They identify problems, make predictions, set out a hypothesis and do testing by observing, collecting, recording data, analysing and drawing conclusions before reporting their findings. In working scientifically, safe handling of scientific instruments or other equipment is necessary to avoid accidents. Students also develop an appreciation of the possible sources of error at the different stages of an investigation and acknowledge them as appropriate.

Unit learning outcomes

Students can:

9.2.1 assess the nature of a particular procedure or instrument and take responsibility for its safe and accurate use

9.2.2 demonstrate mastery in the use of equipment and handling of data

9.2.3 identify information needed and undertake a scientific project in order to make an informed decision

9.2.4 identify work done by Papua New Guinea scientists.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Topic 1: Measurement

Unit systems

Compare and contrast:

- scientific and non-scientific measurements
- estimation and arbitrary units
- SI unit systems and the imperial system
- use of scaled apparatus for measuring.

Measuring length, volume, mass and density

Select different objects and:

- measure length
- measure volume
- measure mass
- calculate density.

Reliability and accuracy in taking measurements

Discuss the importance of:

- making measurements reliable and accurate
- parallax error/meniscus and others.

Topic 2: The scientific approach

Safe use of apparatus and instruments

Identify different scientific equipment used in the science classroom, explain and apply:

- correct operational procedures
- appropriate First Aid and its importance

- rules of safety when working together
- preventative measures e.g. use of gloves and goggles.

Investigative processes

Apply these scientific investigative skills in small guided investigations:

- identifying a problem
- predicting
- inferring
- hypothesising and testing
- experimenting/testing - variables and control
- observing and recording
- collecting and collating data
- analysing
- drawing conclusions
- reporting.

Topic 4: Papua New Guinea scientists

Undertake a case study or analyse a case study of:

- work of one scientist in Papua New Guinea (environmental scientists, geologists including astrogeologists, meteorologists, researchers)
- equipment and technologies scientists are using.

Skills

The specific skills and attitudes practised and gained through this unit.

Attitudes and values:

Being healthy and safe; caring and respecting; self organising; being open-minded; being appreciative; being sceptical or questioning.

Process skills

Investigating skills such as:

observing, classifying, measuring, estimating, experimenting, predicting, hypothesising, researching, using and manipulating equipment, collecting and analysing data, and drawing conclusion.

General skills

Communicating, reading for understanding, analysing, thinking critically, problem solving, making decisions, cooperating, graphing, presenting data and reporting.

Resources

All resources available to the school e.g. science equipment, library, resource - people, local environment, practising scientists

Assessment

Assessment task one

Practical skills

Assessment criteria

Assessment task one will be assessed on the extent to which students can:

- estimate measurements to some degree of accuracy without using equipment
- identify the appropriate equipment needed for a range of measurements
- use and manipulate equipment safely
- measure accurately
- apply correct and appropriate units of measure.

Marks 30

Assessment task two

Report on guided investigation - general investigations

Assessment criteria

Assessment task two will be assessed on the extent to which students can:

- identify information (data) and equipment needed for the investigation
- recognise terms such as hypothesis, observation, control, variables
- present data in different ways such as tables, graphs
- plan and follow the correct order of steps to carry out and report on an investigation
- evaluate the processes and procedures used and suggest improvement
- use appropriate mathematical formulae to solve science problems.

Marks 30

Total marks 60

9.3 Ecology

Strand: Life and living 4-5 weeks

Context

Did you know that the world's largest butterfly is found right here in Papua New Guinea, and the largest tree frog and the largest pigeon? Papua New Guinea is home to over 3000 species of orchids and thousands more of insects, some of which are yet to be identified by scientists. How can they all be protected? Do you know that some actions in local environments and ecosystems can lead to larger disastrous global effects? When some of the ecological problems in local areas are identified and solved acting appropriately locally can make a difference globally.

Content

Students coming into this level have prior knowledge about feeding relationships and interactions in natural ecosystems through the strand Living Things at upper primary level. This unit provides students with an understanding of the balance in nature, and extends their current knowledge about ecosystems leading to investigations of how plants and animals have adapted themselves for survival and how carbon and nitrogen are recycled. It further provides an opportunity to investigate other ecological issues affecting ecosystems and how to maintain balance in nature through sustainable practices.

Process

The unit begins with an exploration of ecosystems by investigating some of the useful life processes such as photosynthesis and nutrient recycling leading to examining the impact of disturbances on the balance of nature, analysing problems associated with these and finding solutions to some of the problems. This unit provides greater opportunities for students to actually apply many of the scientific processes introduced in Unit 9.2 Working Scientifically. The unit also extends student investigations into and discussions about work of ecologists that will provide an understanding of the application of ecology.

Unit learning outcomes

Students can:

9.3.1 demonstrate an understanding of the natural processes that are essential for the survival of biotic life in an ecosystem

9.3.2 investigate natural and human-made changes on ecosystems and make suggestions to preserve the natural environment for all living things

9.3.3 identify how ethical application of knowledge can contribute to economic growth as well as sustain different ecological systems.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Topic 1: Ecology

Introduction

Investigate and identify different:

- ecosystems
- species, population and community
- ecological niche (suitable places) and habitats
- roles of plants in the ecosystem.

Life processes

Investigate and describe life processes like:

- photosynthesis
- interdependence.

Nutrient cycles

Investigate the importance, roles and maintenance of:

- decomposers
- carbon cycle
- nitrogen cycle.

Topic 2: Ecological issues

Human influence on the ecosystems

Research major influences on ecosystems and how to minimise the effects brought about by:

- mining
- logging
- destructive fishing
- invasive species.

Pollutants

Analyse information on:

- use of persistent organic pollutants
- use of pesticides, insecticides, weedicides
- gas emissions, greenhouse effects, acid rain
- atmospheric pollution, atmospheric radiation/measurement.

Topic 3: Maintaining balance

Nature's process of maintaining balance

Identify sustainable management practices for maintaining balance in nature:

- limiting factors such as diseases, natural predation, natural fires
- ecological succession.

Endangered and endemic species

Investigate current practices including work of ecologists in sustaining:

- endemic species of fauna and flora
- endangered and threatened species of fauna and flora.

Skills

The specific science skills and attitudes practised and gained through this unit.

Attitudes and values:

Caring and respecting; self organising; being open-minded; being appreciative; being sceptical or questioning.

Process skills

Observing, investigating, estimating, predicting, hypothesising, researching.

General skills

Communicating, reading for understanding, analysing, thinking critically, problem solving, making decisions, cooperating and collaborating, organising and interpreting data, graphing.

Resources

Empty bottles with lids, fine mesh wire net (made of baby mosquito net attached to long wires for holding); hand lenses, variety of posters on plants and animals of PNG as well as on logging, mining and other impacts, any available resources to the school such as library, forested areas, coral reefs, beaches; a collection of work done by Papua New Guinea ecologists.

Assessment

Assessment task one

Case Study – Human impact on an ecosystem

Assessment criteria

Assessment task one will be assessed on the extent to which student can:

- identify a local environment issue and ask appropriate questions
- investigate, collect, analyse and infer to answer questions
- identify any scientific principles evident in the findings
- recommend practical solutions to reduce impact on environment
- evaluate investigative methods followed for improvement.

Marks 30

Assessment task two

Written test: Multiple choice and short answer

Assessment criteria

Assessment task two will be assessed on the extent to which students can:

- show understanding of natural processes such as photosynthesis
- identify stages of nutrient cycles such as carbon, nitrogen cycles
- recognise the impact of pollutants on natural processes and energy chains
- interpret diagrams, tables, graphs related to ecology.

Marks 20

Total marks 50

9.4 Our Body

Strand: Life and living 5 - 6 weeks

Context

Do you ever stop to think about how your body works tirelessly like a machine, with many systems that function together simultaneously to keep it operating and alive? As a machine, it requires fuel that produces energy for its functions. Like a machine, the body must get rid off its waste products in order to stay alive and do things like move fingers, run and jump, smile and frown, smell, taste, breathe and sweat. This is because our body is made up of different but interrelated systems which include the brain, bones, muscles, heart, blood, lungs, and skin. The importance of maintaining a healthy body through physical exercise and healthy habits is better understood when there is an understanding of the body systems and their interrelated functions.

Content

Students would have studied some systems of the body including; cell structure (Grade 6), digestive system (Grade 7), respiratory system (Grade 7) and reproductive system (Grade 8) through the sub strand Nature of Living things. This unit expands on students prior knowledge by focussing on learning about the structures and functions of the other body systems; the skeletal, muscular, circulatory, respiratory and excretory systems. Students also learn about the interrelatedness of these body systems and their functions and the consequences of the break down of one system on the function of another system.

Process

Students take an investigative approach when studying the prescribed topics through constructing and testing models, direct observations of skeletal and muscular mechanism, measuring heart beat and breathing rates, examining skin structures and comparing with other animals. Appropriate instruments or apparatus are used such as; watch, stethoscope, scalpel and microscope, weighing scales, and gloves to find out more about the different body systems. A health worker can introduce students to safety and first aid procedures like resuscitation. Students are also exposed to the role of organizations like Sir Buri Kidu Heart Foundation in Port Moresby.

Unit learning outcomes

Students can:

9.4.1 describe the basic structure and functions of systems in the body

9.4.2 investigate how the structure of organs enables them to perform their functions

9.4.3 examine how proper diet, habit and exercise keep the body healthy.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Topic 1: Skeletal and muscular system

Introduction

Observe and/or describe:

- human body from the physical appearance
- human body's internal structures and functions
- similarities between human organs and organs of other animals.

Skeletal system

Investigate the human skeletal system:

- role of skeletal system
- structure of a bone
- types of joints
- structure of a typical joint
- what happens when bones break and how bones heal
- safety and health measures.

Muscles and tendons

Investigate:

- movement of bones
- muscles, tendons and ligaments
- functions of muscles and tendons
- construction of models.

Topic 2: Circulatory system

Heart and circulation

Investigate:

- human heart and its position
- structure and function of the heart
- heart rate (pulse) through measurement
- blood vessels and circulation of blood.

Blood and blood cells

Warning! Do not handle human blood

Investigate and identify:

- composition and functions of blood
- constituents of blood cells
- blood cell types, structure and function
- heart and blood related problems.

Topic 3: Respiratory system

Breathing

Investigate the importance of:

- human respiratory system
- inhalation
- exhalation
- gaseous exchange in lungs.

Respiration and energy production

Investigate the importance of the:

- respiration process in the human body and release of energy
- chemical process in the body
- diet
- equations

  Glucose + Oxygen → Carbon dioxide + water + Energy

- waste products of respiration.

Topic 4: Excretory system

The skin

Investigate and describe the:

- structures of layers and functions of skin
- waste products, urea and CO_2 in sweat.

The kidneys

Investigate:

- structures and functions of kidneys
- waste products: urea in urine
- water balance
- kidney related problems and their prevention.

Skills

The specific science skills and attitudes practised and gained through this unit.

Attitudes and values:

Being healthy and safe; caring and respecting; self organising; being open-minded; being appreciative; being sceptical or questioning.

Process skills

Observing, classifying, measuring, estimating, experimenting and investigating, predicting, hypothesising, researching, using and manipulating equipment.

General skills

Communicating, reading for understanding, analysing, thinking critically, problem solving, making decisions, cooperating and collaborating, organising and interpreting data, graphing.

Resources

Health charts and posters from health centres, human resources (health worker), library resources, equipment such as, scalpel, microscope, watch, stethoscope, animal organs such as heart, lungs kidney etc.

Assessment

Assessment task one

Practical skills - make a working model of a part of a body system

Assessment criteria

Assessment task one will be assessed on the extent to which students can:

- demonstrate an understanding of how the system works
- identify and label parts correctly
- describe the functions of the system
- recognise similarities between the body system and simple machines.

Marks 30

Assessment task two

Written test: Multiple choice and short answer

Assessment Criteria

Assessment task two will be assessed on the extent to which students can:

- show understanding of the structure and functions of body systems
- describe how poor diet, bad habits and lack of exercise lead to poor health
- recognise similarities in the body system of humans and other animals
- interpret diagrams, tables, graphs related to body structures and functions.

Marks 30

Total marks 60

9.5 Atoms and The Periodic Table

Strand: Matter and energy 4- 5 weeks

Context

We know that anything that has mass and energy and occupies space is called matter. Do we know what matter including all living and nonliving things is made up of? Why does firewood when burned turn into a black solid we call charcoal or carbon? Why is water known as H_2O or Carbon dioxide as CO_2?

Content

Students have learned about substances, physical and chemical changes, and acids and bases in Upper Primary. In this unit they are challenged to understand abstract atomic structures and patterns, and the organisation and arrangement of the atoms and elements in The Periodic Table. They learn about the development of The Periodic Table because it helps understanding as to why elements are arranged in rows and groups. The Periodic Table shows the valency of atoms of elements and the symbols that are used to write the chemical formulae of compounds. The Periodic Table shows the main classifications of elements into metals and non-metals according to the differences in their properties.

Process

In this unit students study the patterns of the structures and arrangements of particles in class and arrangements of elements in The Periodic Table. Students construct models to study the structures of elements and write chemical formulae.

Unit learning outcomes

Students can:

9.5.1 demonstrate an understanding of the basic structure of atoms

9.5.2 investigate the relationship between the properties of atoms and their structure using their location in The Periodic Table

9.5.3 use combining power concept of atoms to write chemical formula of compounds leading to chemical equations

9.5.4 explain how and why the atomic model has evolved over centuries.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Topic 1: Introducing atomic theory

Matter and elements

Explore and Investigate the:

- three states of matter
- properties of substances.

Atoms, the building blocks of elements

Investigate and define:

- elements
- atoms.

Structures of atoms

Identify the structures of atoms:

- nucleus, consisting of protons and neutrons
- shells, consisting of electrons
- stable structure
- elements and their classification.

Topic 2: The Periodic Table

Development of The Periodic Table

Investigate the historical development of The Periodic Table.

Features of The Periodic Table

- horizontal rows-periods
- vertical columns-groups

How atoms and elements fit into The Periodic Table

Explain with reasons:

- metallic elements on the left of The Periodic Table
- non-metallic elements on the right of The Periodic Table
- how atoms of elements are grouped together in one group.

Combining power

Investigate with The Periodic Table:

- how atoms combine to form compounds
- model how water is formed using plasticine and match sticks.

Writing formulae

Write formulae of simple compounds applying the combining power procedures assisted by The Periodic Table of:

- magnesium oxide
- calcium chloride
- aluminium iodide
- sodium oxide.

Metals and non-metals

Analyse and identify:

- properties of metals and non-metals.

Skills

The specific skills and attitudes practised and gained through this unit.

Attitudes and values

Self organising, being open-minded, being appreciative, being sceptical or questioning.

Process skills

Observing, classifying, measuring, estimating, experimenting and investigating, predicting, hypothesising, researching, using and manipulating equipment.

General skills

Communicating, reading for understanding, analysing, thinking critically, problem solving, making decisions, cooperating and collaborating, organising and interpreting data, graphing.

Resources

Periodic Table charts, (wall, and A4 for class sets), plasticine and wire for model making, samples of metals and non metals, match sticks

Assessment

Assessment task one

Assignment – History of atomic models and The Periodic Table

Assessment criteria

Assessment task one will be assessed on the extent to which students can:

- show knowledge of the origin of the idea of atoms
- demonstrate understanding of the evolution of atomic models over the ages
- describe the origin of and characteristics in The Periodic Table
- demonstrate how atoms fit into the locations allocated space in The Periodic Table
- explain that scientific models change as further knowledge is gained.

Marks 30

Assessment task two

Written test: Multiple choice and short answers

Assessment criteria

Assessment task two will be assessed on the extent to which students can:

- draw the atomic structure of any of the first 20 elements
- recognise a stable atomic structure
- explain the features of The Periodic Table
- compare the physical properties of metals and non-metals
- write chemical formulae of simple molecules using combining power concept.

Marks 30

Total marks 60

9.6 Electricity

Strand: Matter and energy 6 - 7 weeks

Context

Have you watched the news lately on television or heard it on the radio? Have you spoken to a family member on a phone? Have you heard your favourite song, or washed and ironed your clothes? If you did any of these it is because of electricity. We live in an electrical world. Electricity is a common form of energy. Electricity is invisible, clean and quiet, but electricity can give us shocks or kill us instantly. Electrical energy is converted to other forms of energy. The knowledge of electricity and its application has led to the production and use of many different electrical appliances and devices like heaters, stoves and ovens, electromagnets, remote door opening units, and light bulbs and tubes. Electricity is one of our greatest servants.

Content

Students have some learning experiences of electricity in Grade 6 through the sub strand Uses of Electricity in the Home. This unit further develops this by showing how useful electricity is; where it comes from; what electricity is; and how it is transmitted through circuits. Electricity is transmitted efficiently in some substances while other substances do not transmit it efficiently. Students identify which substances let electricity travel through (conductors) and which do not (insulators). They explore how and why electricity moves and demonstrate static charges attracting, e.g. hair and comb or repelling, e.g. two charged balloons. The difference between current and voltage is explained. Students learn to use measuring instruments to make accurate readings in this unit.

Process

Students construct simple circuits, use ammeters and voltmeters correctly, measure amount of current, voltage and resistance accurately and report using correct units. They use circuits to demonstrate how current divides in parallel and series circuits and how current varies in these circuits. They create models of series and parallel circuits. Students should know the relationship V=IR. Students investigate other ways of generating electricity. They use bar magnets and coils attached to the micro ammeter to show current produced and use strong motors to rotate and turn on light. They carry out research into different ways of producing electricity such as hydro, diesel, wind and solar generators. Students work out simple costs involved in the use of electrical energy by carrying out power = IV calculations. Students need to have studied the unit 9.5 Atoms and The Periodic Table before attempting this unit and this unit must be completed before the unit on Communication. The practical nature of the subject should be recognised, and emphasis put on the use of the scientific processes and techniques during the progression of this unit.

Unit learning outcomes

Students can:

9.6.1 demonstrate an understanding of electricity and electromagnetism

9.6.2 construct different types of circuits and recognise their application in household electricity

9.6.3 investigate and explain energy transfers and efficiency of devices

9.6.4 compare different methods of generating electricity and their environmental impact.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Topic 1: Types of electricity

Static electricity

Investigate and explain:

- the natural phenomena-lightning
- like charges repel and opposite charges attract
- the nature of static electricity.

Electric current

Investigate, classify and define:

- electrical conductors and insulators
- characteristics of conductors and insulators
- electric cells; types, functions and applications
- current and voltage.

Safety to prevent electric shock, and First Aid

Knowledge of:

- usefulness and reliability of safety mechanisms
- safety, and prevention of electric shock
- electric fire and fire extinguishers
- first aid and electric shock or burns.

Topic 2: Circuits

Series circuit, current and voltage

Construct series circuits:

- observe energy transformation
- measure current

- measure voltage
- application of series circuits.

Parallel circuits, current and voltage

Construct parallel circuits:

- observe energy transformation
- measure current
- measure voltage
- application of parallel circuits.

Ohm's Law

Investigate relationship and calculate:

- current, voltage, resistance
- I = V/R (R=resistance; I = Current; V= Voltage).

Topic 3: Uses of electricity

Lighting effects

Experiment and analyse:

- resistant wires
- lighting effects
- efficiencies of different lighting devices
- applications of lighting devices.

Heating effects

Investigate and analyse:

- resistant wires
- heating effects
- efficiencies of different heating devices
- applications of different heating devices.

Electromagnetism

Investigate:

- electrical charge-transfer of electrons by friction and inductions applications
- electromagnets
- factors that affect the strength of electromagnets
- applications of electromagnets e.g. bells, buzzers etc.

Topic 4: Household electricity

Electrical power and costing

Demonstrate through calculations:

- cost of different electrical appliances in the home and industries and comment on cost effectiveness

- relationship between electrical power, current and voltage where P = V x I (P-power; V-voltage; I – current)
- formula for cost of power used by Papua New Guinea Power; E = P x T (Energy = Power x Time)
- calculation of rate of power used.

Energy conservation

Investigate and analyse:

- conservation of electrical energy.

Topic 5: Generating electricity

Sources of electrical energy and conversion

Investigate:

- different means of producing electrical energy more cheaply and cleanly
- alternative ways to produce electricity and electrical energy.

Hydroelectricity in Papua New Guinea

Research and describe:

- generators producing electricity on a large scale
- distribution systems from power stations to homes and industries.

Energy conversions

Investigate through projects:

- alternative means of energy conversion
- communicate findings of other appropriate means of energy conversion.

Skills

The specific science skills and attitudes practised and gained through this unit.

Attitudes and values

Being healthy and safe, caring and respecting, self organising, being open-minded, being appreciative, being sceptical or questioning.

Process skills

Observing, classifying, measuring, estimating, experimenting and investigating, predicting, hypothesising, researching, using and manipulating equipment.

General skills

Communicating, reading for understanding, analysing, thinking critically, problem solving, making decisions, cooperating and collaborating, organising and interpreting data, graphing.

Resources

Ammeters and voltmeters, galvanometers, dry cells, light bulbs, copper wires, nichrome wire, magnets (bar), flat magnets (north/south poles), plastic hair comb, iron filing, plotting compass, switches, bulb holders, dry cell holders, crocodile clips, 12 volt battery.

Assessment

Assessment task one

Practical skills -set up electrical circuits

Assessment criteria

Assessment task one will be assessed on the extent to which students can:

- set up series or parallel circuits as instructed, using safe layout
- connect ammeter and/or voltmeter correctly in a circuit
- measure current and voltage accurately using correct units in working circuits
- show magnetic effects of electric current
- demonstrate the factors affecting the strengths of an electromagnet.

Marks 30

Assessment task two

Written test - multiple choice and short answer

Assessment criteria

Assessment task two will be assessed on the extent to which students can:

- recognise energy conversions involved in the generation and application of electricity
- interpret circuit diagrams identifying variations in voltage, current and resistance
- use formula V = I R and P = V I for calculations
- recognise safety precautions in household electricity
- calculate the cost of electricity
- identify environmental implications of methods of generating electricity.

Marks 30

Total marks 60

9.7 Earth and Atmosphere

Strand: Earth and space 5 - 6 weeks

Context

Have you ever wondered what the Earth contains and what it looks like inside? Where does all the hot lava come from when a volcano erupts? Where do the rocks and soil come from and how do they change as time passes by? How do we know that creatures such as dinosaurs lived on Earth and how do we determine how many million years ago they lived? Similarly have you wondered what is around all of us? What makes the trees sway and leaves and twigs move? How is it that there is life on Earth, but not on other planets in our solar system? Why do we feel warm and cool or experience wet and dry weather at different times of the year? How do birds and machines such as planes lift off and fly?

Content

This unit builds on what students learnt in Earth and Beyond in Upper Primary and links to landforms and climate study in other subjects. This unit deals with the structure of the Earth and the atmosphere, weathering, rock formation and cycles, minerals and fossils, and air. Students acquire a clear idea how the active atmosphere makes life possible and sustainable on Earth. They learn how temperature, pressure, altitude and other factors affect weather.

Process

This unit must complement as well as supplement the traditional knowledge and explanations that students have about natural phenomena such as volcanic eruptions or weather. They should be able to read or forecast the occurrence of such phenomena with confidence and be able to make use of the positive and be better prepared to deal with the negative aspects. Students set up a weather station and create a weather chart for their local area.

Unit learning outcomes

Students can:

9.7.1 describe the structure of Earth and its atmosphere and their role in life on Earth

9.7.2 investigate factors affecting weather, weathering and rock formation

9.7.3 compare the traditional and contemporary scientific methods of predicting and explaining natural phenomena

9.7.4 set up and use weather equipment to record and describe local weather patterns.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Topic 1: Structure of the Earth

Layers of the Earth

Investigate, identify, describe and explain:

- crust, mantle, core and inner core
- the characteristics of the layers
- the activity of magma and its effect on the crust
- the formation of volcanoes.

Topic 2: Rock cycle and weathering

Rock cycle and rock formation

Investigate and explain the cycle and formation of:

- igneous, sedimentary, and metamorphic rocks
- fossils
- minerals.

Weathering

Investigate and explain:

- physical and chemical weathering
- the methods of determining the age of rocks and fossils.

Topic 3: Structure of the atmosphere

Layers of the atmosphere

Investigate, describe and explain:

- troposphere, stratosphere, ionosphere
- the characteristics of the layers of the atmosphere
- how atmosphere protects Earth.

Topic 4: Active atmosphere

Troposphere

Investigate, identify, describe and explain:

- the components of air
- the importance of these components.

Air pressure

Investigate, describe and explain:

- why air has pressure and how it is measured
- the effects of altitude, temperature and speed on air pressure
- how birds, insects and aeroplanes take off and fly.

Topic 5: Weather

Convectional currents

Investigate and demonstrate:

- the effects of radiation on land and water
- how convectional currents form
- the formation of land and sea breezes
- the formation of orographic and convectional rains.

Weather charts

- identify and use weather instruments to measure weather factors
- set weather equipment and record weather data
- present weather data in a variety of ways.

Predicting weather

Apply ways of predicting weather patterns using:

- traditional knowledge
- contemporary scientific methods.

Skills

The specific science skills and attitudes practised and gained through this unit.

Attitudes and values

Caring and respecting, self organising, being open-minded, being appreciative, being sceptical or questioning.

Process skills

Observing, classifying, measuring, estimating, experimenting and investigating., predicting, researching, motor or manipulative, using and manipulating equipment.

General skills

Communicating, reading for understanding, analysing, thinking critically, problem solving, making decisions, cooperating and collaborating, organising and interpreting data, graphing.

Resources

Weather instruments, rain gauge, thermometer, balloons, weather map, wind vane, anemometer, radiometer, barometer, hydrometer or wet and dry thermometer, maximum and minimum thermometer.

Assessment

Assessment task one

Projects: - Set up a weather screen and record weather over a period of time

Assessment criteria

Assessment task one will be assessed on the extent to which students can:

- demonstrate an understanding of factors affecting weather
- recognise and use appropriate weather instruments
- measure weather factors such as air pressure, temperature, wind speed and direction
- present weather data in a variety of ways including a weather map.

Marks 30

Assessment task two

Written test: Multiple choice and short answer

Assessment criteria

Assessment task two will be assessed on the extent to which students can:

- show an understanding of the structure of Earth and its atmosphere
- identify the role and components of each structure of the Earth and atmosphere
- recognise factors affecting weather and weathering
- interpret charts, graphs, classification charts for rocks and other related data
- identify the role of the atmosphere in natural processes and protecting life
- identify traditional ways of explaining natural phenomena.

Marks 30

Total marks 60

Grade 10 core units

10.1 Working Scientifically Through Projects and Investigations

Strand: The nature of Science 5 - 6 weeks

Context

What have you used lately to find out the exact length of a piece of string, an accurate measurement of your body temperature, an exact weight of your luggage for air travel, or to give the right amount of cough mixture to a child? Imagine a world without measuring instruments. What would happen without experts like researchers, scientists, and other specialists developing and using scientific instruments and equipment? What would life in general be like? Scientific investigations and research require reliable data, which must be collected using correct scientific processes. Scientists identify problems; then they make predictions, set out hypothesis and test them by observing, collecting and recording data which they analyse and then draw conclusions before reporting and communicating their findings.

Content

Students build on and further apply the skills, knowledge and techniques introduced in Unit 9.2. Accurate measurements using correct instruments and units are vital for working scientifically. Working scientifically can involve risks therefore reasonable precautions must be taken at all times. Projects that involve application of analytical, manipulative, investigative and basic skills are introduced.

Process

The need to apply the scientific processes and techniques during the progress of this unit cannot be emphasised enough. Students learn about and carry out scientific investigations, experiments or projects using the scientific process and specific techniques, in particular; observing and recording, collecting and collating data, analysing data, inferring, hypothesising and testing, drawing conclusions and reporting.

Unit learning outcomes

Students can:

10 1.1 apply scientific skills competently to carry out integrated projects or investigations

10.1.2 assess implications of the findings of a project in relation to people, their environment and ethical considerations.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Topic 1: Working safely

Safety in science

Assess dangers and take responsibility for safe and accurate use of:

- procedures and equipment
- chemicals and other reactive substances
- heating, cutting and handling of delicate substances such as glass
- fire
- biological materials.

First Aid

Familiarise self with common first aid procedures and apply correct treatment when:

- treating minor injuries such as cuts, burns, bites and bruises,
- resuscitation
- avoiding infection e.g. sharing apparatus such as straws, blow pipes, using unsterilised syringes.

Safety equipment

Familiarise self with the correct use of:

- appropriate safety equipment
- gloves, safety goggles and fire extinguishers.

Safety rules

Become familiar with safety rules for:

- self
- laboratory.
- the classroom (or develop new safety rules to follow for various events if not in place)
- handling live animals.

Topic 2: The scientific approach

Investigative processes

Revise and reinforce the scientific approach leading to:

- recognising problems
- finding solutions
- communicating valid and reliable evidence-based information
- appreciate the sources of error in any investigations and take precautions to minimise errors.

Identifying a problem

Consider issues at the community level and design possible solutions by:

- predicting, inferring, hypothesising and testing
- observing and recording
- collecting, collating and analysing data
- drawing conclusions and reporting.

Topic 3: Undertake a scientific project (in groups and/or individually)

For example:

- assessing water quality
- assessing effects on industrial waste (any industry; large or small)
- set up a drinking water purification process for a community living near murky river water.

Skills

The specific science skills and attitudes practised and gained through this unit.

Attitudes and values

Being healthy and safe, caring and respecting, self organising, being open-minded, being appreciative, being sceptical or questioning.

Process skills

Observing, classifying, measuring, estimating, experimenting and investigating, predicting, hypothesising, researching, using and manipulating equipment.

General skills

Communicating, reading for understanding, analysing, thinking critically, , problem solving, making decisions, cooperating and collaborating, organising and interpreting data, graphing.

Resources

All resources available to the school e.g. science equipment, library, people, local environment, practising scientists, first aid kit.

Assessment

Assessment task one

Project – Students select own projects with teacher

Assessment criteria

Assessment task one will be assessed on the extent to which students can:

- plan scientifically accepted methods, procedures, equipment and resources precisely to collect accurate data
- document clearly scientific method used (collect and record data)
- support and justify interpretations through specific data and results
- communicate accurate, relevant and in-depth information to communicate in a variety of ways
- identify issues raised in relation to the implementation of the project
- identify possible sources of inaccuracy.

Total marks 50

10.2 Microbiology

Strand: Life and living 5-6 weeks

Context

Have you stopped to think about what it means to live a healthy life? How has malaria affected the environment in terms of the use of DDT in controlling mosquitoes? Do you consider healthy personal habits when coughing or sharing lime when chewing betel-nut? Have you seriously thought about the consequences of HIV/AIDS, a sexually transmitted disease on families, the communities and the nation as a whole? When did you last stop to appreciate the roles of some invisible living things and their helpful activities that benefit all life?

Content

Students have prior knowledge about the types and characteristics of living things through the Upper Primary sub-strand Nature of Living Things. They also have their own experiences from their communities. Students extend their current understanding and knowledge by looking at the smallest of living things that can only be seen with the aid of a microscope. Students learn what these micro-organisms are, their characteristics and the role they play as a result of their lively activities leading to them being either harmful or beneficial. They also learn how micro-organisms are of economic importance in the production of useful antibiotics, in food processing and beverage industries and maintaining soil fertility.

Process

The unit begins with an investigative introduction of micro-organisms with a focus on the five major groups of microbes.. Students are introduced to the microscope, its parts and functions, and its usefulness in the study of micro-organisms, They become aware of harmful micro-organisms, how they are spread and the kinds of conditions that facilitate the spread or growth of micro-organisms. With a basic understanding and knowledge of micro-organisms, students practise safe and healthy ways of living.

Unit learning outcomes

Students can:

10.2.1 describe and explain the role of microbes in the living world

10.2.2 safely and correctly use a microscope to observe, measure and show the characteristics of micro-organisms

10.2.3 demonstrate how useful and harmful activities of microbes can be utilized for food processing and healthy living.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Warning!
Culturing bacteria should only be attempted by teachers who have clear understanding about what to do and have access to and experience with the use of an autoclave or pressure cooker for sterilization.

Topic 1: Introduction to microbiology

Types of micro-organisms or microbes

Investigate and classify microbes into:

- fungi
- algae
- protozoa
- bacteria
- viruses.

Using a microscope

Investigate:

- parts and functions of a microscope
- magnification of a microscope
- size of objects observed under a microscope
- prepared slides of different pathogens using a microscope
- recognise and differentiate features of organisms under a microscope.

Topic 2: Useful microbes

Investigate, identify and recognise the useful role of microbes in:

Food industry

- food processing - traditional and contemporary
- food preservations - traditional and contemporary.

Medical uses of micro-organisms

- products of microbes for medical uses such as penicillin (antibiotic)
- other useful activities such as:
  -soil fertility
  -digestion of cellulose

Topic 3: Harmful microbes

Investigate the causes, methods of infections, preventions through hygiene, vaccination, healthy and safe behaviour, attitudes and habits of the following diseases:

Food and water diseases

- gastro-intestinal diseases
  - diarrhoea
  - typhoid
  - cholera.

Airborne diseases

- respiratory diseases like tuberculosis (TB)
- ways of transmission

Contagious diseases

- skin diseases
- fungal/grille
- childhood diseases, e.g. chicken pox, mumps, measles, mumps

Vector diseases

- malaria
- other diseases.

Warning!
All blood related activities should not be carried out with fresh blood. Use prepared slides.

Sexually transmitted diseases (STDs) and HIV/AIDS

- types of microbes
- causes and spread
- HIV/AIDS

Other diseases

Analyse the spread of other diseases and ways of preventing them rapidly becoming common for example hepatitis.

Skills

The specific science skills and attitudes practised and gained through this unit.

Attitudes and values

Being healthy and safe, caring and respecting, self organising, being open-minded, being appreciative, being sceptical or questioning.

Process skills

Observing, classifying, measuring, estimating, experimenting and investigating, predicting, hypothesising, researching, using and manipulating equipment.

General skills

Communicating, reading for understanding, analysing, thinking critically, problem solving, making decisions, cooperating and collaborating, organising and interpreting data, graphing.

Resources

Microscopes, prepared slides, hand lenses, empty bottles, ear droppers, slides, stains, tissue box, soap for washing hands.

Assessment

Assessment task 1

Practical skills - Microscope

Assessment task 1 will be assessed on the extent to which students can:

- prepare slides to be viewed through a microscope
- set up a microscope to view slides at the required magnification
- draw diagrams of objects seen through the microscope
- handle slides and microscopes safely and carefully.

Marks 20

Assessment task 2

Written test: Multiple choice and short answer

Assessment task 2 will be assessed on the extent to which students can:

- show understanding of characteristics of microbes
- identify, useful and harmful activities of microbes
- explain cause, spread and prevention of common diseases
- interpret tables, graphs, investigation data related to microbes and diseases.

Marks 30

Total marks 50

10.3 Chemical Reactions

Strand: Matter and energy. 5 - 6 weeks

Context

What's so special about the concept of chemical reactions? Have you ever wondered what is going on in the chemical world? Have you seen a green banana turn yellow? What happens to a piece of wood when you burn it? How is it that chemists and pharmacists speak the same language of chemistry around the globe? Why is it important to write a story of chemical reactions using formulas and that the equations are balanced? How can you tell if chemical reactions are taking place?

Content

Students will have learned some things about substances in Grades 6-8, under sub-strand, Learning about Substances and will know the distinction between physical and chemical changes. In unit 9.5, students studied atoms and The Periodic Table. Students further explore and develop a higher level understanding of how chemical reactions occur. Students understand some common chemical reactions, including those that occur naturally and are an economic burden to individuals and the nation. Students can further explore preventative strategies for destructive chemical reactions in order to minimise their occurrences. Students construct ways to reduce or prevent some of these chemical reactions by changing factors such as surface area, concentration and temperature.

Process

Students examine chemical reactions through simple tests. They perform simple acid reactions with bases, metals and carbonates and write word and formula equations and balance equations. Students do simple flame tests with metal salts and lime water tests with other substances. Students can also design strategies for reducing or preventing some chemical reactions that cause a lot of damage to metallic objects and become an economic burden on individuals and the nation as a whole.

Unit learning outcomes

Students can:

10.3.1 demonstrate understanding of the characteristics of chemical change and factors influencing change in materials

10.3.2 investigate specific reactions of acids and bases and write balanced equations

10.3.3 present an investigative report on at least one chemical process involved in industries in Papua New Guinea.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Topic 1: Chemical changes

Characteristics of chemical changes

Investigate different chemical changes and write simple word equations:

- formation of simple oxides
- decomposition of simple compounds
- formation of precipitates.

Reactions of acids

Investigate (write balanced formula equations, make models, and demonstrate careful and safe use and storage practices) the reactions of acid with:

- bases
- metals
- carbonates
- factors influencing chemical reactions

Reactions of organic substances

Analyse natural processes of:

- respiration
- fuel burning – petrol and/or diesel
- oil formation/crude oil.

Topic 2: Analysing matter

Variety of tests

Perform/demonstrate:

- flame test to test common metals such as calcium, copper, sodium
- litmus/pH/locally available pigments to test acids and bases
- acid and limewater test to test carbonates and carbon dioxide
- glowing splint test to test oxygen gas
- burning splint test to test hydrogen gas.

Topic 3: Corrosion

Factors that cause corrosion

Investigate:

- how corrosion is caused
- how it can be prevented

- oxygen as the precursor to corrosion.

Simple reactivity series

Construct and display:

- a reactivity series table
- metals and halogens.

Preventative measures

Investigate through simple activities the use of the following substances to prevent or reduce corrosion:

- oils and grease
- paint
- coating
- galvanizing.

Skills

The specific science skills and attitudes practised and gained through this unit.

Attitudes and values

Being healthy and safe, caring and respecting, self organising, being open-minded, being appreciative, being sceptical or questioning.

Process skills

Observing, classifying, measuring, estimating, experimenting and investigating, predicting, hypothesising, researching, using and manipulating equipment.

General skills

Communicating, reading for understanding, analysing, thinking critically, , problem solving, making decisions, cooperating and collaborating, organising and interpreting data, graphing.

Resources

Periodic Table; common metals - potassium, calcium, copper, sodium salts; acids-concentrated hydrochloric acid, base; carbonates, lime water, shells, corals, limestone; nichrome wire loops, watch glasses, wooden splints, Bunsen burner, dropping pipette, dropping bottles, test tubes, test tube holders, local dyes/pigments, petri dishes, beakers.

Assessment

Assessment task one

Practical skills: Perform simple chemical reaction processes used in industries

Assessment criteria

Assessment task one will be assessed on the extent to which students can:

- perform simple tests to identify, acids, bases, gases and metals
- make observations of a chemical reaction
- make inferences from a chemical reaction
- recognise the pattern and characteristics of some common reactions
- demonstrate safety measures when dealing with chemicals and reactions.

Marks 20

Assessment task two

Written test: Multiple choice and short answer

Assessment criteria

Assessment task two will be assessed on the extent to which students can:

- explain and show understanding of the general characteristics of a chemical change and factors influencing change in materials
- write word and formulaic equations of common reactions
- calculate number of atoms and formula mass of molecules
- appropriately match names and formulae of chemicals or compounds
- show understanding of natural chemical processes
- show understanding of an industrial reaction and its environmental implications.

Marks 30

Total marks 50

10.4 Light

Strand: Matter and energy 6 - 7 weeks

Context

What is common about the sun during the day and a full moon in the night? They all provide light energy either directly or indirectly and help us to see things. We see some objects because they produce light, others because they reflect light into our eyes. Is seeing the only importance of light? Can green plants produce carbohydrates without absorbing light energy? Can seaweeds survive under water if light is not transmitted through water? What would happen to the living world if light could not travel through space (vacuum) or if opaque objects blocked the light from reaching the Earth? If green plants cannot produce carbohydrates it will extinguish the flow of energy through food webs and destroy the ecosystems. Scientists believe that 60 million years ago a meteorite hit Earth sending clouds of dust into the atmosphere and blocking light from reaching the Earth for a period of time. The outcome was extinction of most organisms including the dinosaurs. Today it is human activity that is sending clouds of dust and smoke particles into the atmosphere and causing global dimming. So light is very important and it is important to learn the nature and properties of light. Having a better understanding of how light works can lead to the discovery of things that are distant or microscopic, new inventions that can be used for better health care and energy conversion methods that are friendly to the environment.

Content

This unit links to Upper Primary and Grade 9 units where students had the opportunity to explore flow of energy in ecosystems, energy conversions and the nature and properties of energy forms such as heat and electricity. This unit deals with the sources and nature of light and its properties with regards to absorption, transmission, reflection and refraction. Students explore how shadows and images are formed. Students appreciate how the knowledge and understanding of the properties of light has led to useful inventions such as cameras, solar cells, spectacles, telescopes and microscopes. They also learn how light plays a role in producing colours and rainbows.

Process

Students experience science at work as they see how the particle model of light has evolved into the wave model of light that explains its properties better. Students learn about reflection, refraction and dispersion by performing experiments using light rays. Students research and find out about the past and present developments in optical inventions and how they lead to major discoveries. Students make working models of some optical inventions and appreciate their usefulness.

Unit learning outcomes

Students can:

10.4.1 demonstrate an understanding of the particle model and wave model of light energy in its propagation and effects

10.4.2 investigate and explain the properties of images formed by optical devices

10.4.3 use wave model of light to explain its place in the electromagnetic spectrum

10.4.4 analyse the impact of optical inventions and associated major discoveries.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Topic 1: Light energy

Introduction of light energy

Investigate light as:

- one of many ray energies that is visible
- a type of energy that does not need a medium to travel through
- the source of energy that flows through organisms in ecosystems.

Sources of light

Identify and describe sources of light as:

- natural
- artificial.

Propagation and nature of light

Explore through various activities the:

- transmission of light through transparent, translucent and opaque objects
- straight line travel of light energy and formation of shadows and eclipses
- particle model of light energy
- wave model of light energy.

Topic 2: Reflection and refraction of light

Laws of reflection

Investigate and demonstrate through ray diagrams reflection of light by:

- plane surfaces
- curved surfaces.

Laws of refraction

Investigate and demonstrate through ray diagrams refraction of light rays by:

- different mediums separated by plane boundaries
- lenses.

Topic 3: Images

Virtual images

Investigate virtual images produced by:

- plane mirrors
- convex mirrors
- concave lenses.

Real images

Investigate real images produced by:

- concave mirrors
- convex lenses.

Topic 4: The eye

Structure

Investigate:

- structure of the eye
- parts of the eye.

Defects

Investigate:

- common eye defects
- how these defects can be corrected.

Topic 5: Dispersion of light and colours

Dispersion

Investigate the:

- dispersion of white light into coloured lights
- place of visible light in the electromagnetic spectrum.

Appearance of surfaces

Investigate the:

- absorption and reflection of light by different surfaces
- appearance of surfaces in coloured lights.

Topic 6: Useful inventions and applications of light

Investigate:

- inventions such as a camera or any other optical instrument
- light as a renewable source of energy
- optical inventions and related major discoveries.

Skills

The specific science skills and attitudes practised and gained through this unit.

Attitudes and values

Being healthy and safe, caring and respecting, self organising, being open-minded, being appreciative, being sceptical or questioning.

Process skills

Observing, classifying, measuring, estimating, experimenting and investigating, predicting, hypothesising, researching, using and manipulating equipment.

General skills

Communicating, reading for understanding, analysing, thinking critically, problem solving, making decisions, cooperating and collaborating, organising and interpreting data, graphing.

Resources

Ray box; mirrors - plane and curved; prisms; lenses - curved, bi-concave, bi-convex; glass blocks; wood blocks; coloured filters; eye test kit

Assessment

Assessment task one

Practical skills: Perform experiments using light rays

Assessment criteria

Assessment task one will be assessed on the extent to which students can:

- demonstrate linear propagation of light rays
- draw ray diagrams to illustrate experiments
- manipulate optical devises to produce required type of image
- measure angles of incidence, reflection and refraction
- measure the focal length of curved mirrors and lenses.

Marks 25

Assessment task two

Written test: Multiple choice and short answer

Assessment criteria

Assessment task two will be assessed on the extent to which students can:

- explain particle and wave models of light based on (simple) investigations/observations
- show understanding of reflection, refraction and dispersion
- describe how the eye works, its defects and corrective methods
- describe the role of light in sustaining the environment
- link optical inventions to major scientific discoveries.

Marks 25

Total marks 50

10.5 Communication

Strand: Earth and space. 5 - 6 Weeks

Context

How did you come to know about your tribal history, customs and values? What is the traditional way of passing information quickly from village to village? What sensory organs are most important for receiving messages and what mediums are used in modern day communication? What happens when telecommunications' repeater stations are vandalised, or telephone cables are cut, or communication satellites are blown out in space? The sending of information by drums (garamut), oral exchange from mountain tops, smoke signals, and messages carried by runners are some common means of traditional communication many of which have been replaced by sophisticated contemporary means of communication.

Content

In this unit students are introduced to different methods of communication - some traditional and some modern. They learn that we may receive messages by sight, touch (e.g. Braille), taste, smell or hearing. In most methods of communication either sight (light) or hearing (sound) is used. Sound waves are looked at in more detail, leading to the study of electromagnetic waves. Telecommunication by electromagnetic waves is considered in the context of radio, microwave, mobile phone and space communication. Mobile phones are basically phones that use radio waves to operate. The importance of Papua New Guinea's mobile phone and microwave repeater systems highlight the importance of science.

Process

Students learn how to generate different sounds with instruments. They investigate sound as a form of energy which travels by waves and find sound energy needs a medium to travel, unlike electromagnetic waves which can travel in a vacuum. Simple transmitters and receivers should be set up to show movement of electromagnetic waves, such as scraping an electromagnet while a radio is turned on.

Unit learning outcomes

Students can:

10.5.1 demonstrate an understanding of wave motion and wave nature of sound

10.5.2 investigate the effect of wave characteristics on volume and pitch

10.5.3 present an investigative report on development of communication means over the ages

10.5.4 analyse the importance of science in communication technology for improved socio-economic development.

Content

Students acquire knowledge and skills through the teaching and learning of this content.

Topic 1: Methods of communication

Traditional and modern ways of communication

Investigate, reflect on and compare the:

- traditional means of communication (past)
- modern means of communication (present)
- sound as an old method of communication
- processes involved in communication.

Topic 2: Sound waves

Making sounds with musical instruments

Investigate:

- sounds made by traditional musical instruments
- sounds made by modern musical instruments
- high or low sounds
- loud or soft notes.

How sound travels

Investigate:

- sound through different medium
- echo.

Sound and vibrations

Examine:

- different sources of sound
- vibration
- sound and energy transmission.

Topic 3: Making waves

Types of waves

Investigate:

- longitudinal waves
- transverse waves.

Water waves

Experiment and explain:

- waves produced on water
- energy transmission.

Amplitude, wavelength, frequency of a wave

Produce, measure and explain:

- wavelength of wave
- amplitude of wave
- frequency of wave
- speed of wave (wavelength x frequency).

Topic 4: Telecommunication

Improved means of communication

Investigate and demonstrate:

- variations in amplitude and wavelength affecting volume and pitch of sound
- how variations in amplitude and wavelength affect communication.

Electromagnetic waves

Investigate and explain:

- applications of electromagnetic waves in telecommunication e.g. microwave repeater system, mobile phones
- AM, FM radio broadcasting
- satellite communication and systems
- the importance of the role of modern communication in development and in the global society.

Skills

The specific science skills and attitudes practised and gained through this unit.

Attitudes and values

Being healthy and safe, caring and respecting, self organising, being open-minded, being appreciative, being sceptical or questioning.

Process skills

Observing, classifying, measuring, estimating, experimenting and investigating, predicting, hypothesising, researching, using and manipulating equipment.

General skills

Communicating, reading for understanding, analysing, thinking critically, problem solving, making decisions, cooperating and collaborating, organising and interpreting data, graphing.

Resources

Ripple tank, musical instruments (string and pipe), drums, electric bell and jar, vacuum pump, radio, old telephones, bamboo flutes, slinky spring, tuning forks.

Assessment

Assessment task one

Practical skills: Production and measurement of waves

Assessment criteria

Assessment task one will be assessed on the extent to which students can:

- identify the sender, the medium and the receiver of communication process
- demonstrate traditional and modern methods of communication (optional)
- show factors that affect the pitch and volume of sound
- measure amplitude, wavelength and frequency and calculate the speed of water wave
- show how different notes are achieved on traditional musical instruments.

Marks 25

Assessment task two

Written test: Multiple choice and short answer

Assessment criteria

Assessment task two will be assessed on the extent to which students can:

- recognise energy conversions involved in a communication process
- show understanding of wave characteristics and properties
- show understanding of factors that affect the pitch and volume of sound
- identify and explain amplitude, wavelength and frequency from wave diagrams.
- show understanding of electromagnetic waves and its applications in communication

Marks 25

Total Marks 50

Assessment, examinations and certification

Assessment and reporting practices described here are detailed further in the *National Assessment and Reporting Policy for Papua New Guinea* (2003) and in other support materials produced by the Department of Education.

Assessment

The main purpose of assessment is to improve student learning.

Assessment needs to be for learning as well as of learning. It is used to evaluate and improve teaching and learning, report achievement and provide feedback to students on their progress.

Assessment measures students' achievement of learning outcomes as described in this syllabus. It is the ongoing process of identifying, gathering and interpreting information about students' achievement of the learning outcomes.

Teaching and learning using an outcomes approach requires teachers to plan their teaching and assess learner performance in relation to outcomes using criteria derived from those outcomes. Assessment involves focusing less on whether a learner has "passed" or "failed" and more on what outcomes a learner has achieved and in which areas further support is required.

Assessment in Science

A student's achievement in Science at the end of Grade 10 will be assessed against the broad learning outcomes. Assessment of student progress towards achieving these broad outcomes is cumulative throughout Grades 9 and 10 using specific outcomes for each unit. The matrix on page 16-18 of this syllabus shows how the unit learning outcomes are linked to the broad learning outcomes.

During the course of each unit students must complete the assessment tasks specified for the unit. Teachers will expand each task and provide clear guidelines to students for how the task will be completed and how the criteria will be applied.

The assessment tasks and criteria in each unit ensure that there is a common focus for internal assessment in the subject across schools while allowing for flexibility in the design of tasks. A variety of tasks are specified to give students the opportunity to demonstrate all the broad learning outcomes in different ways and to improve the validity and reliability of the assessment.

It is important that teachers plan the teaching and learning sequence so that there is a balanced spread of assessment during the unit. Some tasks, such as investigations or case studies can be designed so that they are completed over a period of time rather than at the end of the unit. Other tasks can be done immediately as the relevant section of the unit has been covered.

Assessment for the School Certificate

A student's overall achievement in Science will be both internally and externally assessed. The final results/achievement awarded to each student for the School Certificate will be based on a combination of the internal assessment mark provided by the school and the examination mark.

Internal assessment

Internal assessment provides a measure of a student's achievement based on a wider range of syllabus content and outcomes. For Science the internal assessment marks will provide a summation of each student's achievements in Grades 9 and 10. The assessment tasks used to determine the internal assessment mark must comply with the types of tasks and assessment criteria specified in each of the units.

All schools must meet the requirements for internal assessment as specified in the *Grade 10 Assessment, Examination and Certification Handbook.*

External examination

The external examination provides a measure of student achievement of those aspects of the broad learning outcomes that can be reliably measured in an examination setting. Questions for the external examination in Science will be developed using the outcomes, knowledge and skills in the core units.

Recording

All schools must meet the requirements for maintaining and submitting student records as specified in the *Grade 10 Assessment, Examination and Certification Handbook.*

Certification

Students will be awarded a School Certificate only if they meet all requirements for internal and external assessment. Eligibility rules for the award of the School Certificate are specified in *Grade 10 Assessment, Examination and Certification Handbook.*