

Applied Science

**Upper Secondary
Teacher Guide**



Papua New Guinea
Department of Education

Issued free to schools by the Department of Education

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Secretary's message

This Applied Science teacher guide is to be used by teachers of science when implementing the Upper Secondary Applied Science syllabus (Grades 11 and 12) throughout Papua New Guinea. The Applied Science syllabus states the learning outcomes, identifies content of the subject as well as assessment requirements. This teacher guide gives practical ideas about ways of implementing the syllabus: suggestions about what to teach, strategies for facilitating teaching and learning, how to assess and suggested assessment tasks.

A variety of suggested teaching and learning activities provide teachers with ideas to motivate students to learn, and make learning relevant, interesting and enjoyable. Teachers should relate learning in Applied Science to real people, issues and the local environment. Teaching using meaningful contexts and ensuring students participate in appropriate practical activities assists students to gain deeper knowledge and understanding, and demonstrate more scientific skills in Applied Science.

Teachers are encouraged to recognise the different needs and interests of students who have had substantial achievement already and appropriately involve them working individually and with others in practical, field and interactive activities that are related to theoretical concepts by applying investigative and problem solving skills.

Applied Science is a new science subject that provides opportunities for students to put into practice scientific knowledge and skills in a realistic and meaningful way. Teachers teaching Applied Science need to be creative and innovative so that students can be guided to become interested, ask questions and carry out investigative learning.

Teachers teaching Applied Science must ensure safety measures are taken when handling equipment, chemicals, live animals and plants or dead matter by students.

I commend and approve the Applied Science Teacher Guide for use in all schools with Grades 11 and 12 students throughout Papua New Guinea.



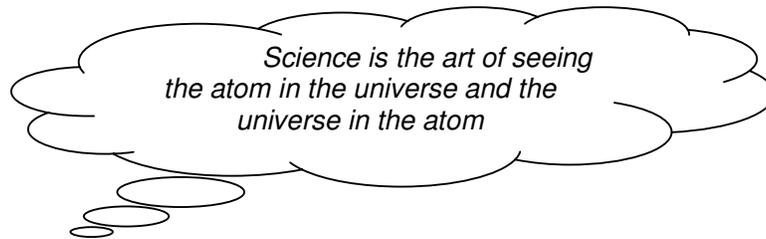
DR JOSEPH PAGELIO
Secretary for Education

Introduction

This teacher guide is to be used by teachers of Science to implement the Upper Secondary Applied Science syllabus. As the name suggests, it is a guide designed to stimulate you to create exciting and meaningful teaching programs and lessons by enabling you to choose relevant and purposeful activities and teaching activities. It will encourage you to research and look for new and challenging ways of facilitating student learning.

The teacher guide supports the Applied Science syllabus. The syllabus states the learning outcomes for the subject units, and outlines the content and skills that students will learn, and the assessment requirements.

This teacher guide provides examples of learning and teaching strategies. It also provides detailed information on criterion referenced assessment, and the resources needed to teach Applied Science. The section on recording and reporting shows you how to record students' marks and how to report against the broad learning outcomes.



The outcomes approach

The Papua New Guinea Lower Secondary and Upper Secondary syllabuses use an outcomes approach. The major change in the curriculum is the shift to what students know and can do at the end of a learning period, rather than a focus on what the teacher intends to teach.

An outcomes approach identifies the knowledge, skills, attitudes and values that all students should achieve or demonstrate at a particular grade in a particular subject (the learning outcomes). The teacher is responsible for identifying and selecting essential content/context and using the most appropriate teaching strategies and resources to facilitate students learning achieve these learning outcomes.

Education can be seen as the process of preparing a student for adult life. Therefore, the student is on a learning journey, heading to a destination. The destination is the learning outcome that is described in the syllabus document. The learning experiences leading to the learning outcomes are to be determined by the teacher. The teacher uses curriculum materials, such as syllabus documents and teacher guides, as well as text books or electronic media and assessment guidelines to plan activities that will assist students achieve the learning outcomes.

The outcomes approach has two purposes. They are:

- to equip all students with knowledge, understandings, skills, attitudes and values needed for future success
- to implement programs and opportunities that maximise learning.

Three assumptions of outcomes based education are:

- all students can learn and succeed (but not on the same day or in the same way)
- success breeds further success
- schools can make a difference.

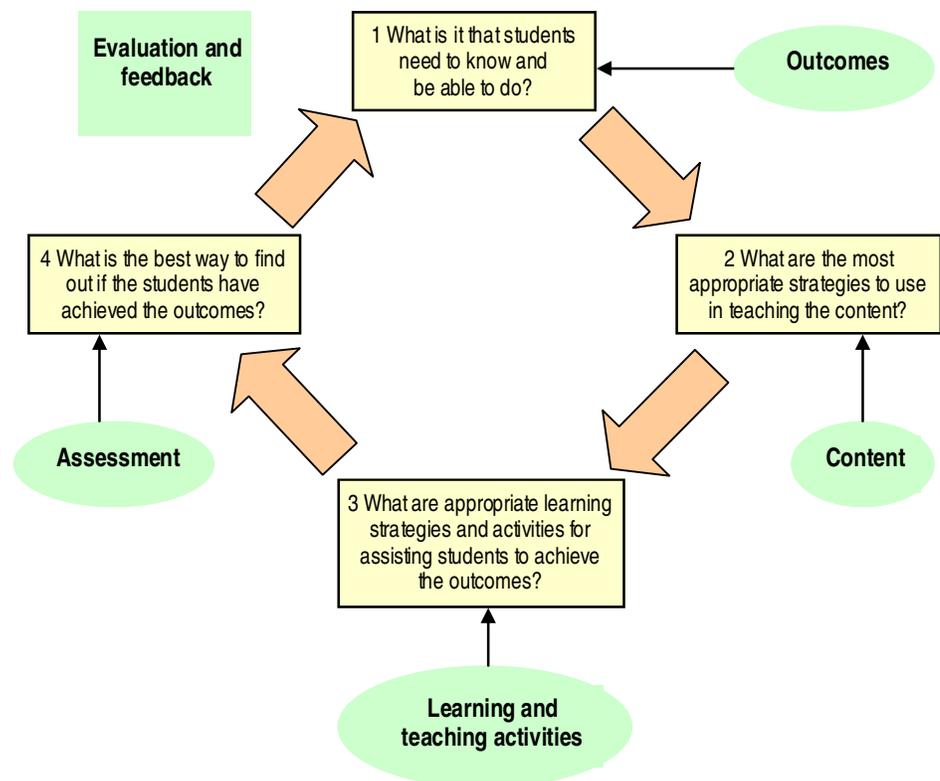
The four principles of the PNG outcomes approach are:

1. Clarity of focus through learning outcomes - this means that everything teachers do must be clearly focussed on what they want students to ultimately be able to do successfully. For this to happen, the learning outcomes should be clearly expressed. If students are expected to learn something teachers must tell them what it is and create appropriate opportunities for them to learn it and demonstrate their learning.]\
2. High expectations of all students – this means that teachers reject comparative forms of assessment and embrace criterion-referenced approaches. The principle of high expectations is about insisting that work be at a very high standard before it is accepted as completed, while giving students the time and support they need to reach this standard. At the same time students begin to realise that they are capable of far more than before and this challenges them to aim even higher.
3. Expanded opportunities to learn - this is based on the idea that not all students can learn the same thing in the same way in the same time.

Some achieve the learning outcomes sooner and others later. However, most students can achieve high standards if they are given appropriate opportunities. Traditional ways of organising schools do not make it easy for teachers to provide expanded opportunities for all students.

4. Planning and programming by designing down – this means that the starting point for planning, programming and assessing must be the learning outcomes – the desired end results. All decisions on inputs and outputs are then traced back from the learning outcomes. The achievement of the outcome is demonstrated by the skills, knowledge and attitudes gained by the student. The syllabuses and/or teacher guides describe some ways in which students can demonstrate the achievement of learning outcomes.

The diagram below shows the cycle of the outcomes-based approach to teaching and learning



Learning outcomes provide teachers with a much clearer focus on what students should learn. They also give teachers greater flexibility to decide what is the most appropriate way of achieving the learning outcomes and meeting the needs of their students by developing programs to suit local context and involve the community.

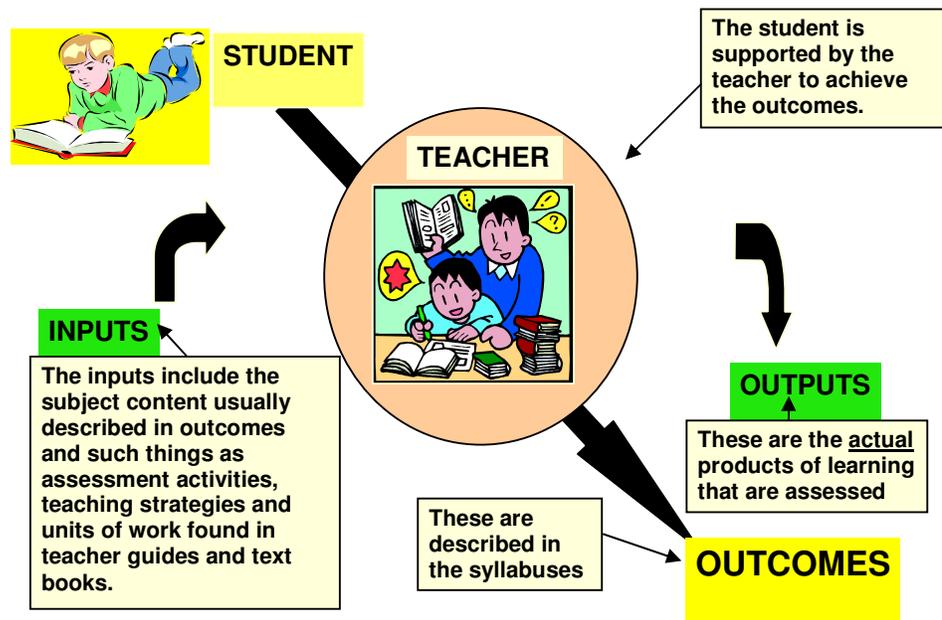
The outcomes approach promotes greater accountability in terms of student achievement because the learning outcomes for each grade are public knowledge - available to teachers, students, parents and the community. It is not the hours of instruction, buildings, equipment or support services that are the most important aspect of the education process but rather, what students know and can do as they progress through each grade.

The outcomes approach means that learning

- has a clearer purpose
- is more interactive – between teacher and students, between students
- has a greater local context than before
- is more closely monitored and acted upon by the teacher uses the teacher as a facilitator of learning as well as an imparter of knowledge.

The diagram below summarises what the reform curriculum simply means - that it is student - centred and the teacher is mainly the facilitator.

Outcomes focus on students



Learning and teaching

You as a teacher must teach the knowledge that is included in the syllabus documents. You have to be able to teach not only what students should know, but also be able to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving which will support learning and teaching. You also need to give students some opportunities to apply their knowledge, to be creative and to solve problems.

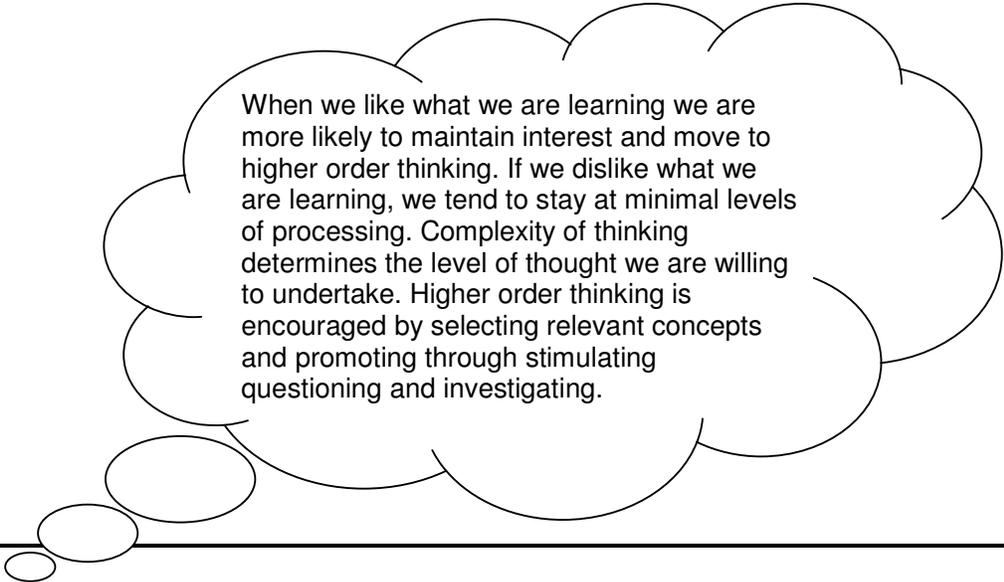
Learning and teaching strategies

Students who participate in guided instruction learn more than students who are left to construct their own knowledge (Mayer, 2004). You need to employ a variety of learning and teaching approaches because all students do not learn in the same way. The auditory learner prefers to use listening as the main way of learning new material whereas a visual learner prefers to see things written down. Students should be actively involved in their learning and therefore you need to design appropriate practical activities or experiments using resources that can be found in your location.

In Grades 11 and 12, students will already have had a wide variety of experiences. You need to make use of your students' experiences when designing and conducting learning in class; learning that is connected to your students' world. There are many learning and teaching strategies described in the Lower Secondary teacher guides that you can use.

Applied Science can be effectively taught using the strategy of team teaching. Team teaching means that you can share units and teach those that you are comfortable with. Other topics can be delegated to other Science teachers or resource personnel.

The most efficient and long-lasting learning occurs when teachers encourage the development of higher-order thinking and critical analysis skills which include applying, analysing, evaluation and creating. Attention should also be paid to developing students' affective and psychomotor skills. To ensure that this occurs, you should encourage deep or rich, rather than shallow coverage of knowledge and understandings.



When we like what we are learning we are more likely to maintain interest and move to higher order thinking. If we dislike what we are learning, we tend to stay at minimal levels of processing. Complexity of thinking determines the level of thought we are willing to undertake. Higher order thinking is encouraged by selecting relevant concepts and promoting through stimulating questioning and investigating.

Learning outcomes

The syllabus learning outcomes describe what students know and can do at the end of grade 12. The level of achievement of the learning outcome should improve during the two years of upper secondary study, and it is at the end of the study that students are given a summative assessment on the level of achievement of the learning outcome.

Students can:

1. demonstrate an understanding of fundamental principles and models of science
2. apply scientific thinking and skills in technological processes and procedures
3. design and undertake scientific investigations to solve problems
4. research and analyse information, procedures and materials
5. communicate scientific investigations and findings in different ways
6. evaluate traditional scientific knowledge and skills and their relevance today

Applied Science skills

Applied Science teachers must strive to provide opportunities for students to develop life skills. Student activities are designed to address the content knowledge that general science strands usually ignore.

The broad areas covered in this strand include knowledge, skills, attitude and values. The knowledge obtained must be relevant to bring about positive changes in attitudes and values which will have impact on the society. The opportunities provided through activities such as laboratory experiments, field work and research will lead to acquiring applicable knowledge and skills.

The acquisition of this knowledge and skills should enable individuals to participate effectively in this contemporary society.

What do students do in Applied Science?

Laboratory experiments, fieldwork, and research

Laboratory experiments, fieldwork, and research are essential parts of the study of Applied Science. They are scientific tools that facilitate the understanding of scientific processes and inquiry. These can enhance learning opportunities for a wide range of students because they cater for a variety of teaching and learning strategies.

Laboratory experiments enable students to:

- identify problems, predict, test hypothesis by conducting experiments, observing, recording and analysing data.
- use data to draw conclusions, recognising errors and make recommendations for improvement.
- communicate findings based on evidence

- Improve manipulative skills

Fieldwork enables students to:

- acquire knowledge about environments by hypothesising, observing, experimenting, measuring and recording phenomena in the real world in a variety of places, including the school
- explore the scientific processes that form and transform lifestyles
- use different kinds of scientific tools and approaches including information and communication technology to assist in the interpretation of, and decision-making about, scientific phenomena
- locate, select, organise and communicate scientific information
- explore different perspectives on scientific issues.

Research enables students to:

- explore various media and sources of obtaining information
- select relevant information and issues and make informed choices
- improve research writing skills
- design and develop models or experiments.

Developing a program

A teaching program outlines the nature and sequence of teaching and learning necessary for students to demonstrate the achievement of the learning outcomes. The content of the syllabus describes the learning context and the knowledge required for the demonstration of each outcome. The relevant learning outcomes for each unit or topic are stated at the beginning of the topic and the requirements of the outcomes are elaborated.

Teachers must develop programs that include appropriate learning activities to enable students to develop the knowledge and skills identified in the outcome statements.

The content prescribed in the units is an indication of the breadth and depth with which topics should be treated. The sequence of teaching is prescribed by the sequence of content. The learning outcomes and assessment however must be central to the planning of the teaching program.

Planning and programming units

The main purpose of planning and programming is to help you to arrange the presentation of the unit in an organised manner. This will help you to know what to teach and when to teach it. It is strongly recommended that you make plans with the other teachers who teach the same subject. By planning together, you will ensure better lessons and make better use of your limited resources.

Points to consider when programming

- Which outcomes are students working towards?
- What is the purpose of this unit/topic/learning experience?
- Which learning experiences will assist students to develop their knowledge and understandings, skills, and values and attitudes in the subject?
- What are the indicators of student learning that you would expect to observe?
- How can the learning experiences be sequenced?
- How do the learning experiences in the unit relate to students' existing knowledge and skills?
- How are individual learning needs to be catered for?
- What are the literacy demands of this unit/learning experience?
- What authentic links can be made with the content of other subjects?
- How can school events and practices be incorporated into the program?
- Do the assessment methods address the outcomes and enhance the learning?
- How can the assessment be part of the teaching and learning program?

The planning process

In this teacher guide, ideas for programming and organising have been provided. These have been arranged in steps to help you teach the unit. The steps follow the thinking processes involved in the outcomes approach.

Step 1 – Interpreting the learning outcomes

The first step is to read the description in the syllabus and then study the learning outcomes and what students do to achieve the learning outcome, to determine what students will know and be able to do by the end of the unit.

You need to look at the action verb, concept and context of each learning outcome. This will help you see what skills and knowledge are embedded in the outcome.

Step 3 – Programming a learning sequence

This step requires you to develop a program outlining a sequence of topics and the amount of time spent on each topic. If the unit involves a project for example, you may plan to teach some theory at appropriate stages during the project, rather than teaching all the theory before the students start the project.

To develop your program you need to study the topics listed in the syllabus and to think about the learning activities that will best provide students with the opportunity to learn the content and practice the appropriate skills, and how long the activities will take. You will have to think about some major activities that last several weeks and smaller activities that may be completed in a single lesson.

Step 4 – Elaboration of activities and content

Once you have mapped out your program for the term you must then develop more detailed plans for each topic in the unit. All units require students to be actively engaged in learning, not just copying from the board. Make sure you develop a range of activities that suit all learning needs – some reading and writing, some speaking and listening, some observing and doing.

Browse through the text books and teaching resources you have access to and list chapters, pages or items that you will use for each topic in your program. The text books should also provide you with ideas for activities related to the topic. You may have to collect or develop some resources for yourself.

Once you have sorted out your ideas and information you can then develop your more detailed weekly program and daily lesson plans.

This teacher guide gives some suggested teaching and learning activities for each unit and some suggested assessment tasks which you might like to use to ensure active learning.

Step 4– Planning for assessment

It is necessary to plan for assessment early to ensure that you teach the content and skills students need to achieve the learning outcomes.

You will have to decide when to schedule assessment tasks to allow yourself time to teach the required content and time for students to develop the necessary skills. You will also need time to mark the task and provide feedback. Practical tasks may, for example, be broken into a series of stages that are marked over several weeks as students progress with making their product. It is not appropriate to leave all the assessment until the end of the unit.

This teacher guide provides performance standards and examples of a marking guide. You should develop marking guides when you are marking tasks to ensure consistency of in your assessment. You must also develop clear and detailed instructions for completing the task and ensure all students know exactly what they have to do.

Applied Science requirements

There are six units in Grade 11 and four units in Grade 12 which all students must complete. There are also assessment tasks

Grade	Weeks	Term	Unit	Essential resources for activities and assessment
11	1-2	1	11.1 Introduction to Applied Science	School Library, Newspapers, blank papers, folders.
11	5-6	1	11.2 Traditional technology	Traditional artefacts, tools, variety of traditional food, local dyes, resource personnel, library,
11	8-10	1 - 2	11.3 Energy Around Us	Models, photocells, connecting wires, magnets, copper plates, light bulbs & holders, library, resource personnel
11	5-6	2 - 3	11.4 Hydrology	Local water supply system, variety of water sources, microscopes & slides, calcium compounds, soap, gas, Bunsen burner,
11	8-10	3 - 4	11.5 Environmental Management	resource personnel, library, posters, brochures, videos, water test kits, indicators, pH kits,
11	5-6	4	11.6 Health Science	Health posters & books, resource personnel, charts, models, First Aid Kit, pregnancy test kit, HIV AIDS test & VCT centres,
12	5-6	1	12.1 Modern Electronic Communication	Electronic devices, electronic tools set, connecting wires, capacitors, transistors, diodes, resistors, electronic circuit boards, electromagnets, power packs,
12	8 -10	1-2	12.2 Food Technology	Samples of processed foods, samples of packaging materials, iodine solution, ethanol, Benedict's solution, copper sulphate solution, GCSE Biology text book,
12	8 -10	3	12.3 Biotechnology	Variety of oily nuts, jars with lid, sifter, caustic soda, grater, scraper, oil, mould
12	8-10	3-4	12.4 Mineral Products	Lime concentrate, cement, sand, limestone, coral, shells, fire wood, empty containers, brick mould

Assessing Applied Science

Assessment is an important part of learning and teaching. It is used to:

- evaluate and improve learning and teaching
- report achievement
- provide feedback to students on their progress

Criteria referenced assessment

Assessment in Applied Science is criteria referenced and measures students' achievement of the learning outcomes described in the syllabus. In criterion-referenced assessment particular knowledge, skills or abilities are specified as criteria which must be achieved. The extent to which they are achieved is assessed and facilitated by the teacher.

Criterion-referenced assessment often takes on a problem-centred rather than merely a knowledge-based orientation. To achieve an outcome means having to demonstrate the attainment of skills and attitudes, not just write about them. Assessment becomes not merely a means of judging knowledge and performance, but an integral part of the learning process itself.

Criteria referenced assessment is:

- Standards or criterion-referenced - outcomes are judged against pre-defined standards (see page
- Direct and authentic, related directly to the learning situation. This has the potential for motivating learning, since students can see a direct relevance between what is learnt and what is assessed.

Norm-referenced assessment

Norm-referenced assessment makes judgments on how well the student did in relation to others who took the test and is often used in conjunction with a curve of 'normal distribution' which assumes that a few will do exceptionally well and a few will do badly and the majority will peak in the middle, normally judged as average.

Example of a criterion referenced test

The driving test is the classic example of a criterion-referenced test. The examiner has a list of criteria each of which must be satisfactorily demonstrated in order to pass - completing a three-point turn without hitting either kerb for example. The important thing is that failure in one criterion cannot be compensated for by above average performance in others; neither can a student fail despite meeting every criterion (as they can in norm-referenced assessment) simply because everybody else that day surpassed the criteria and was better than him or her.

Criteria-referenced assessment has the following characteristics:

- a syllabus that describes what students are expected to learn in terms of aims, outcomes and content
- a syllabus that provides a clear sense of the syllabus standards through its aims, outcomes and content
- tasks designed to produce an image of what students have achieved at that point in the learning and teaching process relative to the outcomes
- standards of performance at different levels: the Performance Standards

- a report that gives marks referenced to predetermined standards
- assessment tasks that refer to syllabus outcomes, content, assessment components and component weightings.
- external exams that based on syllabus outcomes and content. External markers use standards-referenced marking guidelines developed by the Applied Science examination committee.
- assessment that is better integrated with learning and teaching.

See page 56 and 57 for the learning outcomes performance standards which are criterion referenced and must be used for assessment purposes.

Assessment *for* learning

Assessment *for* learning is often called formative assessment and is assessment that gathers data and evidence about student learning during the learning process. It enables you to see where students are having problems and to give immediate feedback which will help your students learn better. It also helps you plan your program to make student learning, and your teaching more effective. Often it is informal and students can mark their own work or their friend's. An example is a quick class quiz to see if students remember the important points of the previous lesson.

Assessment *of* learning

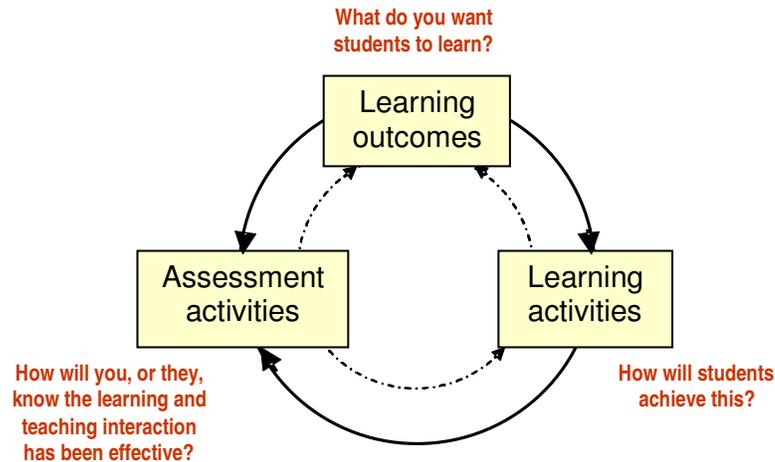
Assessment of learning is often called summative assessment. It is used to obtain evidence and data that shows how much learning has occurred, usually at the end of the term or unit. End of year examinations are examples of summative assessment. It is usually done for formal recording and reporting purposes.

Assessing Applied Science units

In Applied Science the learning outcomes are assessed using the range of assessment methods specified in the Table of components, weightings and tasks.

In deciding what to assess, the first point to start is at “what do you want to students to do and/or learn?” and following from this “how will the students engage with the material?” which leads to the design and development of learning tasks and activities. It is crucial; at this point that the assessment tasks are developed and that they clearly link back to the learning outcomes and are appropriate for the learning activities. The assessment can be used for formative and summative purposes. Assessment can be represented as follows:

The assessment process



Once it is clear what needs to be assessed and why, then the form the assessment will take will need to be determined. There are many types of assessment tasks that can be implemented and the factors that will determine include:

- the students – how many are there, what is expected of them, how long will the assessment task take?
- the learning outcomes of the subject and how they might be best achieved.

During the year you must set assessment tasks which ensure that all the learning outcomes of the subject have been assessed internally. Each task you set must include assessment criteria which provide clear guidelines to students as to how, and to what extent, the achievement of the learning outcomes may be demonstrated. Marking guides and assessment criteria help you with the marking process and ensure that your assessment is consistent across classes. It is important that marking guides and assessment criteria are collectively developed.

Students must complete the assessment tasks set. Each task must provide clear guidelines to students for how the task will be completed and how the criteria will be applied.

When you set a task make sure that:

- the requirements of the task are made as clear as possible to the student
- the assessment criteria and performance standards or marking guides are provided to the student so that they know what it is that they have to do
- any sources or stimulus material used are clear and appropriate to the task
- instructions are clear and concise
- the language level is appropriate for the grade
- it does not contain gender, cultural or any other bias
- materials and equipment needed are available to students
- adequate time is allowed for completion of the task.

Assessment methods

Although assessment methods and weightings are stipulated in the syllabus, you decide which assessment method to use when assessing the learning outcomes. You should use a variety of assessment methods to suit the purpose of the assessment.

Assessment can be classified into four categories: tests, product/project assessments, performance assessments and process skills assessments. Each has limitations therefore maintaining a balance of assessment methods is very important.

Tests

A test is a formal and structured assessment of student achievement and progress which the teacher administers to the class.

Tests are an important aspect of the teaching and learning process if they are integrated into the regular class routine and not treated merely as a summative strategy. They allow students to monitor their progress and provide valuable information for you in planning further teaching and learning activities.

Tests will assist student learning if they are clearly linked to the outcomes. Evidence has shown that several short tests are more effective for student progress than one long test. It is extremely important that tests are marked and that students are given feedback on their performance.

There are many different types of tests. Tests should be designed to find out what students know and about the development of thinking processes and skills. Open questions provide more detailed information about achievement than a question to which there is only one answer.

Principles of designing classroom tests

Tests allow a wide variety of ways for students to demonstrate what they know and can do. Therefore:

- students need to understand the purpose and value of the test
- the test must assess intended outcomes
- clear directions must be given for each section of the test
- the questions should vary from simple to complex
- marks should be awarded for each section
- the question types (true/false, fill-in-the-blank, multiple choice, extended response, short answer, matching) should be varied.

Tests should:

- be easy to read (and have space between questions to facilitate reading and writing)
- reflect an appropriate reading level
- involve a variety of tasks
- make allowance for students with special needs
- give students some choice in the questions they select
- vary the levels of questions to include gathering, processing and applying information

- provide sufficient time for all students to finish.

Product or project assessments

A project can be an assessment task given to an individual student or a group of students on a topic related to the subject. The project results in a product that is assessed. The project may involve both in-class and out-of-class research and development. The project should be primarily a learning experience not solely an assessment task.

A great deal of time and effort goes into producing a quality product from a project assignment task; therefore you should allow class time to work on the project.

A product or project:

- allows the students to formulate their own questions and then try to find answers to them
- provides students with opportunities to use their multiple intelligences to create a product
- allows teachers to assign projects at different levels of difficulty to account for individual learning styles and ability levels
- can be motivating to students
- provides an opportunity for positive interaction and collaboration among peers
- provides an alternative for students who have problems reading and writing
- increase the self-esteem of students who would not get recognition on tests or traditional writing assignments
- allows for students to share their learning and accomplishments with other students, classes, parents, or community members
- can achieve essential learning outcomes through application and transfer.

Assignments

Assignments are unsupervised pieces of work that often combine formative and summative assessment tasks. They form a major component of continuous assessment in which more than one assessment item is completed within the term. Any of the methods of assessment can be set as assignments although restrictions in format, such as word limits and due dates, are often put on the assessment task to increase their practicality.

Investigation

Investigations involve students in a study of an issue or a problem Teachers may guide students through their study of the issue or individual students or groups of students may choose and develop an issue in negotiation with the teacher. The emphasis in this assessment component is on the student's investigation of the issue in its context by collecting, analysing, and commenting on secondary data and information. Students should be encouraged to consider and explore a variety of perspectives as they develop and state their position on the issue. Students may present the investigation for assessment in a variety of forms, including one or a

combination of the following: a written report, an oral presentation, a website, linked documents, multimedia, a video or audio recording.

Criteria for Judging Performance

The student's performance in the investigation will be judged by the extent to which the student:

- identified and described the issue or problem
- described and explained the causes and effects
- critically analysed information and outlined possible steps leading to a solution or recommendation.

Portfolios

Portfolios provide evidence for judgments of student achievement in a range of contexts. Portfolios contain a specific collection of student work or evidence. This collection of work should provide a fair, valid and informative picture of the student's accomplishments.

Computer-based tasks

Using computers to administer student assessment can provide flexibility in the time, location or even the questions being answered of students. The most common type of computer-based assessment is based on multiple-choice questions which can assist teachers manage large volumes of marking and feedback.

Process skills assessments

This method of assessment component involves assessing students' understanding of concepts based on the practical skills that can be used, the evaluation of work done, and/or the reporting of information. These skills include, for example:

- interpretation skills
- evaluation skills
- reflection skills
- communication skills (e.g. writing, speaking, and listening).

Types of assessment tasks

Different assessment tasks provide the means of ensuring that students are able to demonstrate the range of their abilities in different contexts.

Each category has advantages in assessing different learning outcomes. For example, a selected response assessment task, such as a series of multiple-choice questions, is able to assess all areas of mastery of knowledge but only some kinds of reasoning.

Assessment ideas for individual students or groups

Tests	Products/Projects	Performances	Process Skills
Essay	Scientific report	Observing experiments	Checklist observations for processes
Multiple-choice	Models	Reading instruments	Observations
Matching	Assignments	Doing simple experiments	Concept mapping
Short answer	Writing portfolios	Making inferences	Process-folios
Open book	Posters/charts	Discussions	Journal entries regarding processes
Practical	Projects	Presentations	Recording feedback
	Displays	Debates	
	Drawings		
	Case studies		

Feedback

When you assess the task, remember that feedback will help the student understand why he/she received the result and how to do better next time.

Feedback should be:

- *constructive*, so that students feel encouraged and motivated to improve
- *timely*, so that students can use it for subsequent learning
- *prompt*, so that students can remember what they did and thought at the time
- *focused on achievement*, not effort. The work should be assessed, not the student
- *specific to the learning outcomes*, so that assessment is clearly linked to learning.

Feedback can be:

- *informal or indirect*: such as verbal feedback in the classroom to the whole class, or person to person
- *formal or direct*: in writing, such as checklists or written commentary to individual student either in written or verbal form
- *formative*: given during the topic with the purpose of helping the student know how to improve
- *summative*: given at the end of the topic with the purpose of letting the students know what they have achieved.

Who assesses?

Teacher assessment

Assessment is a continuous process. You should:

- always ask questions that are relevant to the outcomes and content
- use frequent formative tests or quizzes

- check understanding of the previous lesson at the beginning of the next lesson through questions or a short quiz
- constantly mark/check the students' written exercises, class tests, homework activities
- use appropriate assessment methods to assess the tasks.

Frequency of assessment

You should schedule the specified assessment tasks to fit in with the teaching of the content of the unit that is being assessed. Some assessment tasks might be programmed to be undertaken early in the unit, others at the end of the unit. You should take care not to overload classes with assessment tasks at the end of the term.

Judging student performance

Student achievement is recorded and reported against standards. You must use performance standards or marking guides, examples of which are provided in this teacher guide, when making a decision about the achievement of your students in relation to the learning outcomes. The performance standards describe the level at which the student has to be working to achieve a particular standard or mark.

Students should always have access to a copy of the assessment criteria and the performance standards so that they know what it is they have to know and be able to do to get a good mark in a particular task. The performance standards will help you in your marking and will help your students improve their performance in the future. They are useful when providing feedback to students as they explain what it is the student needs to do to improve.

Moderation

To ensure that you are interpreting the performance standards correctly when assessing your students, it is important to undertake subject moderation of student work within your school and with teachers of nearby schools.

To moderate student work, a common assessment task must be used and a marking scheme developed so that all students complete the same task under the same conditions, and all teachers use the same marking scheme. Teachers can then compare (moderate) the students' work and come to a common understanding of the performance standards and the requirements for a particular mark or level of achievement.

Moderation enables you to be sure that your understanding of the required standards for levels of achievement is similar to the understanding of other teachers and that you are assessing students at the appropriate level.

Self assessment and peer assessment

Self and peer assessment helps students to understand more about how to learn. Students should be provided with opportunities to assess their own learning (self assessment) and the learning of others (peer assessment) according to set criteria.

Self and peer assessment:

- continues the learning cycle by making assessment part of learning
- shows students their strengths and areas where they need to improve
- engages them actively in the assessment process
- enables them to be responsible for the learning
- helps to build self-esteem through a realistic view of their abilities
- helps students understand the assessment criteria and performance standards

Managing assessment tasks for Applied Science

Usually, the marking of assessment tasks is done by the teacher.

To reduce the amount of work it is necessary to develop a strategic approach to assessment and develop efficiencies in marking.

In Applied Science there are a number of assessment tasks that may be new to teachers and students. Below are suggestions on how to manage some of these tasks to minimise marking or presentation time.

Develop efficiency in marking

Clarify assessment criteria

Plan the assessment task carefully, and ensure that all students are informed of the criteria before they begin. Discuss the task and its criteria in class, giving examples of what is required. Distribute a written copy of the instructions and the criteria, or put them on the board. Making the assessment criteria explicit speeds marking and simplifies feedback.

Supply guidelines on what is required for the task

This reduces the amount of time wasted evaluating student work that is irrelevant.

Use attachment sheets such as marking guides

An assignment attachment sheet, which is returned with the assessed work, rates aspects of the task with a brief comment. Such a system enables each student's work to be marked systematically and quickly. This strategy can be applied to posters, presentations and performances.

Assess in class

Use class time to carry out and to assess tasks. Performances or art works, marked by you or the students, enables instant developmental evaluation and feedback. Brief assessments of projects, stages of the design process, or practical work take less time to mark and are useful because they give immediate feedback to students on their progress and allow you to mark the project in stages with minimum effort.

Feedback to the whole class

Feedback to the whole class can cut down on the amount of individual feedback required. On returning assessed work, emphasise the criteria for judging the work, discuss the characteristics of good and bad answers, and highlight common strengths and weaknesses.

Set group-work alternatives

Assess one performance per group. The student's mark is the group mark, but may include a component based on the contribution of the individual. A strategy for allocating an individual mark includes each member of the group using criteria to evaluate the relative contributions of individuals, with the marks averaged for the individual.

Set clear deadlines

Set aside a time for marking. Be careful about extending this period through allowing students to hand in work late.

Shift the responsibility*Introduce self and peer assessment*

Develop in students the skills to evaluate their own work and that of their peers. With the students, use the assessment criteria against which work is judged, highlighting strengths and weaknesses. Self-assessment increases the amount of feedback students get. It can supplement or replace teacher assessment.

Treat each task differently

Every piece of work need not be evaluated to the same degree; a mark need not be the outcome in every case; and every piece of student work need not contribute to the final grade. Assessment is designed to enhance the teaching and learning experience for the teacher and the learner, not just to give marks.

Sample assessment tasks

Grade 11

All assessment tasks must test whether or not the student has achieved the outcome or outcomes. Each task must have clear and detailed instructions. Students must know exactly what they have to do. You should develop marking guides when you are marking tasks to ensure consistency of your assessment. The following are examples of assessment tasks and a marking guide.

Sample task: Research report

Students undertake research on a topic of interest related to the application of science concepts and present a report. This task links with Unit 11.1 -11.6

Learning outcomes

Students can:

1. demonstrate an understanding of fundamental principles and models of science
2. apply scientific thinking and skills in technological processes and procedures
3. design and undertake scientific investigations to solve problems
4. research and analyse information, procedures and materials
5. communicate scientific investigations and findings in different ways
6. evaluate traditional scientific knowledge and skills and their relevance today

Assessment criteria

Students will be assessed on the extent to which they can:

- identify a practice used in the community or a suitable science project
- conduct extensive research using different sources (library, community, interviews, internet, etc.)
- analyse and interpret the findings
- communicate the findings in a variety of ways.

Sample Task: Field trip

Students undertake a field trip and present a scientific report

Assessment criteria

The assessment task will be assessed on the extent to which the students can:

- collect and categorise information
- demonstrate knowledge and understanding of scientific concept and processes

- analyse information
 - communicate the findings in a variety of ways.

Grade 12

Sample task: A working model of an electric motor

Students construct a working model of an electric motor.

Learning outcomes

Students can:

1. demonstrate an understanding of fundamental principles and models of science
2. apply scientific thinking and skills in technological processes and procedures
3. design and undertake scientific investigations to solve problems
4. research and analyse information, procedures and materials
5. communicate scientific investigations and findings in different ways

Assessment criteria

The assessment task will be assessed on the extent to which the students can:

- identify a model for construction
- resource identification
- planning and researching
- construction
- workability
- presentation and evaluation

Sample task 2: Processing

Assessment criteria

The assessment task will be assessed on the extent to which the students can:

- identify a process
- identify resources and plan
- planning and researching
- execute the process
- finish product
- test the finish product and evaluate the result

Marking guides

Marking guides like the one on page 30 can be used to assess the tasks you set.

Learning activities and assessment tasks

Examples of learning activities and assessment tasks for each units are provided in the following sections. Some examples are explained in detail.

Grade 11 units

11.1 Introduction to Applied Science

This is an introductory unit with a maximum time requirement of 1-2 weeks. It is recommended that this unit be taught first.

Suggested activities

A range of activities can be used to ensure students learn the expected content knowledge of this unit. Some are identified and elaborated below.

- brain storm the meaning of Applied Science through the use of concept or mind maps
- review scientific processes such as problem identification, hypothesising, investigation, analysis and application
- discuss and list some application of science concepts in everyday life
- research some local and global issues which are direct/indirect results of scientific manipulation
- investigate different ways of reporting global scientific issues

The following table gives elaboration of some selected activities from the above list.

Activity	Elaboration
Brain storm or do concept map on the question "what is applied science?"	<ul style="list-style-type: none"> - Put students in groups of 5. Give each group some blank paper. - Students write down Applied Science in the centre of the paper in a circle. - Students write down any connected ideas to Applied Science and draw arrows from the circle. - Using the concept map, they can come up with a definition for Applied Science.
Research the global & local effect of climate change	<p>Questions like these could be asked to help students find out about climate change. They can also be asked to collect data, discuss and present both oral and written presentations.</p> <ul style="list-style-type: none"> - What is climate change? - How is climate change caused? - What substances add to the effect of climate change? - How does climate change threaten biodiversity both locally and globally? - How can the impact of climate change be addressed? - How does climate change affect global and local weather patterns?

Suggested assessment task

Students undertake research on one global issue. (20 marks)

Assessment criteria

The assessment task will be assessed on the extent to which the student can:

- choose a current global issue. e.g. climate change/global warming
- discuss the issue and its effect in detail
- describe how science can help solve some of the identified problems
- conclude with an effective measure that can be undertaken locally to address the problem.

11.1 Performance standards for assessment task 1: Students undertake research on ozone depletion and greenhouse effect				
20 marks				
Performance Criteria	Very High Achievement (18–20 marks)	High Achievement (14–17 marks)	Satisfactory Achievement (10–13 marks)	Low Achievement (0–9 marks)
Suitable Title (2 marks)	Clearly stated and appropriate (2)	Stated well (1–2)		Not related to content (0-1)
Appropriate Introduction (3 marks)	Very clear definitions of ozone depletion, green house effects and what research is about (3)	Clear definition of Ozone and greenhouse effect and explanation of research (2–3)	Definitions and explanations stated (1– 2)	Unclear definition and explanations (0–1)
Detailed discussion on the body (5 marks)	Very detail explanation and discussion on substances that deplete Ozone and greenhouse effect (5)	Clear discussions and explanations on substances that deplete Ozone and greenhouse effect (3-5)	Few discussions on substances that deplete Ozone and greenhouse effect (1–3)	Poor discussions on substances that deplete Ozone and greenhouse effect (0–1)
Effects of ozone depletion and greenhouse on biodiversity and global weather patterns (4 marks)	Comprehensive explanation on the effects (4)	Good explanations on the effects (3-4)	Fair explanation of effects (1–3)	Little or no explanation on effects (0–1)
Conclusion (3 marks)	Outstanding conclusion (3 marks)	Good conclusion (2 -3 marks)	Fair conclusion (1–2)	Poor conclusion (0-1)

Recommendation (3 marks)	Very good recommendations made (3)	Good recommendations made (2-3)	Appropriate recommendations (1-2)	Minimal recommendations (0-1)
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11.2 Traditional Technology

The maximum time requirement for teaching this unit is 5-6 weeks.

Suggested activities

A range of activities can be used to ensure students learn the expected content knowledge of this unit. Some examples are identified and elaborated below:

- brainstorm and identify traditional technologies. Carry out a community survey to determine how many types of traditional technologies are still in use.
- construct examples of traditional equipment/artefacts. (Students can choose an item in the local area)
- explain and demonstrate the application of science in these technologies.
- compare and discuss traditional and modern technologies.

Elaboration of content

The following table gives elaboration of some selected activities from the above list.

Activity	Elaboration
Constructing a traditional artefact. e.g. paddle, bow & arrow, spear, stone axe, canoe, flute, kundu,	Construct a simple questionnaire and interview locals on the <ul style="list-style-type: none"> - history of the traditional artefact - shape of the artefact - type of wood used to make the artefact - how the artefact is handled and used Write an essay about the traditional artefact stemming from the interview. Explain the science principle/concept behind the traditional artefact Design and construct the artefact.
Compare and contrast traditional and modern technologies. e.g. arrows and bullets, canoes and motorised boats.	Students can work in groups. Each group chooses a traditional and modern technology Compare and contrast the similarities and differences between the two technologies in terms of: <ul style="list-style-type: none"> - shape and structure - applications of science principles - types of materials - efficiency and durability.

Suggested assessment task

- Undertake a community survey to find out how many traditional technologies are still used today in their communities (villages).
- Carry out research on a particular traditional technology e.g. sago making, pottery making or basketry.

Assessment criteria

The assessment task will be assessed on the extent to which the students can:

- draft simple questions in any language that can be easily understood by the respondents
- collect information through the community survey
- tabulate information
- present information
- choose a particular traditional technology e.g. canoe making, pottery making, basketry
- explain the history of this traditional technology
- construct this traditional technology
- explain and describe how it is used
- demonstrate the use of this traditional technology.

Marking guide

11.2 Performance standards for assessment task 2: Identify and carry out research on a particular traditional technology				
20 marks				
Performance Criteria	Very High Achievement (18–20 marks)	High Achievement (14–17 marks)	Satisfactory Achievement (10–13 marks)	Low Achievement (0–9 marks)
Title (2 marks)	Clearly stated (2)	Title stated (1-2)		Inappropriate title (1)
Introduction (3 marks)	Clearly define what technology is and state reasons for studying technology (3)	Good definitions of technology and reasons for studying technology (2-3)	Adequate discussions (1-2)	Inadequate discussions (0-1)
Content (5 marks)	Comprehensive discussions of history and construction methods/materials (5)	Sufficient discussions of history and construction methods/materials (3-5)	Fair discussions of history and construction methods/materials (1-3)	Inadequate discussion on history and construction methods/materials (0-1)
Application of science concepts (5 marks)	Very clear outline of application of science concepts (5)	Clear outline of application of science concepts (3-5)	Adequate outline of application of science concepts (1-3)	Inadequate outline of application of science concepts (0-1)

Appropriate conclusion (3 marks)	Detailed information and suggestions (3)	Good information and suggestions (2-3)	Adequate information and suggestions (1-2)	Inadequate information with no suggestions (0-1)
High level of presentation (2 marks)	Excellent presentation (2)	Very good presentation (1-2)	Good presentation (1-2)	Poor presentation (0-1)

11.3 Energy Around Us

This unit will take 8-10 weeks. It is recommended that this unit be taught as outlined.

Suggested activities

A range of activities can be used to ensure students learn the expected content knowledge of this unit., such as:

- review and reinforce the concept of energy and energy changes through various demonstrations such as firing an arrow with a bow
- demonstrate principles of energy conservation through simple experiments
- construct simple models of energy converters such as solar heater, photovoltaic cell
- research, analyse and present information on developing alternative energy sources and their associated problems
- calculate the amount of energy produced by various electrical devices used at homes and schools. suggest ways to minimise overuse of energy
- investigate the composition and derivatives of fossil fuels and their uses
- use charts, diagrams and pictures to compare and debate cheaper and cleaner energy sources available to Papua New Guinea
- investigate use of ethanol from the fermentation of glucose and discuss the advantages and disadvantages as an alternative energy source
- excursion or field trip to a power plant or other energy sources
- conduct case studies and surveys on energy use at home and communicate ideas in a variety of ways

Elaboration of content

The following table gives elaboration of some selected activities from the above list.

Activity	Elaboration
Construct simple models of energy converters. e.g. solar	Research into solar heater and other simple energy converters and draw models appropriate to your selected project. Construct models using

heater	simple apparatus for display, presentation and assessment.
Case study on alternate energy sources	Carry out case study on a selected topic from an alternative energy source. Provide unique accounts of situations, sequence of events & developments of energy source. Suggest advantages and disadvantages of these sources and how to provide efficiency and sustainability.
Seminar and presentation on cleaner energy	Students collect information, present view points on cleaner energy sources available to Papua New Guinea. Propose ideas prior to discussion and evaluation. This method trains students for public speaking and group dynamics. Talk could include construction materials for models, posters, charts, diagrams or pictures.

Suggested assessment tasks

- Design and carry out survey on energy usage at home.
- Investigate fractional distillation process in the laboratory and identify how the diversity of products is obtained from crude oil.
- Calculate energy consumption in the home.
- Construct models of energy producing devices e.g. dynamos.

Assessment criteria

The assessment tasks will be assessed on the extent to which the student can:

- devise and format activity
- gather information
- calculate energy usage
- complete activities
- communicate ideas/findings through oral and written presentations.

11.3: Design and carry out survey on energy usage at home				20 marks
Performance Criteria	Very High Achievement (18–20 marks)	High Achievement (14–17 marks)	Satisfactory Achievement (10–13 marks)	Low Achievement (0–9 marks)
Appropriate title (2 marks)	Title well chosen and clearly written (2 marks)	Title stated and appropriate (1-2 marks)		Title not stated (0-1 marks)
Planning and formatting (3 marks)	Excellent sequence of planning (3 marks)	Very Good sequence of planning (2-3 marks)	Adequate planning (1-2 marks)	Poor Planning (0-1 marks)
Introduction (3 marks)	Very clear discussion (3 marks)	Clear discussion (2-3 marks)	Adequate (1-2 marks)	Inadequate (0-1 mark)

Content (5 marks)	A very detailed discussion on energy usage (4-5marks)	Good discussions (3-4 marks)	Adequate (1-2 marks)	Not adequately discussed (0-1 mark)
Results and conclusion (4 marks)	Excellent statistical interpretation (4 marks)	Very good statistical interpretation (2-3 marks)	Adequate statistical interpretation (1-2 marks)	Poor statistical interpretation (0-1 mark)
Recommendations (3 marks)	Excellent recommendation to improve survey (3 marks)	Clear recommendations to improve survey (2-3 marks)	Adequate recommendations (1-2 marks)	Poor recommendations (0-1 mark)

11.4 Hydrology

This is a 5-6 weeks unit. It is to be taught as recommended.

Suggested activities

A range of activities can be used to ensure students learn the expected content knowledge of this unit, such as:

- find the physical and chemical properties of water through simple experiments e.g. hardness test, pH test
- research and identify importance of water in animals, plants, ecosystems, industries and homes
- use the knowledge of water cycle to discuss processes of obtaining pure water from various sources such as sea, swamps, artesian basins
- visit a local town or school water supply system to see how it is setup for clean and safe drinking water. Discuss observations and suggest ways to improve
- explore possible water sources and discuss using diagrams showing how water tables and aquifers are formed
- investigate, design and construct simple purification models to extract and purify water
- research the cause and effects of eutrophication and biomagnification and suggest measures to reduce these issues
- explore and suggest methods of water conservation in areas where water is scarce

Practical activities

- conduct water analysis experiments; for example, pH, salinity and solubility tests
- design a water purification model for a local area

- research water conservation methods and make recommendations for the local area

Elaboration of content

The following table gives elaboration of some selected activities from the above list.

Activity	Elaboration
Laboratory task Investigate chemical properties of water –	Conduct laboratory activities to investigate the hardness of water. Examine the causes of hard water through addition of chemical substances like calcium compounds. Use soap to determine the hardness from lather quality. Include simple equations to demonstrate the chemical reactions.
Visit local water supply system	Visit and investigate the town/school water supply system. Identify and describe the different stages of water reticulation and detail the purification, filtration and treatment strategies used. Examine sources and storage of water and emphasise conservative use of water. Further test for impurities and stress on clean and safe water.

Suggested assessment tasks

- Conduct laboratory activities to demonstrate the chemical properties of water in particular testing hardness and the process of removing hardness.
- Investigate and produce a portfolio of the functions of water in plants, animals, ecosystems, industries and homes.
- Conduct pH test of different water sources to determine the acidity.

Assessment criteria

The assessment tasks will be assessed on the extent to which the student can show the following:

A: General criteria:

- topic identification
- introduction
- content
 - diagrams/illustrations
 - written work
 - equations
 - constructions
 - presentations
- Conclusions

B. Standard check

- interesting
- challenging
- relevant/applicable
- sound knowledge
- confidence

- follow procedures
- workable

11.4 Conduct laboratory activities to demonstrate the chemical properties of water in particular testing hardness and the process of removing hardness 20 marks

Performance Criteria	Very High Achievement (18–20 marks)	High Achievement (14–17 marks)	Satisfactory Achievement (10–13 marks)	Low Achievement (0–9 marks)
Appropriate Title (2 marks)	Very good and appropriate title (2)	Good Title (1-2)	Title stated (1-2)	Inappropriate title or not stated (0-1)
Appropriate aims (2 marks)	Correctly and clearly state the required aims (2)	Clearly state the aims (1-2)	Aims stated (1-2)	Inappropriate aims (0-1)
Suitable Hypothesis (3 marks)	Hypothesis clearly and correctly written (3)	Hypothesis clearly stated (2-3)	Hypothesis stated (1-2)	Irrelevant hypothesis (0 -1)
Logical steps and procedures (4 marks)	Correctly stated and followed all the steps and procedures in sequence (4-5)	Steps and procedures stated and followed (3-4)	Some steps and procedures adequately followed (1-2)	Steps and procedures not followed (0-1)
Detailed analysis and explanation (5 marks)	Very detailed analysis and logical explanations (5)	Good analysis and explanation (3-4)	Fair analysis and explanation (1-2)	Poor analysis with minimum explanation (0-1)
Appropriate conclusion (4 marks)	Very reliable and well written conclusion (4)	Well written conclusion (3-4)	Conclusion appropriate (1-2)	Inappropriate conclusion (0-1)

11.5 Environmental Management

This is an 8-10 weeks unit. It is to be taught as recommended.

Suggested activities

A range of activities can be used to ensure students learn the expected content knowledge of this unit, such as:

- recount traditional uses of forest products in various communities in Papua New Guinea and discuss their cultural implications
- investigate the status of forest and wetlands ecosystems through research. Discuss the findings
- carry out research on forests, grasslands and wetlands resources, their uses and threats on their availability. Communicate the findings through written and oral presentations

- explore current forestry practices and its impact on the environment. Tabulate the findings and make recommendations on how these practices can be improved for our benefit
- investigate and discuss alternative methods of harvesting wood, wood products and other non timber products. Propose best practices for sustainable harvesting
- undertake an excursion to a reforestation project
- explore traditional and modern fishing practices and discuss their advantages and disadvantages
- undertake case studies on sustainable fishing practices used by various communities in Papua New Guinea
- examine various policies on forestry and fisheries and discuss how effective these are. Recommend ways to improve these policies to meet current needs without jeopardising the future generations
- research grassland resources, their uses and threats. Present the findings through written and oral presentations
- research traditional and modern fishing practices; discuss the findings
- carry out a survey to determine types of wastes and their sources and discuss results of the findings. Suggest safe and improved waste disposal methods
- investigate current waste management practices both locally and globally and develop improved strategies to minimise waste problems
- investigate various forms of pollution and their impact on the environment and explore ways to minimise them

Practical work

- excursion to a reforestation project
- plot out forestry activities on a PNG map
- visit a sustainable wetlands project
- set up recycling centres for cans, plastic bags and other used white goods such as refrigerators, and stoves
- carry out experiments on decomposition rate of selected biodegradable materials and design ways to recycle them
- a litter survey in the local area and recommendations to the town council
- research global waste management practices and discuss its implications for Papua New Guinea
- water test to determine pollution rate of a local fresh water system and suggest ways to improve it.

Elaboration of content

The following table gives elaboration of some selected activities from the above list.

Activity	Elaboration
Carry out research on forest, grasslands and wetlands	Assign each ecosystem type to a group of three or four. Have each group do a research to collect information on location, and

resources, their uses and threats to their availability. Communicate the findings through oral and written presentations.	types of resources found in each ecosystem. Discuss the uses, availability and threats on these resources and identify and discuss ways to manage these resources. Have students do both oral and written presentations on their findings.
Investigate various forms of pollution and their impact on the environment and explore ways to minimise them.	Brain storming exercises with students on different types of pollution – air, water and land. Students (i) do library research on air pollution, (ii) visit a land pollution site and, (iii) carry out an experiment on water pollution. Have a class discussion on the library research, students complete a questionnaire for the field visit and; do an experiment on pH test for various water samples from local fresh water systems to determine if it is polluted.

Suggested assessment tasks

- Field trip to a forest, grassland, reforestation or wetland site and write a post trip report.
- An experiment to determine the pollution rate of a local fresh water system.
- Undertake a litter survey in the local area and make recommendations to the town council.

Assessment criteria for task 1

The assessment task will be assessed on the extent to which the student can:

- recognise and state the link between the trip and the importance of forest, grassland and wetlands ecosystems
- provide a 4–5 page report on the location, aim of the trip, a summarised view of the site and its purposes, what was seen at the site and how it links to the importance of forest, grassland and wetland ecosystems
- describe how this site can be managed sustainably to meet its purpose
- conclude with any views or recommendations of improvement or maintenance.

Marking guide

11.5 Field trip to a forest, grassland, reforestation or wetland site and write a post trip report				
20 marks				
Performance Criteria	Very High Achievement (18–20 marks)	High Achievement (14–17 marks)	Satisfactory Achievement (10–13 marks)	Low Achievement (0–9 marks)
Appropriate topic (2 marks)	Topic clearly stated (2)	Topic stated (1-2)		Inappropriate topic (0-1))
Suitable introduction and aim (2 marks)	Appropriate introduction and aim which is clearly written (2)	Clear introduction and aim stated (1-2)	Stated (1)	Irrelevant (0)

Description of location and purpose (3 marks)	Very clear descriptions of the location and its purpose (3)	Clear descriptions of location and purpose of site (2-3)	Description and purpose of site stated (1-2)	Incorrect description and purpose (0-1)
Detailed discussion on relevance of excursion (5 marks)	Detailed discussions with clear mention of relevance to forest, grassland and wetland ecosystems (5)	Discussions state relevance to forest, grassland and wetlands ecosystems (3-4)	Some mention of relevance to forest, grassland and wetland ecosystems (1-3)	Very little mention of relevance to forest, grassland and wetland ecosystem (0-1)
Discussion on site management and sustainability (5 marks)	Discussions clearly detail site management and demonstrate clear understanding of sustainable practices (5)	Discussion of site management and demonstrate understanding of sustainable practices (3-4)	Site management and sustainable practices identified (1-3)	No or very little mention of site management and sustainable practices (0-1)
Appropriate conclusion and recommendations (3 marks)	Very clear conclusion and recommendations (3)	Clear conclusion and recommendations (2-3)	Conclusion and recommendations made (1-2)	Inappropriate conclusion and recommendations (0-1)

Assessment criteria for task 2

The assessment task will be assessed on the extent to which the student can:

- write a scientific report that should clearly outline the topic, introduction, aim, methods used, materials used, results, discussions and conclusion.
- clearly discuss and explain the results of the experiments and what their findings are.
- suggest ways in which issues of pollution can be addressed.

Marking guide

11.5 An experiment to determine the pollution rate of a local fresh water system 20 marks				
Performance Criteria	Very High Achievement (18–20 marks)	High Achievement (14–17 marks)	Satisfactory Achievement (10–13 marks)	Low Achievement (0–9 marks)
Appropriate topic (2 marks)	Clearly state topic (2)	Topic stated (1-2)		Inappropriate topic (0-1)
Suitable introduction and aim (3 marks)	Clearly and correctly stated (3)	Clearly stated (2-3)	Stated (1-2)	Irrelevant (0-1)
Logical steps and procedures (3 marks)	Very clear descriptions of procedures and equipment used (3)	Clear descriptions of procedures and equipment used (2)	Procedures and use of equipment described (1-2)	Incorrect description of procedures and equipment used (0-1)

Analysis of results (4 marks)	Detailed scientific analysis of results (4-5)	Good analysis of results (3-4)	Fair analysis of results (1-2)	Poor analysis (0-1)
Discussion and explanation (5 marks)	Detailed and relevant discussion and explanation (4-5)	Good discussion and explanation (3-4)	Sound discussion and explanation (1-3)	Inadequate discussion and explanation (0-1)
Appropriate conclusion (3 marks)	Scientifically reliable and well written with clear achievement of aims (3)	Reliable and well written conclusion (2-3)	Conclusion appropriate (1-2)	Inappropriate conclusion (0-1)

11.6 Health Science

This is a 5-6 weeks unit. It is to be taught as recommended.

Suggested activities

To ensure that teaching and learning is to occur, below are some suggested learning activities and teaching strategies. They can be adapted and refined to suit different learning needs.

Health technology

- investigate uses and functions of various medical technologies such as clinical thermometers, image scanners, sphygmomanometer, stethoscopes
- take blood pressure readings, pulse rates, listen to heart beat

Caution

You are not allowed to carry out surgical types of activities or handle fresh human blood

Health chemistry

- investigate different testing kits available and state their purposes
 - urine test, pregnancy test, drugs, hormones, blood-sugar level

- invite a certified medical personnel to give a talk or demonstrate various types of tests

Monitoring our bodies

- discuss reasons for carrying out regular health checks
 - eyes, blood pressure, dental
- comparing healthy and unhealthy habits
 - importance of balanced meals
 - under or over nourishment
 - exercises and fitness or lack of fitness
- carry out a few days clinical work experience at local health centres, aid posts, clinics or hospitals
 - specific skills such as midwifery, treating cuts, sores and snake bites

Common diseases

- talk from a medical person on common diseases
- research the causes and effects of common diseases like obesity, diabetes, heart attack and high blood pressure and communicate the findings
- produce awareness posters that depict signs and symptoms of common diseases like obesity, diabetes, heart attack and high blood pressure
- compare and discuss traditional and modern practices in prevention and treatment of diseases
- compile a portfolio of traditional and introduced medicinal plants that are used to treat diseases/ailments
- conduct awareness on importance of traditional diets for healthy living in both rural and urban homes

HIV and AIDS

- compare local, provincial, national and global statistics on HIV and AIDS and discuss strategies to minimise spread of epidemic
- debate on issues related to HIV and AIDS i.e. high risk areas, stigmatisation
- invite certified trainer to highlight counselling for people living with HIV and AIDS or visit a Voluntary Counselling and Testing (VCT) centre
- investigate methods and procedures for HIV testing
- discuss implications of rape, needle sharing, drugs and other social behaviours leading to HIV
- research on the policies and practices for HIV and AIDS e.g. HIV and AIDS Management and Prevention Act 2004 (HAMP ACT) and create awareness in the communities

Health and safety

- identify, prevent and manage hazardous situations in schools and public facilities taking into account crisis management procedures.
- invite a certified first aid trainer to conduct training on First Aid, counselling and follow up support.

- conduct mock accidents role plays and apply first aid skills for common injuries such as minor burns, cuts and grazes, broken limbs

Elaboration of content

The following table gives elaboration of some selected activities from the above list.

Activity	Elaboration
Identify and describe signs and symptoms of common diseases with reference to human anatomy charts and models.	<p>Source resource materials from various resource centres. Research and tabulate the signs and symptoms of common diseases like diabetes</p> <p>Use human anatomy charts and models to identify the body parts/systems that can get affected by common diseases.</p> <p>Discuss signs and symptoms that appear when affected by these diseases.</p>
Identify, prevent and manage hazardous situations in schools and public facilities using crisis management procedures.	Take a walk around the school and/or public facilities. Identify and note down hazardous situations. In groups, discuss preventive and management procedures for the identified hazardous situation. Carry out awareness on preventive measures. Conduct mock hazardous situations role plays and apply management and treatment procedures

Note: It is important that qualified First Aid personnel help conduct lessons related to First Aid skills.

Suggested assessment tasks

- Compile a portfolio on traditional and introduced medicinal plants.
- Debate on an issue on HIV and AIDS e.g. HIV is transmitted by sex workers only.

Assessment criteria

The assessment task will be assessed on the extent to which the student can:

- select several traditional medicinal plants that are easily accessible. e.g. ginger, noni plant, lemon grass, guava
- classify and describe traditional medicinal plants according to their characteristics
- sketch the plants and their parts
- describe and explain how traditional medicinal plants are used to treat and cure ailments and diseases.

Assessment task two will be assessed using the following:

- language usage
- confidence
- constructive arguments
- interaction
- body language
- relevance to topic

- organisation of material.

11.6: Compile a portfolio on traditional and introduced medicinal plants.				20 marks
Performance Criteria	Very High Achievement (18–20 marks)	High Achievement (14–17 marks)	Satisfactory Achievement (10–13 marks)	Low Achievement (0–9 marks)
Selection of traditional and introduced medicinal plants (3 marks)	Selection is varied and above the minimum requirement (3)	Within the minimum requirement (2-3)	Slightly below the minimum requirement (1-2)	Below the minimum requirement (0-1)
Classification system used (4 marks)	Included all information on the Phylum, Family, Scientific/common name (4)	Included most information on the Phylum, Family, Scientific/common name (2-3)	Basic information on the Phylum, Family, Scientific/common name (1-2)	Little or no information on the Phylum, Family, Scientific/common name (0-1)
Describe and sketch the plants and their parts (5 marks)	Demonstrates clear understanding of climatic preferences, varieties, adaptations, general shape and structure, and clear well labelled drawings presented (5)	Demonstrates understanding of climatic preferences, varieties, adaptations, general shape and structure, and clear drawings presented (3-4)	Demonstrates some understanding of climatic preferences, varieties, adaptations, general shape and structure, and clear drawings presented (1-2)	Demonstrates little or no understanding of climatic preferences, varieties, adaptations, general shape and structure. Poor drawings presented (0-1)
Procedures of extraction and treatment (4 marks)	Excellent explanations on the procedures of extraction and treatment and cures of diseases and ailments (4)	Very good explanations on the procedures of extraction and treatment and cures of diseases and ailments (2-3)	Good explanations on the procedures of extraction and treatment and cures of diseases and ailments (1-2 marks)	Poor explanations on the procedures of extraction and treatment and cures of diseases and ailments (0-1)
Portfolio (4 marks)	High level display of layout, creativity, neatness, flow of information (4)	Good display of layout, creativity, neatness, flow of information (2-3)	Appropriate display of layout, creativity, neatness, flow of information (1-2 marks)	Low level display of layout, creativity, neatness, flow of information (0-1)

Grade 12 units

12.1 Modern Electronic Communication

This is a 5-6 weeks unit. It is to be taught as recommended.

Suggested activities

A range of activities can be used to ensure students learn the expected content knowledge of this unit, such as:

- define and explain electronic communication and its applications in the modern world
- history of radio and television
- transmission and reception of electromagnetic signals
- components of modern devices
- conduct experiments on Faraday's Laws of electromagnetism and explain its uses
- dismantle appliances and draw circuit diagrams
- investigate and describe the functions of a capacitor, transistor, light emitting diodes (LED) and resistors from an old appliance
- identify and retrieve diodes from old circuits and explain its function in the generating process
- investigate the principles of basic electronics in radio communication
- discuss simple digital electronics e.g. switches, LEDs
- research case studies on the effects of electromagnetic radiation on humans and present findings
- discuss safety procedures in the usage of electronic devices.
- excursion to a Telikom tower or radio station and compile a report
- debate the advantages and disadvantages and future of electronic communication in Papua New Guinea

Practical activities

- research and design a communication device that uses basic electronics
- dismantle an old appliance and draw circuit diagrams
- build working loud speakers and microphones
- construct models of early radios and television

Elaboration of content

The following table gives elaboration of some selected activities from the above list.

Activity	Elaboration
Conduct experiments on Faraday's Laws of Electromagnetism and explain its uses	Students experiment with coils of copper wire, permanent magnets and galvanometers to produce electricity. - a moving magnet inside a coil of wire - a moving wire in between a magnetic field Discuss the use of this principle in generators and electric motors.
Report of an excursion to a Telikom tower or radio station	Students can visit a Telikom tower or radio station find out how these facilities are operated and maintained, and investigate the application of the principles of electromagnetism in modern electronic communication.

Suggested assessment tasks

- Write a report on an excursion to a Telikom/Digicel tower or radio station
- Construct a simple radio receiver.

Assessment criteria

The assessment task will be assessed on the extent to which the student can:

- state the aim of the excursion and write a report indicating
 - title
 - introduction
 - body
 - conclusion
- construct a simple radio receiver
 - design
 - materials
 - completed product

12.1: Report on excursion to Telikom/Digicel tower or radio station				20 marks
Performance Criteria	Very High Achievement (18–20 marks)	High Achievement (14–17 marks)	Satisfactory Achievement (10–13 marks)	Low Achievement (0–9 marks)
Appropriate title (2 marks)	Topic clearly stated (2)	Topic stated (1-2)		Inappropriate topic (0-1)
Suitable introduction and aim (3 marks)	Appropriate and clear introduction and aim (3)	Clear introduction and aim stated (2-3)	Stated (1-2)	Irrelevant (0-1)
Detailed information on the facility and equipment used (4 marks)	Very detailed information on the facility and equipment used (4)	Clear information on the facility and equipment used (3-4)	Adequate information on the facility and equipment used (2-3)	Inadequate information on the facility and equipment used (0-1)

Detailed discussion on application of the principles of electromagnetism (6 marks)	Detailed discussions with clear mention of application of the principles of electromagnetism (6)	Discussions on application of the principles of electromagnetism stated (4-5)	Some mention of application of the principles of electromagnetism (2-3)	Very little mention of application of the principles of electromagnetism (0-1)
Appropriate conclusion (3 marks)	Very clear conclusion (3)	Clear conclusion (2-3)	Conclusion made (1-2)	Inappropriate conclusion (0-1)
Written presentation (2 marks)	Very neat, legible presentation with cover (3)	Clear, legible presentation with cover (2-3)	Adequate presentation (1-2)	Poor presentation (0-1)

12.2 Food Technology

This is an 8-10 week unit.

Suggested activities

A range of activities can be used to ensure students learn the expected content knowledge of this unit, such as:

- conduct research and present findings on food technology as an industry
- source information on laws that govern food quality and safety and discuss the implications
- list different types of traditional food technologies practiced in Papua New Guinean societies
- describe the importance of scientific procedures in food quality and safety
- compare traditional and modern food processing practices
- demonstrate scientific procedures which are used in food processing including distillation, fermentation, filtration and separation
- investigate and report on traditional food processing methods and preservation techniques
- excursion to a food processing plant and complete prepared tasks
- test different classes of food for the presence of starch, sugar, protein, vitamins, fats, oils and preservatives
- identify food compounds from labels on food packages and determine the nutritional values
- discuss and debate current issues on genetic engineering with specific emphasis on genetically modified foods (GMF)
- research on how plants and animals are genetically modified
- visit a research station and observe genetic modification in process
- listen to talks from experts on genetic modification on both plants and animals.

Elaboration of content

The following table gives elaboration of some selected activities from the above list.

Activity	Elaboration
Carry out simple food tests on samples	Explain the body's need for minerals like iron and calcium for healthy growth and maintenance. Collect food samples, set up experiments, and test for protein, starch, fats, oils, vitamins and mineral content. Recommend proper diets.
Excursions to a local food processing plant	Take a guided tour of a plant, collect information on raw materials and products. Identify various stages of the process line, safety and quality, aspects of the product. Describe preservation techniques used and packaging and storage processes. Collate information on a prepared worksheet.
Compare and discuss the importance of traditional and modern food preservation techniques	Recount traditional food preservative techniques. Describe the scientific principles in the above techniques. Research modern preservation techniques including canning, adding preservatives, chilling, pasteurization and so on. Identify similarities in terms of principles and procedures; explore ways to improve the traditional techniques.

Suggested experiments

- separation of mixed ingredients
- test for various food components i.e. fats, carbohydrates, proteins, sugar, vitamins
- water analysis in food
- verify boiling and freezing points of food solutions
- calculate concentrations of solutions
- compute percentage compositions of ingredients
- determine solubility of salts e.g. sodium chloride, magnesium chloride, in food processing

Suggested assessment tasks

- Produce a process chart on a chosen food product and present using an oral presentation.
- Construct a flow chart on: (i) a traditional food preservation technique and (ii) a rival modern technique.
- Validate compositions of various foods through food tests.
- Construct a flow chart on food analysis procedures.

Assessment criteria

The assessment task will be assessed on the extent to which the student can include:

- appropriate title
- number of stages
- explanation of stages
- creativity and originality
- neatness
- oral presentation
 - confidence
 - content knowledge
 - use of language
 - voice modulations
 - gesture
 - eye contact
 - visibility.

12.2: Produce a process chart on a chosen food product and present using an oral presentation				
20 marks				
Performance Criteria	Very High Achievement (18–20 marks)	High Achievement (14–17 marks)	Satisfactory Achievement (10–13 marks)	Low Achievement (0–9 marks)
Appropriate title (2 marks)	Appropriate and clear (2)	Stated (1-2)		Inappropriate (0-1)
Procedures and explanations (5marks)	All stages (5) clearly and correctly identified and stated (5)	Most stages (4) clearly and correctly identified and stated (3-4)	Less than 3 correct stages (2-3)	Incorrect stages (0–1)
Creativity and originality (4 marks)	Very creative and original (4)	Creative and original (2-3)	Creative but not original (1-2)	Lacks creativity and originality (0-1)
Neatness (3 marks)	Well presented, clear and very neat and tidy (3)	Neat and tidy (2-3)	Neat (1-2)	Untidy (0-1)
Presentation (6 marks)	Excellent presentation with very high content knowledge and good command of language (6)	Very good presentation with high content knowledge and good command of language, (4-5)	Good presentation and content knowledge with some command of language (2-3)	Inadequate presentation and content knowledge (0-1)

12.3 Biotechnology

This is an 8-10 week unit. It is to be taught as recommended.

Suggested activities

A range of activities can be used to ensure students learn the expected content knowledge of this unit, such as:

- research and present discussions on the principles and applications of biotechnology
- compare different ways of extracting oil and derive a simple method to extract oil from plants or plant products
- analyse the properties of virgin oil in comparison with other oil types and determine its density, viscosity, boiling point and energy efficiency
- apply the procedures of making soap, cosmetics and other products using natural oils.

Note

Caustic soda is corrosive to the skin. Care should be taken when handling caustic soda.

- use appropriate techniques to extract animal products like wax from bee hive, leather from cattle carcass and biogas from animal wastes and make them into useful products (belts, candle, bags, wallets)
- research on how biogas is extracted from animal wastes and explain the principles employed in the production of biogas
- research and discuss the types and application of bio-fertilisers
- set up a mini bio-fertiliser plant (compost) and measure the temperature of bacterial activity at different stages of decomposition

Elaboration of content

The following table gives elaboration of some selected activities from the above list.

Activity	Elaboration
Method of extracting Virgin oil from Coconut, 'Fermented Process.'	Put students into groups of five. Each group should have 20 coconuts each. Husk, split and grate the kernel and squeeze the milk into a jar. Seal the jar and allow it to ferment for 48 hours. Separate the oil from water to collect virgin oil. (refer to Appendix 1 on page 72)
Soap Making with oil and caustic soda	Students and teachers follow specific instruction and use appropriate materials to make soap from extracted oil and caustic soda. Note: Caustic soda is corrosive. care must be taken when handling caustic soda. (refer to Appendix 1 on page 73)

Suggested assessment task

Construct a mini biogas plant and collect the gas produced.

Assessment criteria

The assessment task will be assessed on the extent to which the students can:

- research and design a mini biogas plant
- construct a mini plant according to design
- put animal waste in the plant to produce biogas (methane gas)

Marking guide

12.3 Construct a mini biogas plant and collect the gas produced.				20 marks
Performance Criteria	Very High Achievement (18–20 marks)	High Achievement (14–17 marks)	Satisfactory Achievement (10–13 marks)	Low Achievement (0–9 marks)
Draw up activity plan for the construction (3 marks)	Accurately draw up activity plan based on design (3 marks)	Activity plan drawn (1 - 3 marks)		Inaccurate activity plans (0 - 1 marks)
Use of correct materials (4 marks)	Appropriate materials collected and used correctly (4)	Adequate materials collected and used (2-3)	Few materials collected (1-2)	Incorrect materials (0-1)
Construction of plant (10 marks)	Plant accurately completed, constructed according to design and can be used (9-10)	Plant completed, and constructed according to design (7-9 marks)	Plant completed but not constructed according to design (3-6 marks)	Incomplete work (0-2 marks)
Collection and testing of gas (3 marks)	Maximum gas produced, collected and tested (3)	Some gas collected and tested (2–3)	Minimum gas collected (1–2)	No gas collected (0-1)

12.4 Mineral Products

This is an 8-10 week unit. It is to be taught as recommended.

Suggested activities

A range of activities can be used to ensure students learn the expected content knowledge of this unit, such as:

- define mineral products and discuss different types
- research, design and construct suitable fire places for lime making and produce lime from various raw materials
- write word and symbol equations to illustrate chemical changes in lime making
- calculate the amount of reactants and products in lime making
- explain some chemical and physical properties of lime
- discuss the various applications of lime
- research and describe different procedures of glass making
- research different techniques and materials in brick making and discuss their uses
- make bricks from local materials

Elaboration of content

The following table gives elaboration of some selected activities from the above list.

Activity	Elaboration
Calculate amount of reactants and products in lime making	<p>Write a balanced equation to represent the thermal decomposition of calcium carbonate. Work out number of moles of calcium oxide and the molar mass based on the equation. Compare the masses of calcium carbonate and calcium oxide used in the manufacturing process through calculations. Explain any differences in the masses. Determine the efficiency of this process:</p> $\text{Efficiency} = \frac{\text{mass of calcium oxide}}{\text{mass of calcium carbonate}} \times 100$
Make bricks from local materials	Collect and collate information from the library and other sources. Apply these findings to make bricks from local materials such as cattle dung, shredded recycled paper, mud/clay and grass straw, cement and sand.

Suggested assessment tasks

- Construct a suitable fire place and manufacture lime from various sources.
- Produce lime from different sources and compare their pH value.
- Research and do a presentation on glass manufacturing.

- Make bricks from local materials.

Assessment criteria

The assessment task will be assessed on the extent to which the students can:

- collect suitable raw materials such as cow dung, shredded recycled paper, mud and grass straw, cement and sand, etc
- use prepared moulds to make bricks
- present a practical report which includes
 - title
 - hypothesis
 - aim
 - methods
 - results
 - interpretation
 - conclusion.

12.4 Performance standards for assessment task 1: Make bricks from local materials and write a report

Performance Criteria	Very High Achievement (18–20 marks)	High Achievement (14–17 marks)	Satisfactory Achievement (10–13 marks)	Low Achievement (0–9 marks)
Title (2 marks)	Appropriate and clear (2)	Appropriate title (1-2)	Stated but unclear (1)	Not stated (0)
Introduction and aim (3 marks)	Appropriate and clear introduction and aim (3)	Introduction and aim stated (2-3)	Introduction stated with no aim (1-2)	Poor introduction (0-1)
Detailed description of brick making processes with illustrations (6 marks)	Excellent description with illustrations of brick making processes (6)	Very good description with some illustrations of brick making processes (4-5)	Good description of brick making processes (2-3)	Poor description with of brick making processes (0-1)
Conclusion and presentation of report (4 marks)	Excellent conclusion and presentation (4)	Very good conclusion and presentation (3-4)	Good conclusion (2-3)	Inappropriate conclusion (0-1)
Quality of finished product (5 marks)	Exceptional product - strong - durable - appropriate size - usable (5)	Fine product - strong - durable (3-4)	Reasonable product (2-3)	Poor product (0-1)

Recording and reporting

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

Recording and reporting student achievement

When recording and reporting student achievement you must record the achievement of the students in each unit and then, at the end of the year make a final judgment about the overall achievement, or progress towards achievement, of the learning outcomes. To help you do this, descriptions of the levels of achievement of the learning outcomes are provided in the Learning Outcome Performance Standards.

When reporting to parents, the school will determine the method of recording and reporting. In an outcomes based system, student results should be reported as levels of achievement rather than marks.

Remember that the final school-based mark will be statistically moderated using the external exam results. The students' overall level of achievement may change.

Levels of achievement

The level of achievement of the learning outcomes is determined by the students' performance in the assessment tasks. Marks are given for each assessment task with a total of 100 marks for each 10 week unit, or 50 marks for each five week unit. The marks show the student's level of achievement in the unit, and therefore progress towards achievement of the learning outcomes.

There are five levels of achievement:

1. very high achievement
2. high achievement
3. satisfactory achievement
4. low achievement
5. below minimum standard.

A very high achievement means overall, that the student has an extensive knowledge and understanding of the content and can readily apply this knowledge. In addition, the student has achieved a very high level of competence in the processes and skills and can apply these skills to new situations.

A high achievement means overall that the student has a thorough knowledge and understanding of the content and a high level of competence in the processes and skills. In addition, the student is able to apply this knowledge and these skills to most situations.

A satisfactory achievement means overall that the student has a sound knowledge and understanding of the main areas of content and has achieved an adequate level of competence in the processes and skills.

A low achievement means overall that the student has a basic knowledge and some understanding of the content and has achieved a limited or very limited level of competence in the processes and skills.

Below the minimum standard means that the student has provided insufficient evidence to demonstrate achievement of the broad learning outcomes.

Achievement level					
Total marks	Very High Achievement	High Achievement	Satisfactory Achievement	Low Achievement	Below minimum standard
700	630 – 700	490 – 629	350 – 489	200 – 349	0 – 199
600	540 – 600	420 – 539	300 – 419	120 – 299	0 – 119
500	450 – 500	350 – 449	250 – 349	100 – 249	0 – 99
400	360 – 400	280 – 359	200 – 279	80 – 199	0 – 79
300	270 – 300	210 – 269	150 – 209	60 – 149	0 – 59
200	180 – 200	140 – 179	100 – 139	40 – 99	0 – 39
100	90 – 100	70 – 89	50 – 69	20 – 49	0 – 19
60	54 – 60	42 – 53	30 – 41	12 – 29	0 – 11
50	45 – 50	35 – 44	25 – 34	10 – 24	0 – 9
40	36 – 40	28 – 35	20 – 27	8 – 19	0 – 7
20	19 – 20	14 – 18	10 – 13	4 – 9	0 – 3

Marks are given according to criterion referenced standards below

Criteria/standards referenced assessment

Learning Outcomes Performance Standards					
Learning Outcomes	Very High Achievement	High Achievement	Satisfactory Achievement	Low Achievement	Below minimum standard
1. Demonstrate an understanding of fundamental principles and models of science	Demonstrates extensive knowledge and understanding of a wide range of complex scientific principles and models of science	Demonstrates sound knowledge and understanding of a range of scientific principles and models of science	Demonstrates knowledge and understanding of a some scientific principles and models of science	Demonstrates some knowledge of scientific principles and models of science	Has failed to meet the minimum standard required
2. Apply scientific thinking and skills in technological processes and procedures	Independently selects and proficiently applies an extensive range of scientific thinking, motor and process skills in technological processes and procedures	Independently selects and applies a range of scientific thinking, motor and process skills in technological processes and procedures	Selects and applies scientific thinking, motor and process skills in technological processes and procedures	Applies a limited range of scientific thinking, motor and process skills in technological processes and procedures	Failed to apply scientific thinking, motor and process skills in technological process and procedures
3. Design and undertake scientific investigations to solve problems	Independently designs and undertakes scientific investigations by selecting and proficiently applying a wide range of innovative scientific methodologies to solve complex problems	Designs and undertakes scientific investigations by selecting and proficiently applying a range of scientific methodologies to solve problems	Designs and conducts investigations by using scientific methodologies to solve problems	Designs and conducts investigations with some help and assistance to solve simple problems	Failed to design and conduct investigations
4. Research and analyse information, procedures and materials	Independently follows investigative procedures, collects, analyses and evaluates a wide range of information, procedures and materials	Follows investigative procedures, collects, analyses and evaluates a range of information, procedures and materials	Follows adequate procedures, collects, analyses and evaluates information, procedures and materials	Follows limited investigative procedures	Failed to investigate, collect, analyse and evaluate information
5. Communicate scientific investigations and findings in different ways	Communicates complex scientific investigations and findings succinctly and logically in a variety of appropriate ways	Communicates scientific investigations and findings clearly in a variety of appropriate ways	Communicates scientific investigations and findings in several different ways	Limited communication of scientific investigation and findings in one or two ways	Failed to communicate scientific investigations and findings.
6. Demonstrate understanding of	Demonstrates excellent knowledge and	Demonstrates sound knowledge and understanding	Demonstrates adequate understanding of	Demonstrates limited or knowledge of	Failed to demonstrate

traditional scientific knowledge and skills and their relevance today	understanding of traditional scientific knowledge/skills and their relevance to science today and the future	traditional scientific knowledge and skills and their relevant application today	traditional knowledge and skills and their relevance to science today	traditional scientific knowledge and skills and their relevance to science today	knowledge of traditional scientific knowledge and skills
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Sample format for recording Applied Science assessment task results over two years

Student Name:

Grade 11			
Unit	Assessment task	Mark	Student mark
11.1	Students undertake research on one global issue.	20	These marks would be the adjustment period
11.2	Community survey to find out how many traditional technologies are still used today in our communities (villages) Unit test	20 30	
11.3	Survey on energy usage at home Unit test	20 30	
11.4	Laboratory activities to demonstrate the chemical properties of water in particular testing hardness and the process of removing hardness Unit test	20 30	
11.5	Field trip to a forest, reforestation or wetlands site and write a post trip report. Experiments on water test to determine the pollution rate of a local fresh water system Unit test	20 10 30	
11.6	Portfolio on traditional and introduced medicinal plants Debate on an issue on HIV AIDS e.g. HIV AIDS is transmitted by sex workers only Unit test	20 20 30	
Total marks Grade 11		300	

Student Name:

Grade 12			
Unit	Assessment task	Marks	Student mark
12.1	Construction of a simple radio receiver	20	
	Excursion to a Telkom tower or radio station and report	20	
	Unit test	30	
12.2	Process chart on a chosen food product and do an oral presentation	20	
	Practical food test for fats, carbohydrates, proteins, sugar, vitamins	20	
	Unit test	40	
12.3	Construction of a mini biogas plant and collection of the gas produced	20	
	Production of soap using natural oils	20	
	Unit test	40	
12.4	Calculation of the amount of reactants and products in lime making	10	
	Manufacture bricks from local ingredients	20	
	Unit test	40	
	Total marks Grade 12	300	
	Total marks Grade 11 and 12	600	

Learning outcomes and levels of achievement

Levels of achievement in Grade 11 and Grade 12 are recorded and reported against the learning outcomes. The performance standards for the levels of achievement are described in the table on page 18.

Steps for awarding final student level of achievement

1. Assess unit tasks using unit performance standards and assessment criteria.
2. Record results for each task in each unit.
3. Add marks to achieve a unit result and term result.
4. Add term marks to get a year result.
5. Determine the overall achievement using the achievement level grid.
6. Report results using the broad learning outcome performance standards.

Example of reporting using the learning outcomes performance standards descriptors

Student: **Andrew Johns**

Subject: **Applied Science**

*School-based assessment – **High achievement***

This means Andrew Johns:

Demonstrates sound knowledge and understanding of scientific principles and models of science

Independently selects and applied a range of relevant scientific thinking, motor and process skills in technological processes and procedures

Designs and undertakes investigations using scientific methodologies to solve environmental issues with confidence and sound knowledge.

Shows clear evidence of experimentation, analysis and evaluation of information

Demonstrates sound communication of scientific investigations and findings in many ways

Demonstrates sound traditional scientific knowledge and skills and their relevant application today

Resources

Applied Science becomes more interesting and meaningful when you use a variety of resources and local materials in your teaching.

You should be always trying to adapt, improvise, make, find or write material that will be useful for lessons. Applied Science can be taught without expensive equipment by making use of what is around you, though there is some equipment and materials that are essential to teach the Applied Science syllabus.

General guidelines for selecting and using resources

The effectiveness of the resource very much depends on whether it is suitable for the knowledge or skill to be learned and the attitude of the students. Classroom organisation is the key to using resources successfully.

You need to prepare thoroughly. Make sure that you are familiar with the resource so that you use it with confidence and assurance. If equipment is involved, check that it is in working order, make sure that you know how to operate it and that it is available when required.

Use the resource at the right place and time in the lesson. The resource should fit in with the flow and sequence of the lesson. It should serve a definite teaching purpose.

Using the internet for classroom activities

Planning

- Where appropriate, incorporate computer sessions as part of planned learning experiences.
- Be aware that computers can be time-consuming and may require additional teacher support at unexpected times.
- Consider methods of troubleshooting, eg having students with computer expertise designated as computer assistants.
- Design activities that provide the opportunity for students to access, compare and evaluate information from different sources.
- Check protocols, procedures and policies of your school and system regarding the use of the Internet.

Managing

- Ensure that all students have the opportunity to explore and familiarise themselves with the technologies, navigation tools, e-mail facilities and texts on the Internet. It is likely that students will have varying degrees of expertise in searching for information and navigating the internet. Students will also have varying experiences and familiarity with the way texts are presented on the World Wide Web.
- Ensure that all students have an understanding of how to access the Internet and how to perform basic functions, eg searching, sending and receiving e-mail.
- Students with more experience in using the internet may have information that will benefit the whole class. Provide opportunities for

students to share their experiences, interests, information and understandings. As well as planning lessons to instruct students in these skills, pairing students, and peer tutoring on the computer can enable more experienced students to assist other students.

- Ensure that students critically analyse arts information gathered on the internet just as they would for any other text. They should be aware that material posted on the World Wide Web is not necessarily subject to the conventional editorial checks and processes generally applied to print-based publications. When evaluating information students might consider:
 - the intended audience of the site
 - bias in the presentation of information, or in the information itself including commercial or political motives
 - accuracy of information
 - balanced points of view
 - currency of information, including publishing dates
 - authority of source or author (institution, private individual)
 - ownership of the website (corporate, small business, government authority, academic)
 - cultural or gender stereotyping.
- Ensure that software and hardware (computer, modem) are maintained in good working order.
- Ensure that all students are given equal opportunities to use the computer.

Assessing student work containing material from the internet

- Students can download large quantities of information from the internet. By itself this information provides very little evidence of student effort or student achievement. Students must make judgments about the validity and safety of information when working from the World Wide Web. They must consider the purpose of the text, identify bias, and consider the validity of arguments presented and the nature and quality of the evidence provided.
- When assessing student work that includes material drawn from the internet, therefore, it is important to recognise how students have accessed the particular information, what value they place on it and how they have used it for the particular topic being studied in class. It is useful to look for evidence of critical evaluation, and the development of students' capacities to access, manipulate, create, restore and retrieve information.

Types of Applied Science resources

- text books, reference books
- magazines
- diagrams, charts, posters
- worksheets, information sheets
- pamphlets, brochures
- television and radio broadcasts,

- video, film, film strips
- audio recordings
- computer software
- pictures, photographs
- models
- newspapers
- made or found objects.

Natural and human resources

- natural environment sites – rivers, beaches, rock pools, forests, cliffs, caves
- community elders
- teachers
- parents

Contacts and list of additional Resources and personnel

The following organizations whose addresses appear below could be contacted for assistance to help with posters, brochures or information:

Research & Conservation Foundation
P.O Box 1261, Goroka EHP
Tel: 732 3211 Fax: 732 1123

The Nature Conservancy
P.O Box 2750
Boroko, NCD
Tel: 323 0699 Fax: 323 0397

P.O Box 217
Madang, Madang Province
Tel: 852 2366 Fax: 852 3518

World Wide Fund for Nature
P.O Box 158

Diwai, Madang Province
Tel: 852 1763 Fax: 852 2291

Conservation International
P.O Box 106
Waigani, NCD
Tel: 323 1532 Fax: 325 4234

P.O Box 176
Alotau, Milne Bay Province
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University of Technology, Lae
Department of Environment and Conservation
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National and Provincial AIDS Council
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Glossary for Applied Science

Aquifer	Structure that stores or transmits water
Atmosphere	The gaseous envelope surrounding the earth where all weather processes occur
Alkaline	Soluble basic substances that have a pH more than 7
Analysis	Chemicals tests carried out to find out how much of a particular element or compound is present
Biodegradable	Able to be rotted by living organisms, especially bacteria
Bromochlorofluorocarbon (Halons) are very good	Fire-extinguishing chemicals
Carbon tetrachloride	Solvent used in chemistry laboratories
Clone	To make an exact copy of another living thing
Chlorofluorocarbons (CFCs)	Used to make products spray out of aerosol cans, to keep air conditioners and refrigerators cool and in the manufacture of foam plastics
DNA	Deoxyribonucleic acid
Energy	The ability of an object to do work. Energy is measured in joules (J) and mega joules (MJ)
Energy efficient appliance	These appliances cost less to run and have less environmental impact than similar appliances that are less energy efficient
Expanded polystyrene (EPS)	A light, foamy plastic used to make hot drink cups and take away food containers
Extraction	Process of separating substances from raw materials
Genes	Information inside a cell about how a plant or animal looks or behaves
Genetic Modification	Changing as modification – changing or modifying the genes of plants and animals in the laboratory
Genetic Engineers	Scientists who experiment with decoding and making changes to DNA
GM Foods	Genetically modified foods
Grafted	Transplanted a piece of skin or other organ
Green house gas	A gas that traps heat in the Earth's atmosphere
Hardness	Concentration indication of salts in water mainly Calcium and Magnesium
Herbicide	A poison that kills plants
High density polyethylene (HDPE)	A white or colored plastic used to make shopping bags and milk bottles
Hydrochlorofluorocarbons (HCFCs)	HCFCs can be used for many of the same purposes as cfc
Hydrology	The study of water
Inherited	Genetic characteristics received from parents

Low density polyethylene (LDPE)	A soft, flexible plastic used to make garbage bags and lids for ice-cream containers
Methyl bromide	Used in agriculture to fumigate, or disinfect, soil
Methyl chloroform	A solvent used in industry to dissolve other substances such as adhesives and paints
Natural Gas	A fossil fuel, meaning that it is derived from organic material that was deposited and buried in the earth millions of years ago. The main component of natural gas is methane. Methane is composed of one carbon and four hydrogen atoms (CH ₄). It is a colourless, non-toxic gas that can be used as fuel in the generation of electricity, the production of mechanical energy or in heat. The power rating of gas is stated in MJ/hour
Organic matter	Matter that has come from living things
Ozone-depleting substances	People made chemicals that reduce the amount of ozone in the stratosphere
Pesticides	Poisons that kills pests
Plasticised polyvinyl chloride (PPVC)	A clear, flexible plastic used to make garden hoses and shoe soles
PLWHIV AIDS	People living with HIV AIDS.
Polyethylene terephthalate (PET)	A clear, tough plastic used to make soft drink bottles.
Polypropylene (PP)	A hard, flexible plastic used to make ice-cream containers, potato-crisp bags, drinking straws and hinged lunch boxes
Polystyrene (PS)	A stiff, brittle plastic used to make yoghurt containers and plastic cutlery
Power	The rate of doing work or more, generally, the rate of converting energy from one form to another. Measured in watts (W)
Procedure	Scientific methods applied in various stages of certain food processes
Process	A series of stages of activities in a production line
Renewable resource	Energy resources, for example, wind and sunlight that are constantly replenished
Stratosphere	The layer of atmosphere between 10 to 20 kilometres and 50 kilometres from the Earth's surface
Sustainable	Using resources such as water and forests carefully so they will continue to be healthy in the future
Sustainable energy	Sustainable energy is the production or use of energy in a manner that meets current energy needs without compromising the ability of future generations to meet their economic, social and environmental needs.
Technology	Knowledge and skills used in making certain products
Unplasticised polyvinyl chloride (UPVC)	A hard, stiff plastic used to make cordial bottles
Ultraviolet B radiation	Invisible rays from the sun that cause skin cancer
Water table	Top of the underground water or aquifer
Watt	The rate at which energy use is measured. A watt is defined as the number of joules per second, i.e.1 W = 1 J/S

Watt-hours, kilowatt-hours.	Electricity consumption is measured in units of watt-hours (WH) or, more typically, kilowatt –hours (KWH) and megawatt-hours (MWH), where 1 MWH = 1000KWH. 1 KWH means 1 KW of power being used for 1 hour
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Assessment glossary

Syllabus outcomes, criteria and performance standards, and examination questions have key words that state what students are expected to be able to do. A glossary of key words has been developed to help provide a common language and consistent meaning in the syllabus and teacher guide documents.

Using the glossary will help teachers and students understand what is expected in responses to examinations and assessment tasks.

Account	Account for: state reasons for, report on. Give an account of: narrate a series of events or transactions
Analyse	Identify components and the relationship between them; draw out and relate implications
Apply	Use, utilise, employ in a particular situation
Appreciate	Make a judgment about the value of
Assess	Make a judgment of value, quality, outcomes, results or size
Calculate	Ascertain/determine from given facts, figures or information
Clarify	Make clear or plain
Classify	Arrange or include in classes/categories
Compare	Show how things are similar or different
Construct	Make; build; put together items or arguments
Contrast	Show how things are different or opposite
Critically (analysis/evaluate)	Add a degree or level of accuracy depth, knowledge and understanding, logic, questioning, reflection and quality to (analyse/evaluation)
Deduce	Draw conclusions
Define	State meaning and identify essential qualities
Demonstrate	Show by example
Describe	Provide characteristics and features
Discuss	Identify issues and provide points for and/or against
Distinguish	Recognise or note/indicate as being distinct or different from; to note differences between
Evaluate	Make a judgment based on criteria; determine the value of
Examine	Inquire into
Explain	Relate cause and effect; make the relationships between things evident; provide why and/or how
Extract	Choose relevant and/or appropriate details
Extrapolate	Infer from what is known
Identify	Recognise and name
Interpret	Draw meaning from
Investigate	Plan, inquire into and draw conclusions about
Justify	Support an argument or conclusion

Outline	Sketch in general terms; indicate the main features of
Predict	Suggest what may happen based on available information
Propose	Put forward (for example a point of view, idea, argument, suggestion) for consideration or action
Recall	Present remembered ideas, facts or experiences
Recommend	Provide reasons in favour
Recount	Retell a series of events
Summarise	Express, concisely, the relevant details
Synthesise	Putting together various elements to make a whole

Appendixes

Appendix 1: Making products from traditional materials

A. Oil

Materials and equipment

2 electric/manual graters

A light and portable drying table (90 cm high x 1.2m wide x 3m long)

2 black visqueen canvasses (3m x 1 m)

1 oil holder/bucket

20 mature coconuts

Grating/Scraping

1. Clean and prepare the coconuts for scraping
2. Split the coconuts in half and scrape the flesh into a container. Do not scrape the inner shell as this can contaminate the oil

(Care should be taken when using electric scrapers. Always wear hand gloves when using electric scrapers).

Sun drying

1. Position the solar drying table in a sunny spot, away from shadows, dust and flies. Cover the table with the black visqueen canvas to make a good drying surface
2. Place the shredded coconuts on the drier. Regularly turn the shredded coconut dry evenly
3. Test a sample between thumb and finger by pressing. If no milk appears, the oil is ready to be extracted

Oil extraction

1. Place a hand full of dried shredded coconut into a cut out rice bag
2. Roll up the bag, tie the two ends and securely fastened this to two firm poles
3. Push a shorter stick about 50 cm long between the ends and turn the stick to twist the bag. This squeezes out the oil which can be collected in a container

Settling

1. The extracted oil should be allowed to settle for at least 24 hours. During the process, heavier particles sink to the bottom leaving the oil transparent
2. Drain the settled oil into another container and to obtain clean oil. Transfer the residue to the press for further extraction

Deodorizing and Packaging

1. Add 500ml of water to 1000ml of oil

2. Boil the mixture over low heat until all the water evaporates
3. Filter the clean oil into clean and sterilised containers for storage
4. Label containers for safe use

Note

Deodorization eliminates volatile compounds and other contaminants in the oil.

B. Soap Production

Materials and equipment

35 ml of soft (rain) water,

110ml of pressed coconut oil

18 grams or 2 tea spoon of caustic Soda (NaOH)

Hand gloves

Fragrance and food dye

50 ml of 2 percent salt solution (optional)

Small plastic bowl

Dissolving caustic soda in water

1. Pour 35ml of soft water into a small plastic bowl and place in a larger bowl of water
2. Gently and slowly add 18g of caustic soda to the water in the plastic bowl and stir constantly. NOTE: allow the mixture to cool for an hour as it does get hot

Note: Caustic soda is a very strong base that can cause severe burns to the skin if not handled with care!

Mixing caustic solution and oil

1. Place 100ml of oil in a plastic container
2. Add caustic solution slowly to the oil and stir continuously in one direction only
3. Continue stirring, for 1-2 hours, with 5 minute breaks after every half an hour until you see a white precipitate forming
4. Pour the mixture into a clean drying mould and leave to dry for at least 24 hours
5. After drying, the soap can be wrapped with clean plastic wrappers and sealed. The packed soap can now be stored in a clean dry place for use.

Note

The next procedure is optional and can be added during step 3

Colouring and adding fragrance (optional)

1. Add a lid full of food dye and fragrance to the mixture during the stirring process
2. Continue stirring until the solution is thoroughly mixed.

C. Dish washing paste

Materials and equipment

100g calcium oxide

100g B29 soap powder (or other types)

Water/lemon/lime

Food colouring or dye

Empty plastic tubs

Plastic spoon or stirrer

Method

1. Put 100g of lime into a plastic container
2. Add 100g of B29 soap powder to the lime and mix thoroughly
3. Add water (or lime/lemon) slowly and mix with plastic spoon until a paste forms
4. Add 2-3 drops of food dye to the paste and allow to dry for 24 hours before use

Appendix 2: Constructing a mini biogas plant

Biogas Plant

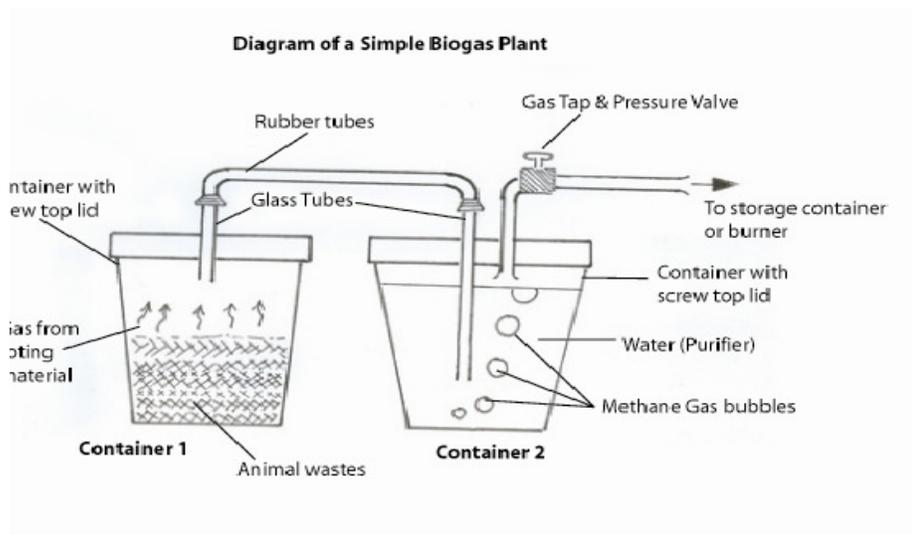
Materials and equipment

2 plastic containers with screw tops

Glass tubes

Rubber tubes

Animal wastes



Method

1. Collect 2 plastic containers with screw tops
2. Drill a hole in the lid of container 1, enough to insert a tight fitting glass tube
3. Drill two holes in the lid of container 2, enough to insert two tight fitting glass tubes
4. Fill container 1 with three-quarters animal wastes and container 2 with three-quarters water
5. Screw the lids of the containers on with the glass tubes tightly fitted.
 - (a) glass tube in container 1 must not be submerged in the decomposing waste
 - (b) the first glass tube in container 2 must be submerged in the water. The second glass tube must be kept dry.
6. Connect the glass tube from container 1 to the first glass tube in container 2 with a rubber tube
7. Connect the second glass tube in container 2 to a rubber tube and to a storage container

Note

- make sure that all connections are sealed properly to trap any gas produced
- allow the animal wastes to decompose for 3 to 4 weeks
- test the gas collected outside in open air.