

**Mathematics**  
**Lower 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 teacher guide is to be used by teachers when implementing the Lower Secondary Mathematics Syllabus (Grades 9 and 10) throughout Papua New Guinea. This teacher guide has lots of practical suggestions for hands on activities that students can do in order to learn Mathematics

The lower secondary Mathematics syllabus identifies the unit learning outcomes and assessment requirements. The lower secondary Mathematics teacher guide gives more information about what to teach and assess and describes ways of implementing the syllabus.

There are many ideas on different teaching and learning strategies that can be used to make mathematics lessons more interesting. The teacher must provide a classroom environment for Mathematics that encourages creativity and enjoyment. When planning, teachers must relate mathematical activities and problems to relevant, real life situations. Teaching using meaningful contexts and ensuring students participate in hands-on experiences assists students to understand mathematical concepts.

Teachers are encouraged, where appropriate to integrate Mathematics skills and content across the whole curriculum.

I commend and approve this Mathematics teacher guide for use in all schools with Grades 9 and 10 students throughout Papua New Guinea.



**DR JOSEPH PAGELIO**  
Secretary for Education

## Introduction

The purpose of this teacher guide is to help you to implement the Mathematics syllabus. It is designed to stimulate you to create exciting and meaningful teaching programs and lessons by enabling you to choose relevant and purposeful activities and teaching strategies. It will encourage you to research and look for new and challenging ways of facilitating students' learning.

*The teacher guide and the syllabus must be used side by side.* The syllabus states the learning unit learning outcomes for the subject and each unit, and outlines the content and skills that students will learn, and the assessment requirements.

The teacher guide provides direction for you in using the outcomes approach in your classroom using a step by step approach. Although the syllabus provides the assessment tasks at the end of each unit, the outcomes approach requires you to consider the assessment requirements early in your planning. This is reflected in the teacher guide.

This teacher guide provides examples of teaching and learning strategies for Mathematics, sample programs for each unit, elaboration of suggested activities and content, detailed information on how to mark assessment tasks and the resources needed to teach Mathematics. The section on recording and reporting shows you how to record students' marks and how to report against the broad learning outcomes.

## Teaching and learning

### How students learn

What I hear I forget

What I hear and see I remember a little

What I hear, see and discuss I begin to understand

What I hear, see, discuss and do, I acquire knowledge and skill

What I teach to another, I master.

(Active Learning Credo statement by Silberman, 1996)

In support of this are the findings that we remember:

- 20% of what we hear
- 40% of what we see
- 90% of what we see, hear, say and do or what we discover for ourselves.

### A student-centred approach to learning

Different students learn in different ways. Some students learn best by writing, others by talking and discussing, others by reading and others by listening. Most students learn by using a combination of these. All students learn skills through practicing and repetition. You need to use a variety of teaching strategies to cater for the different ways your students learn.

### Teaching and learning strategies

To assist and encourage students to learn, you perform certain tasks. These are referred to as teaching strategies. You need to engage students directly in learning but there are times when you have to take charge of the learning in the class and teach particular concepts or ideas.

To have common understanding of the different teaching and learning strategies, there should be collaboration among teachers. This is to ensure that teachers are using the strategies in a similar way. This is collaborative planning.

Teaching strategies include:

- group work
- role play
- skills practice
- research/inquiry
- class discussions
- problem-solving activities
- teacher talk, instructions, explanations, lectures or reading aloud
- directed question and answer sessions

- audio-visual presentations
- text books or worksheets
- directed assignments
- demonstration and modelling
- guest speakers
- field work
- classroom displays.

### **Using groups as a teaching and learning strategy**

Using groups is an important strategy in Mathematics as students learn from each other, not just from the teacher. Group work encourages students to participate in achieving a shared goal and collaborative learning.

In deciding whether to use groups or not, you need to consider:

- your intended outcomes
- the extent to which the unit learning outcomes can be achieved by a group
- the lesson content
- the time allocated for the completion of the task
- the classroom setting
- available materials and resources
- the structure of the group based on gender, ability, cultural background and student preferences.

Groups work well when:

- the group decides upon their goal, timelines and tasks
- students realise that success depends on the achievement of the whole group, not individuals
- the task is broken into subtasks which must be finished to successfully complete the overall task
- everyone has a role to play, e.g. group projects or investigations
- membership of small groups is changed regularly to provide a variety of learning experiences for all students.

Strategies for organising and managing groups:

- mixed-ability groups—the more able learners in the group can help the others to master the work so that you need not teach some parts
- same-ability groups—you can leave the groups of faster learners to get on with the work on their own. She/he can give extra help to individual learners in the slower groups
- using group leaders—you can appoint faster, more able learners as group leaders who can help slower learners.

## Developing skills

### Principles and procedures

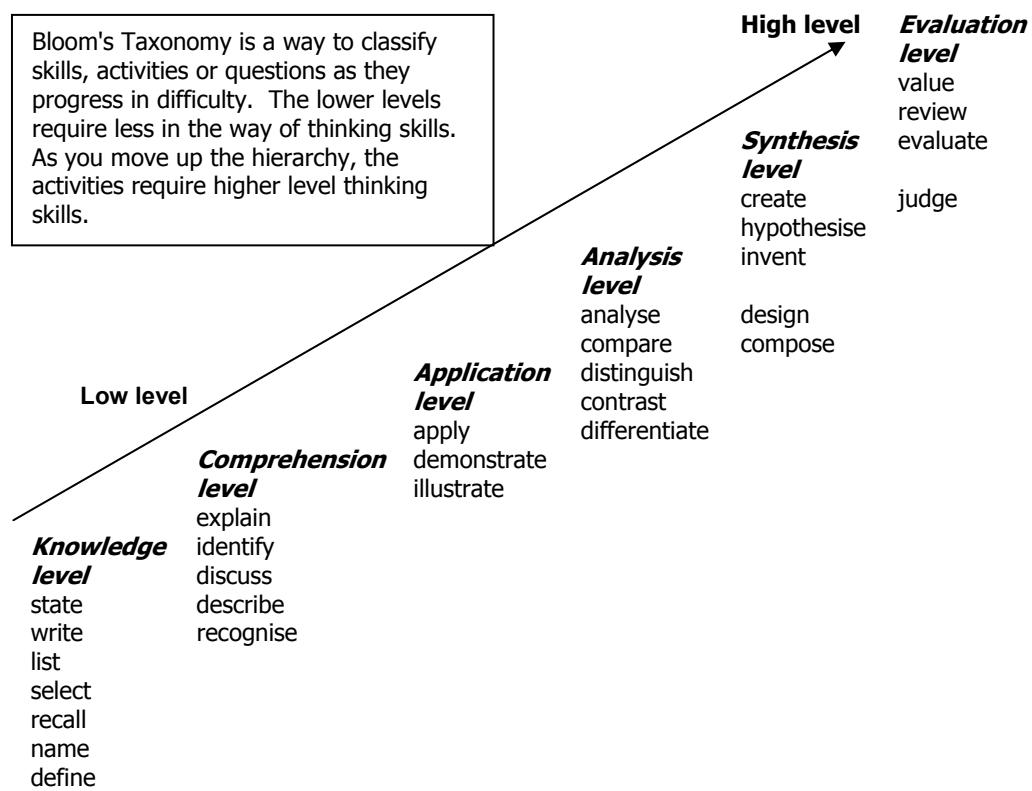
Students need to develop skills to help them learn. Skills development should happen as a part of a student's learning experience and the learning and practicing of skills needs to occur in the context of the units being taught.

Skills learning tends to be most effective when:

- students go from the known to the unknown
- students understand why it is necessary to gain mastery of specific skills
- skills are developed sequentially at increasing levels of difficulty
- students identify the components of the skill
- the whole skill and the components of the skill are demonstrated
- there are frequent opportunities for practice and immediate feedback
- the skills being taught are varied in terms of amount and type, according to the needs of students
- the skill is used in a range of contexts.

To teach skills effectively you need to include learning activities that span the range from teacher-directed to student-centred learning, use groups of different sizes ranging from the whole class to small groups and use a range of teaching strategies which use higher order skills as your students' progress.

### Bloom's taxonomy of skills



## Mathematical skills

Applying Mathematics usually involves one or more of the following skills:

- Gathering, recording, reading and interpreting data
- Using calculation tools (calculators, computers etc)
- Using rules and procedures
- Estimating
- Problem-solving.

## Estimation

Estimation and problem-solving are probably the hardest skills to learn. Students' estimation skills will improve with practice. When estimating follow these steps:

- Make a first guess or estimate
- Discuss the estimate and improve it if possible
- Calculate the actual and compare it with the estimate
- Use these comparisons to help with future estimates.

## Language skills for Mathematics

Students need to learn how to speak and listen, read and write, view and observe. Students learn language skills through, for example:

- discussions
- oral and written reports
- interviewing opportunities.

Activities can help with regard to language skills and you should provide opportunities for your students to practice whenever you can. Students should be encouraged to use new terms or concepts learnt in different units.

Providing opportunities for students to listen is very important. Guest speakers, oral presentations, group discussions, CD's, tapes, radio and television are listening resources. When students have listening experiences as a regular part of classroom activities, their ability to listen and their comprehension will improve.

## Place of vernacular in lower secondary

Maintenance of the student's language is something that continues at lower secondary as stated in the Department of Education's Language policy in all schools. At times it will be appropriate to use vernacular, Motu or Tok Pisin to explain concepts or ideas. Vernacular can be used to describe and illustrate those things that do not have English translations. There will also be opportunities to use exercises which target vernacular development such as from English to the vernacular Motu or Tok Pisin. For example, it would be appropriate to use the vernacular when using surveys or finding information from the community.

## Writing skills

Students must be able to choose the right word to get the message across and be able to put words together in a way that makes sense to the reader. The ability to write well and use appropriate Mathematical terms and vocabulary takes a lot of practice and writing skills and techniques should be emphasised in Mathematics.

## Thinking and questioning skills

Mathematics assists students to analyse and think critically about information they come across. By processing information rather than rote learning, students are more likely to understand and retain what they have learnt. Students must be involved in the process of thinking instead of simply accepting the end products of someone else's thoughts. The ability to think critically can be taught effectively

By asking the types of questions listed below:

- what do you notice/see/find?
- what difference do you ...?
- what similarities do you ...?
- which ones belong together? why?
- why don't these belong to this group ...?
- what could have happened if ...?
- what would ... be like if ...?
- how would you ...?
- what explanation would you give for ...?
- is this always so?
- does evidence of ... change the original explanation?
- how can this be tested/checked?
- suppose ...what would happen?
- what makes you think this would happen?
- what would be needed for that to happen?
- is there a different explanation?
- if ... happened, what would happen next?

## Measuring skills

Measuring is often done using special instruments or maps, but it can also be done with simple items such as a ruler, tape measure, trundle wheel, cubes, and measuring cylinders. Students can measure length, height, weight, speed, volume, capacity. Estimation of measurement is also a skill that must be developed in the students. Lots of opportunities should be provided for students to practice estimation and hands on experiences using measurement.

## Teaching and learning strategies for Mathematics

Here are teaching and learning strategies which can be used to make learning more meaningful and interesting in Mathematics. You should vary your lessons by using different teaching strategies, making sure that the ones you use for the lessons are suitable for your lesson outcomes. Many of these strategies work together, for example developing a relationship chart between the different quadrilaterals helps students to understand visually the similarities and differences.

### Brainstorming

This is a technique in which a class or group meets in order to record all the information already known on a topic, to develop new ideas or to stimulate creative thinking. Participants let the ideas come into their heads, write them down, sort them and decide which require further research. Brainstorming is a useful way of determining prior knowledge of a topic. It would be appropriate to use when introducing a unit or topic or when summarising the unit or topic.

### Classroom displays

A classroom display provides a way of focusing on the current unit. It stimulates learning, provides a record of learning as well as encouraging students to interact and to respond to learning.

### Charts

Helping students use charts, that is, to organise information in various groupings under different headings, is valuable. Charts (for example, properties of different shapes and solids) are a powerful teaching aid and of considerable help in getting students to think about data.

### Diagrams

Diagrams are employed by teachers in a variety of situations. They may be used to illustrate properties of lines and shapes. They can show something complex like a scale drawing. The best diagrams are clear, with all the necessary details, and labels to identify features and explain processes.

### Flow charts

A flow chart is a diagram showing a series of step-by-step operations which make up a particular process. The main elements of the process are shown in picture form and are linked by arrows to indicate how one operation leads to the next. A flow chart can, for example be used to show stages in the flow of money or probability.

## **Cultural activities**

Through participation in cultural mathematical activities, students are exposed to a variety of activities such as patterns in weaving, measurement in their traditional society, their traditional counting systems that give them insight into their own culture or that of others.

## **Decision-making**

Decision-making is the process of choosing from two or more alternatives. Part of the process is the analysis and evaluation of the possible outcomes of the decision. Decision making is important when choosing which operations or formula to use to solve problems.

## **Evaluation**

Evaluation involves weighing options, consequences and evidence in decision making contexts in order to make decisions and take action in effective ways. The evaluation process often requires us to make decisions between values which are in apparent or real conflict.

## **Guest speaker or visitor**

A guest speaker or visitor is a person who is invited to share his/her knowledge and skills with the students. This may be a teacher from another class, a parent, a member of the local community or a representative from a group, organisation or institution. It would be appropriate to invite a guest speaker from a small business in the community to speak to students about money matters in Unit 10.1.

## **Interviews**

An interview involves asking questions in order to find out more information about a subject. In this way, students can learn about things and peoples' opinions first hand. There are usually many people with special knowledge about a topic. Students can invite them to the classroom. To conduct an interview successfully students need to:

- prepare their questions beforehand
- make sure questions are simple, relevant, to the point and that they require more than a single word answer
- make sure they tell the interviewee their purpose and thank them at the end
- listen carefully to answers
- take notes if possible.

## Learning games

Learning games are activities that involve students in simulated experiences to develop concepts and understandings, record information or demonstrate knowledge and understandings. Learning games can be made by teachers or students. For example, in chance students can create a game of chance and explain it to their friends.

## Mapping

It is important for students to use mathematical techniques to interpret maps. Finding directions, computing distances, locating places, relative location; use of scale and symbols, exposure to different kinds of projections, comparisons between different kinds of maps and drawing inferences from maps are all important.

## Mind maps/concept maps

A mind or concept map is a way of recording information. It allows students to organise their ideas either as a class, small group or individually. A mind map is often associated with brainstorming and is useful for drawing connections between ideas and concepts, assisting in the further research of a topic such as probability.

## Models

Models provide demonstration of a concept in concrete form. Models can include items made from cardboard which are useful in the topics on solids.

## Presentations

Presentations are used to share information obtained through individual and group research and study. Presentations can be spoken, written or multimedia. They give students experience in organising, planning and presenting information and material to a particular audience and are therefore valuable experiences for both the presenter and the audience.

## Problem solving

A particularly relevant teaching and learning strategy for mathematical topics is problem solving. Students can be involved in identifying and working towards solutions to problems. The classroom, school grounds, community and home all contain problems which are appropriate starting points for investigation by students.

The purpose of learning through the application of problem solving skills is to link conceptual understandings with practical experiences. It is important that students be given opportunities to apply problem solving techniques to a range of issues.

The teacher's role is to:

- assist students identify problems that are relevant and solvable
- organise learning that develops skills in problem solving
- choose learning activities which encourage responsible actions.

## **Research**

One of the best ways to learn about Mathematics is to think of the questions you want answered or what you want to know and inquire about the things which interest you. This means doing your own research to find the answers. The same applies to your students.

There are a number of steps involved in doing research and the best results are achieved if students do things in the right order and ask the following questions.

### **Defining**

- what do I want to find out?
- what is my purpose?
- what are the key words and ideas of this task?
- what do I need to do it?

### **Locating**

- where can I find the information I need
- what do I already know?
- what do I still need to find out?

### **Selecting**

- what information do I really need?
- what can I leave out?
- how relevant is the information I have found?
- how reliable is the information I have found?
- how will I record all the information?

### **Organising**

- how can I best use this information?
- do I need to use all the information?
- how can I best combine information from different sources?

### **Presenting**

- how can I present this information?
- with whom will I share this information?
- how does the audience affect my presentation?

### Assessing

- what did I learn from all this?
- did I achieve what I set out to achieve?
- how did I go with each step of the information process?
- how did I go with presenting my information?
- where do I go from here?

### Task cards

Task cards are teacher-defined activities or pieces of research work, presented in a written form and assigned to individual students or groups. They are a method of directing student learning. You can devise task cards to direct activities on an aspect of a topic.

### Using the internet

The Internet encompasses a number of facilities including the World Wide Web and electronic mail (e-mail). It is both a useful source of information on many topics and a means of communicating with people in other places. Specific skills are required to access information on the Internet and more importantly to critically evaluate and validate such information.

## Assessing Mathematics

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

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

Assessment in Mathematics measures students' achievements of the unit learning outcomes described in the syllabus. It is an ongoing process of identifying, gathering and interpreting information about students' achievement and can be integrated into the students' normal learning activities.

### 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 that of their friends. 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 Mathematics units

In the Mathematics syllabus, the unit learning outcomes, which link to the broad learning outcomes, are assessed through specified assessment tasks using a range of assessment methods. Assessment criteria for each unit outcome provide clear indications of how, and to what extent, the achievement of the unit learning outcomes may be demonstrated. Performance standards, marking guides and assessment criterion help teachers with the marking process and ensure that assessment is consistent across schools.

Students must complete the assessment tasks for the unit. You will expand each task and 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 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
- achievement is measured in terms of more than one outcome
- 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.

### **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 unit 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 unit with the purpose of letting the students know what they have achieved.

## **Tests**

A test is a formal and structured assessment of student achievement and progress which you administer 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 assist student learning if they are clearly linked to the unit learning 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 about student knowledge of content and about the development of thinking processes and skills. Open questions provide more detailed information about student skills 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 unit learning 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.

## Who assesses?

### Teacher assessment

Assessment is a continuous process. You should:

- always ask questions that are relevant to the outcomes and content
- 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 in the first few weeks of the unit, others at the end of the term. You should take care not to overload classes with assessment tasks at the end of the term. You can also check with other subjects so students can do a task where certain parts can be assessed for the different subjects the student studies.

## Judging student performance

Student achievement is recorded and reported against standards. You must use the performance standards provided in each unit of this teacher guide when making a decision about the achievement of your students in relation to the unit 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 the student 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 set 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 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 assess their own work (self assessment) or the work of others (peer assessment). 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 students actively in the assessment process
- enables students to be responsible for the learning
- helps students understand the assessment criteria and performance standards.

## Managing assessment tasks for Mathematics

Usually, the marking of assessment tasks is done by you. To reduce the amount of work it is necessary to develop a strategic approach to assessment and develop efficiencies in marking. In Mathematics there are a number of assessment tasks that may be new to you and the 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 assignment 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 assignments and projects.

*Assess in class* – use class time to carry out and to assess tasks. Oral presentations and multiple choice tests marked by the students enable instant developmental evaluation and feedback. On-the-spot assessment on projects or practical work are briefer, take less time to mark, and are useful, because five immediate feedback on students' progress.

*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 report 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. Help the students, use performance standards and assessment criteria. Self and peer assessment increases the amount of feedback students get. It can supplement 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 you and the learner, not just to accredit students.

## Use observation sheets and spotlighting

You might record student achievement while observing your students by using observation sheets. The most common observation sheets are individual student checklists and whole class grids. They can be used for all the projects that students undertake.

Spotlighting uses individual student checklists. This method can be used to focus on a few selected aspects of student performance or outcomes. It is best to focus on five to six students at a time, systematically working through the class over time. Focused questioning is a technique often used in conjunction with spotlighting. With focused questioning you can gain a deeper awareness as to whether or not students understand the concept being taught.

## Reports

Reports are an authentic form of assessment. They encourage students to develop observation and recording skills, and require organisational skills in both collecting and analysing information and communicating information clearly.

Reports in Mathematics can be oral, written or in graphic form or a mixture of these. Duration of reports vary according to the task. Reporting in groups is a common strategy used in big classes however each student should be allowed a turn at reporting during the year.

## Managing individual and group presentations

Group and individual oral presentations and report backs can be very time consuming both in their use of valuable lesson time and in marking. Too often these presentations are repetitive and boring and the rest of the class is not required to be actively involved in listening and responding to the presentations.

The best approach is to allocate or allow students to choose from a variety of topics; to develop clear criteria for presentations; and to require the rest of the class (audience) to take notes, identify key points or write a summary to enhance their learning. Make sure individuals and groups have access to a fair share of adequate resources to complete the task

For individual presentations select two or three students to present at the beginning of each lesson over several weeks rather than using 4-5 lessons in a row just listening to speeches.

A number of strategies can be used to manage group presentations.

- Assign each group a different topic or part of a topic to avoid repetition (e.g. the jigsaw approach).
- If the activity is essential learning then give all groups the same topic but ask each group to report back on one aspect of the topic only. Don't allocate the report back section until all groups have completed the task. For example groups pin their work sheets on the wall and you highlight one item on each sheet and ask the group to describe or explain that item.
- Rather than responding back, all groups display their work and then students are required to read and answer questions on work from groups other than their own.
- If group work is a regular activity make sure all students have a turn at reporting back, and at different group roles.

Discuss the criteria for the presentation with the whole class before the activity to make sure everyone is clear about what they have to do. This includes specifying the relative importance of the content as well as presentation skills such as speaking clearly and engaging the audience.

For both individual and group presentations limit speeches to 2-3 minutes and don't allow students to go overtime. Organising and presenting material in a limited time is an important skill for students to develop.

Peer assessment is an ideal strategy for marking group and individual presentations, provided you use the task criteria to develop clear marking guides or checklists. Peer assessment is also a way of ensuring that the audience is actively listening to the presentation

## 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 plan with the other teachers who teach the same grade. By planning together, you will all have better lessons and make better use of your limited resources.

### Points to consider when programming

- Which unit learning 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 unit learning outcomes and enhance the learning?
- How can the assessment be part of the teaching and learning program?
- Which options and projects can be done to make best use of the school's resources?
- How can a balanced program be developed?

## The planning process

In this teacher guide, ideas for programming and organising each unit 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-based approach.

### Step 1 – Interpreting the unit learning outcomes

The first step is to read the unit description in the syllabus and then study the unit learning outcomes 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. Remember the unit learning outcomes link to the broad learning outcomes.

This teacher guide gives you a brief description of the main requirements of each learning outcome.

## **Step 2 – Planning for assessment**

It is necessary to study the assessment requirements of the unit early in your planning to ensure that you teach the content and skills students need to achieve the unit learning outcomes.

The assessment tasks are described in the syllabus. They indicate what specific knowledge and skills students will need to demonstrate that they have achieved the unit learning outcomes.

You will have to decide when to schedule the 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 the performance standards and/or marking guide which you must use when you are marking the tasks. This is to ensure consistency with marks awarded to students in all schools in PNG. However you must develop clear and detailed instructions for completing the task yourself and ensure all students know exactly what they have to do.

## **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. You may follow the topics in the order they are listed in the syllabus or you may cover the topics through integrated activities or a thematic approach. 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.

Once you have completed your unit plan you will have to consider each topic in more detail. For example, if you have allocated two weeks for a topic that means you have six lessons available (three lessons per week). You will have to develop a plan for each topic that includes in more detail what you will cover in each lesson. Your topic plan must include a sequence of student activities and teaching points that contribute to the overall achievement of the unit outcomes. Your topic plan should include what you think your students will do in each lesson, but you must remember that the individual lessons must flow logically, one from the previous and must be adjusted according to how students are progressing through the topic. You

may develop outcomes for the topic and for each lesson, but these must be related to the unit outcomes.

This teacher guide provides a sample program for each unit. It does not provide individual lesson plans.

#### **Step 4 – Elaboration of content and activities**

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.

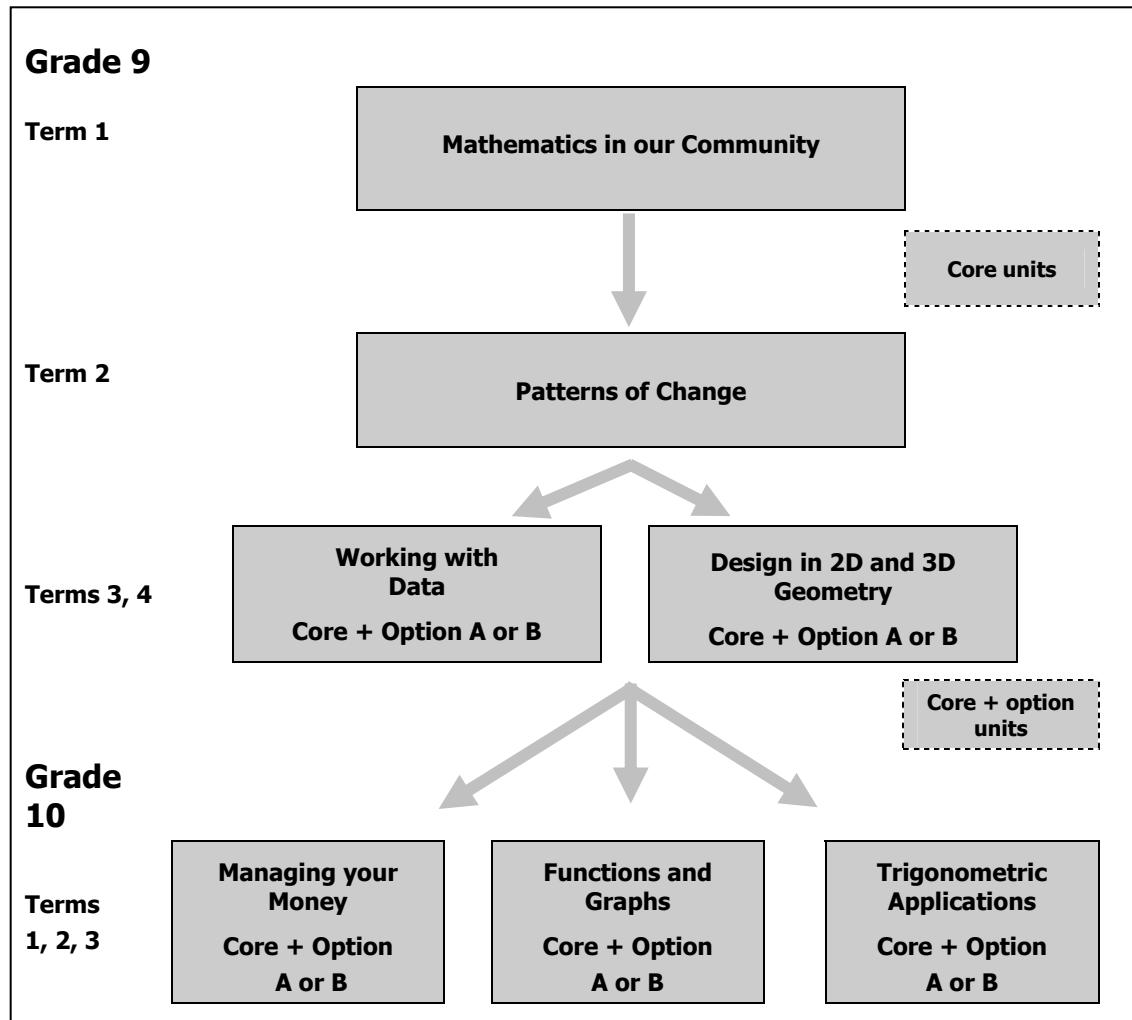
Once you have sorted out your ideas and information you can then develop your more detailed weekly program and daily lesson plans.

This teacher guide gives examples in each unit of some activities you might like to use to ensure active learning. It also gives background information on some of the content.

#### **Mathematics requirements**

Mathematics is one of the three compulsory subjects in Grades 9 & 10, along with English and Personal Development. Like all subjects Mathematics is allocated 5 periods per week.

(10 weeks per unit)



In Grade 9 the Mathematics in our Community unit should be taught first, followed by the Patterns of Change unit. Schools may program the remaining units as they see fit. In Grade 10 there is no recommended order for the three units.

All students must complete all the core units and one of the optional components each term within the core-option units. To meet local needs and resources you may choose to teach more than one unit at a time, mixing and matching the material from two or more units.

In units 9.4 and 10.2 option B is designed for the more able students, particularly those planning to continue with Mathematics in Grades 11 and 12. In the rest of the units, the options can be selected out of interest.

#### List of essential resources

1. The current books – Secondary School Mathematics 9A, 9B, 10A, 10B.
2. Teacher Resource Book Grade 9 and 10 – Number, Statistics (a section on Probability in this resource book), Shape and Space, Problem Solving, Algebra, SSM 9 Problem Solving Answers, SSM 10 Problem Solving Answers,
3. Text books that have exercises on Traditional Maths, Probability, Plane Table Surveying and Navigation.

## Grade 9 units

### 9.1 Mathematics in Our Community

#### Step 1: Interpreting the unit learning outcomes

**Outcome 9.1.1:** Students can identify everyday situations where basic mathematical operations can be applied.

This outcome requires you to teach students to identify and use numbers and operations, ratio and percentages, rates, money, measurement and data using examples in the real world.

**Outcome 9.1.2:** Students can make calculations using a range of methods and be aware of whether or not the result is reasonable.

This outcome requires you to teach students the skill of estimation within the context of the different topics. Students need to develop the skill and habit of checking their answers before moving onto the next exercise or problem. Students should be given the opportunity and encouraged to perform calculations both mentally as well as using pen and paper and calculator where available and appropriate.

**Outcome 9.1.3:** Students can identify everyday situations where traditional mathematical methods can be applied.

This outcome requires you to help students identify everyday situations where traditional mathematical methods can be applied. Students should be encouraged to value their cultural knowledge in mathematics and be prepared to share it with others.

**Outcome 9.1.4:** Students can communicate mathematical processes and results.

This outcome requires students to present their findings through, for example, a report, an illustrated chart, a poster, a flow chart, an article or using some other method. They must use the mathematical processes they have learnt in the core unit.

**Outcome 9.1.5:** Students can undertake investigations individually and cooperatively in which mathematics can be applied to solve problems.

This outcome requires students to work in groups/teams of three to six to investigate a topic drawn from the topics: rates, money, measurement and data. It requires students to use the mathematical processes they have learnt in the core unit to investigate any of the topics stated further.

#### Step 2 – Planning for assessment

Study the assessment requirements of the unit. These will tell you what specific knowledge and skills students will need to demonstrate to show that they have achieved the unit learning outcomes.

Assessment task one consists of a test covering:

- basic operations with numbers, ratios and percentages
- estimation and calculation involving money
- simple costing/budgeting
- measurement of length and area
- simple organisation and graphical representation of data
- calculation of the arithmetic mean (average), median and mode.

The test is seeking evidence that students can calculate percentages correctly; use percentages when solving problems related to real life situations, and use estimation skills to check if their solutions are likely to be accurate. It is also seeking evidence that students have understood the basic ideas of number and measurement and have developed basic skills in these areas.

The task can be divided into three parts which should be given to the students over the term, rather than one big test at the end. You should give marks for each item in the test.

During the course of the unit you should make sure students are taught these skills and that they apply them in a range of different contexts. It is recommended that formative tests and quizzes be used to help students gauge their learning.

Assessment task two is a project on either rates, money, measurement or data.

The project is to be conducted in groups of three to six students and the results presented in writing.

### **Sample task for assessment task 2**

Design a commemorative garden/tiled area/wall for the school or community.

Produce:

- a sketch or artists' impression of the area
- a scale plan for the design
- a listing of the materials needed
- an estimate of the labour needed
- a costing of the project.

Group roles:

- project coordinator –oversees the planning process, leads the initial creative process, decides on the focus of the project and makes oral presentation to the audience who may include representatives of possible funding donors
- artist – produces the sketch or artist's impression drawing
- architect/surveyor – produces the accurate scale plan, details the quantities of materials needed

- accountant – calculates costs of materials and labour; produces a costing statement,
- promotions manager – designs, and produces an information drawing or plan for the proposal.

Note that all students in the group should be knowledgeable/familiar with all parts of the project and not just their particular tasks.

The aim of this task is to see whether students are able to use concepts in mathematics, particularly in the areas of design, measures and money, and that they are able to communicate this information to others.

The performance standards for the project are on page 36.

### Step 3 – Programming a learning sequence

#### Sample program

Week/s	Topic	Activities	Assessment
1	School orientation	School orientation	
2–3	Money transactions	Calculating discounts Profit and Loss	Test part 1 – 20 marks
4–5–6	Planning to build a Haus Win	Preparation to build Haus Win Gathering materials Complete Haus Win Using scales Unit conversion	Quiz (formative assessment)  Assessment task 2 40 marks
7	Using data	Lets explore data Lets collect data Lets display data Identifying types of data	Test part 2 – 20 marks
8–9	Group project: discussion on examples of problems similar to what will be done for the project Work on Project: assignments, teams formation, research, preparation of written presentation		Test part 3 – 20 marks
10	Submission of written materials		

Once you have completed your unit plan you will have to consider each topic in more detail. For example, if you have allocated two weeks for a topic that means you have ten lessons available (five lessons per week). You will have to develop a plan for each topic that includes in more detail what you will cover in each lesson. Your topic plan must include a sequence of student activities and teaching points that contribute to the overall achievement of the unit learning outcomes. Your topic plan should include what you think your students will do in each lesson, but you must remember that the individual lessons must flow logically, one from the previous and must be adjusted according to how students are progressing through the topic. You may develop outcomes for the topic and for each lesson, but these must be related to the unit learning outcomes.

### Example of a topic plan

Topic: Money transactions (Weeks 2–3)				
Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
Rounding	Conversion	Interest Bearing Deposit	Loans	Loans
Rounding to the nearest 5 toea or to the nearest kina	Converting your spending into fractions, percentages and decimals	Calculating interest and balance	What kinds of loans are available to your local community?	Calculate loan repayment for school fees, a sewing machine and a wheel barrow
Lesson 6	Lesson 7	Lesson 8	Lesson 9	Lesson 10
Loans	Profit and Loss	Profit and Loss	Profit and Loss	Profit and Loss
Calculate amount to be repaid and how long it would take to repay a housing loan	List prices of goods sold at a nearby trade store/school canteen/supermarket	Draw up a table showing discount as a fraction. Calculate the discount price	Calculate 10% VAT after discount	Calculate total earnings with and without discounts

This unit requires students to do projects in groups. This means that:

- space should be allocated for each group including classroom display space
- students should understand their role within the group and their responsibilities to the group
- it is appropriate for students to undertake an excursion to look at aspects of the topics they are researching.

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. Textbooks may also provide you with ideas for activities related to the topic. You will have to collect or develop some resources yourself, for example statistical tables and graphs from newspapers and journals, coins, cards and so on. Other useful resources include games of chance played locally and some television shows such as “Scratch lotto” etc.

## Step 4 – Elaboration of content and activities

### Suggested activities

#### Money transactions

##### *Calculating discounts*

- Collect information from advertisements on sales from newspapers and commercial brochures and calculate the percentage decrease and increase of prices on sale items.
- Using Kina and Toea we are able to buy and sell in such places like hotels, food bars, stores, and markets. As of March 2006, 1t and 2t were no longer in circulation or accepted as legal tender. We need to know how to round up or down an amount of money to the nearest 5 toea. Provide activities for rounding up and rounding down to the nearest 5 toea.

##### *How much can you spend?*

- In your personal account you have saved K1 000 000.00. Express in fraction, percentage and decimal each of the following amounts you plan to spend from the K1 000 000:
  - K100 a day beginning of 1st of March to the 30th of April
  - K300.00 a day for 30 days
  - K500.00 a week for 20 weeks

#### Profit and Loss

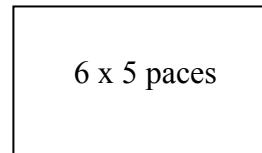
- Imagine you are managing a supermarket and want to get your goods on sale for the Easter season. Visit the store closest to your place of residence and:
  - list the some of the goods sold at this store with marked prices
  - draw up a table showing discount on each item as a fraction
  - give the table to other friends in the class and ask them to calculate:
    1. the amount you would earn if you sold all the items without discount
    2. discount price for each particular item
    3. 10% VAT on the price after discount from each item
    4. the amount you would earn if you sold all the items with discount
    5. the difference between the total earnings from goods with and without discount.
- Provide students with an answer sheet to check their calculations.

#### Arbitrary and standard units

##### *Building a rest house (haus win)*

Antonia had an open space in front of her house. She wanted to build a rest house for relaxation purposes. These are the steps she went through in planning the building:

- She walked around the open ground and found out that it was 20 paces by 18 paces. She used this measurement to plan;
  - the actual amount of space for her haus win
  - how big (length, width and height)
  - number of persons it could house
  - how much the building materials would cost.
- She found a stick, one pace in length and placed it as her marker for the starting point.
  - She took 6 paces from the starting point to the west and placed a second marker.
  - Turning south she took 5 paces and placed the third marker.
  - Then she turned east and took 6 paces and placed the final marker.
  - Finally she took 5 paces north and ended up at the starting point.
  - She replaced the markers with 3 sticks; each 1 pace long.
  - Then she fastened a rope 30 arm spans long to connect 4 sticks. This is what she marked out.



- Estimated list of materials required

Quantity	Name of parts and materials	Number of paces	Number of arm spans
4	Post forks (front)		2½
4	Post forks (back)		2
2	Roof frame (top plates)	6	
4	Roof frame (rafters)	5	
25	Bamboo splits – kunai roof		3
32	Kanda/vine		10
10	Kunai (bundles) – for roof		
4	Post forks for seat	1½	
4	Seat rest (Width of seat)	1	
12	Black palm		1½

- Students sketch the rest haus to scale (the haus win was about 2 1/2 arm spans in height)
- Students draw a plan of the haus win.

*From arbitrary units to standard units*

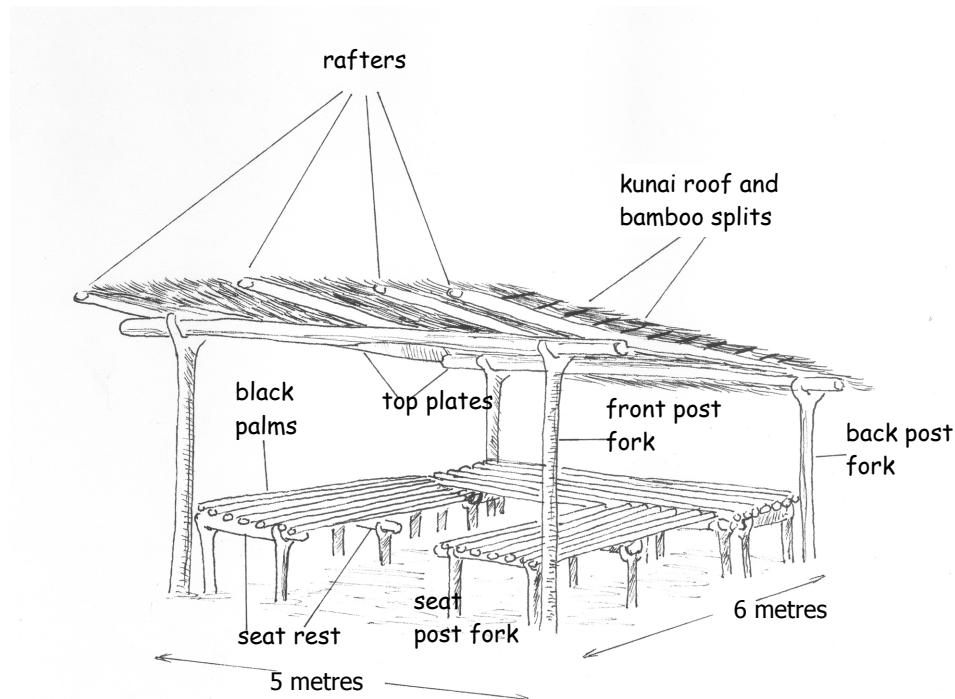
A friend wanted to build his Haus Win in town. Antonia gave him the information she had collected above. He bought a 50 metre long tape measure and drew up scales for measuring.

Scale:

- 1 arm span = 1:1.5 m
- 1 pace: 1 m

Using the scale given he completed the same activities as Antonia leading up to building the Haus Win.

- Students do their versions of Antonia's friend's plan. As they are working take note of the following:
  - use his scale
  - set out work
  - show all calculations
  - draw samples wherever appropriate.



### Number in different cultural contexts

- In groups of 4, discuss the different ways of counting people use today compared to in the past. Discuss contemporary and traditional methods.
  - List the different ways.
  - Make classroom displays showing traditional counting methods.
- Max picked up an empty carton of twisties in the nearby store. He measured the length, height and width of the carton using his hand span. This is the result:
  - length 2 hand spans
  - width 1 hand span

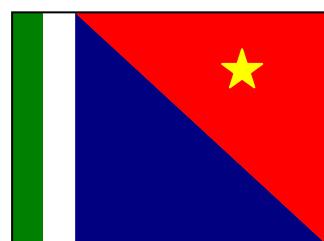
- height  $1\frac{1}{2}$  hand spans
- scale: 1 hand span = 180 millimetres.
- Convert Max's measurement to standard units using the scale. Draw the carton and label with correct measurements. Explain your answer.

### Conversions

- Do you know the biggest squid in the world, the giant squid, has an eye diameter of 0.5 metres Convert this measurement into:
  - centimetres and
  - millimetres.
- The furthest depth for a submarine to go under the ocean is 652 7000 centimetres. Convert this measurement into kilometres, metres and millimetres.

### Measurement

- Take a piece of rope 0.5 metres long and measure an object that has a diameter of the same length.
  - Draw and name the object.
  - Draw the giant squid next to the object, making sure the drawing is to scale so that the eye of the squid is the same size as the object.
- Milne Bay students decide that they want to make 100 Milne Bay flags to fly on the front fence of their school. Each flag is to be  $60\text{cm} \times 80\text{cm}$  in size and will need to be fixed to a 3m pole. The students will sew up the flags themselves but will need to buy the materials and poles. How much will the materials for the project cost? Cloth material and poles will need to be decided, and costed from local retailers.



### Using data

Data is information. It is collected in a number of ways; from records, from surveys (face-to-face; mail and telephone), by direct observation or by measuring or counting. Data can be collected for a whole population or for a sample of the population.

- Students complete the table below displaying the things they already know and want to know about data. The last column must be completed by the students after completing all the activities on data and have learnt about data.

Know	Want to know	Learnt

- Using the information in the table describe, “What is Data?”
- Many Grade 9 students in an urban school are late for school every morning. School starts at 8 am. A group of students are investigating why they are late by finding out how the students get to school in the morning. They chose a sample of 200 students from the school and four modes of transport:
  - private cars
  - PMV
  - taxi
  - walking.

The survey was carried out in 2 days and this is the result.

Mode of transport	Taxi	Private car	PMV	Walk
No of students	15	49	71	65

- How many more students walk to school than come by taxi?
- If the PMVs arrive at school at 8.30am, how many students are 30 minutes late for classes each day?
- Study the data from the survey and present this information on a frequency table

Mode of transport	Tally	Frequency

- Display this data on two different graphs
  - a bar chart or column graph and
  - pie graph-indicate the sections of the pie graph in percentages

#### *Statistical investigation*

- In groups of 5 choose one of the topics listed below and do a statistical investigation. Suggested topics are:
  - babies between the age of 1 month and 2 years with HIV AIDS
  - students who do not have lunch at school
  - students with physical disabilities in the school
- Present the data using a segmented bar to display your statistics.

*Types of data*

Most commonly used types of data are categorical, numerical, discrete and continuous data.

- In groups find at least 4 different examples of statistical data and identify them under the following headings:
  - categorical
  - numerical
  - discrete and
  - continuous data.
- Describe in your own words each group of data.

## Performance standards

Assessment task two must be assessed using the following performance standards based on the assessment criteria. Note that the assessment performance standards should be made available to students at the beginning of the projects.

<b>Performance standards for assessment task 2 –Research Project</b>					<b>Total marks – 40</b>
<b>Assessment Criteria</b>	<b>Very high achievement 36–40 marks</b>	<b>High achievement 28–35 marks</b>	<b>Satisfactory achievement 20–27 marks</b>	<b>Low achievement 0–19 marks</b>	
(15 marks) Demonstrate appropriate investigation skills	14–15 marks Consistently stays focused on the task. Very self-directed. Actively collects information and creates insightful solutions to problems. Uses a wide range of resources.	11–13 marks Focused on the task most of the time. Collects information and finds standard solutions to problems. Uses at least two different resources.	7–10 marks Focused on the task some of the time. Collects information and finds solutions to problems with some assistance. Uses at least two different resources.	0–6 marks Rarely focuses on the task. Collects some information without providing adequate solutions. Uses at most one resource.	
(15 marks) Choose and apply relevant mathematical techniques	14–15 marks Appropriate and efficient mathematical techniques used at all times The solution contains no mathematical errors, or almost none	11–13 marks Usually uses appropriate and effective mathematical techniques The solution contains few mathematical errors	7–10 marks Sometimes uses appropriate and effective mathematical techniques but does not do it consistently The solution contains some major mathematical errors	0–6 marks Rarely uses an appropriate mathematical techniques The solution contains many mathematical errors	
(10 marks) Make an effective communication of the project results	9–10 marks Work is presented in a well organised fashion that is easy to read or listen to and is easy to understand All project results communicated clearly	7–8 marks Work is presented in an organised fashion and is mostly easy to read and understand. Most project results communicated.	5–6 marks Work is presented in a reasonably organised fashion but is not always easy to read or understand. Some project results communicated.	0–4 marks Work appears sloppy and unorganised. It is hard to know what information goes together. Few if any project results communicated.	

**Sample test****20 marks**

1. Match each of these expressions with the correct statements in words:

**a**  $m - 7$   
**b**  $m + n$   
**c**  $n + 5$   
**d**  $3(m + n)$

**A** five more than  $n$   
**B** three times the sum of  $m$  and  $n$   
**C** seven less than  $m$   
**D** the sum of  $m$  and  $n$

**4 marks**

2. Estimate the answers to the following calculations. Show working:

a)  $7.9 + 0.81 + 13.56$

b)  $5.6 \times (7.2 + 5.9)$

**2 marks**

3. Wendy earns K16.00 per hour

a) How much would she earn in  $7 \frac{1}{2}$  hours?  
b) How many hours would she have to work to earn K200.00?

**3 marks**4. A car travels 190 km in  $2 \frac{1}{2}$  hours. What is its average speed in kilometres per hour?

**A** 38 km/h   **B** 76 km/h   **C** 100 km/h   **D** 158 km/h

**1 mark**

5. Listed are three situations where mathematical operations are used. Complete the table by stating examples of operations used and why they are used.

<b>Situation</b>	<b>What operation?</b>	<b>Why?</b>
Shopping	1 2	1 2
Travelling on a PMV	1	1
Gardening	1	1

**4 marks**

6. A man has a job earning K2.00 per hour. He works 40 hours. Complete the table and draw a graph showing the information from the table. Put time on the horizontal axis with 1 cm representing 5 hours, and put Kina on the vertical axis with 1cm representing K10.

<b>Time (h)</b>	0	10	20	30	40
<b>Pay (K)</b>					

**6 marks**

## 9.2 Patterns of Change

### Step 1 – Interpreting the unit learning outcomes

These unit learning outcomes link to the broad learning outcomes 2, 3, 4 and 5. Note that this unit links with units in Science.

**Outcome 9.2.1:** Students can identify and create representations of patterns to solve equations.

This outcome requires you to teach students to identify and create representations of patterns to solve problems. Students need to practice with a variety of patterns and solve problems in both abstract and real life contexts.

**Outcome 9.2.2:** Students can create, investigate and interpret equations, explain the effect of order of operations, and justify solutions to equations.

This outcome requires you to teach students to create, investigate and interpret equations. Students need to develop the skills of justifying their solutions to equations. Students also have to be taught to explain the effect of using an order of operation when many operations are given. As much as possible problems should be taken from real life situations.

**Outcome 9.2.3:** Students can communicate mathematical processes and results in writing.

This outcome requires students to present their findings from an individual directed investigation through, for example, a report, an illustrated chart, a poster, a flow chart, an article or other documents. They must use the mathematical processes they have learnt in the core.

**Outcome 9.2.4:** Students can undertake investigations individually in which mathematics can be applied to solve problems.

This outcome requires students to work individually to investigate a topic which should be drawn from directed numbers, indices or equations. It requires students to use the mathematical processes they have learnt in the core to investigate any of the suggested topics.

### Step 2: Planning for assessment

Assessment task one consists of a test covering

- operations with directed numbers
- operations with indices and scientific notation
- forming of simple algebraic expressions and equations
- simplifying algebraic expressions
- solving linear equations.

The test is seeking evidence that students have understood the elementary ideas of number and algebra and have developed basic skills in these areas.

The test can be divided into three parts and be given to the students over the term, rather than one big test at the end of term. You should give marks for each item in the test. During the course of the unit you should make sure students are taught these skills and that they apply them in a range of different contexts. It is recommended that formative tests and quizzes be used to help students to gauge their learning.

Assessment task two requires students to work individually on a directed investigation. The topic of the investigation should be drawn from directed numbers, indices or equations.

This investigation project is to be conducted by students working individually. Students present their findings in writing after:

- analysing a mathematical ‘pattern finding’ problem
- producing:
  - a systematic list of simple examples
  - a solution to a harder example requiring a generalised technique
  - an algebraic rule for the general case
  - an algebraic solution to a harder example
- communicating the findings in a written form (article, poster, etc)

*Sample problem*

- (a) Extend the pattern for the next three figures
- (b) How many tiles are needed for each figure?
- (c) How many tiles are needed to make Fig 100?
- (d) Which figure can be made with 41 tiles? .. and 93 tiles?
- (e) How many tiles to make Figure  $n$ ?
- (f) Which figure can be made with 1001 tiles? .. and  $k$  tiles?
- (g) (Extension) How many tiles are needed to make all of Figures 1 to  $n$ ?

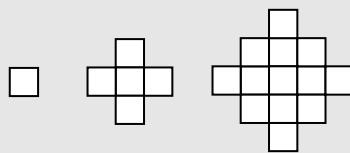


Fig 1

Fig 2

Fig 3

This task is seeking evidence that students can use basic algebra to represent situations and to solve related problems.

The performance standards for marking assessment task two are at the end of the unit.

## Step 3: Programming a learning sequence

### Sample program

Weeks	Topics	Activities	Assessment
1–2	Directed numbers	Arranging and comparing directed numbers Adding and subtracting directed numbers Discover the rules of multiplying and dividing directed numbers Calculate using 'order of operations' Tug of war	Formative quiz on basic skills  Test part 1 (20 Marks)
3–4	Indices	Revising squares and square roots using tables Discuss the laws of indices	Test part 2 (20 Marks)
5–6	Scientific Notation	When is scientific notation used? Solving problems involving scientific notation. Card game Blood Bank (Project Research) Caption game Red blood cells	Formative quiz on basic skills  Test part 3 (20 Marks)  Individual directed investigation (40 marks)
7–8	Equations	Introducing the ideas and concepts of sequences and series Discuss the meaning and formula of arithmetic progression (sequence) and arithmetic series Discuss finding the missing term of a sequence and a series given the first term and the common difference Card game Discuss and enumerate commonly grouping symbols used Extend by giving the rules when removing grouping symbols ,e.g. - removing grouping symbol precede by a + plus sign - removing grouping symbol preceded by a – minus sign - removing grouping symbols preceded by a factor - removing grouping symbol within a grouping symbol. Factorising expressions with common Monomial Factor	Formative quiz on basic skills
9–10	Equations	Revise solving simple equations and discuss the principles of equality in solving equations Solving equations with grouping symbols Evaluating formulas Solving problems using formulas	Formative quiz on basic skills
<b>Resources:</b> Mathematics text books			

## Step 4 – Elaboration of content and activities

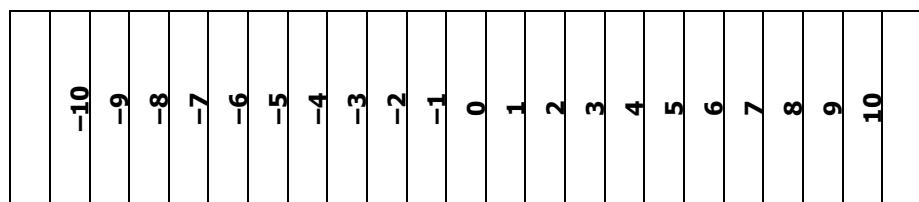
Study the topics and think about the learning activities which will best provide students with the opportunity to learn the content and practice the appropriate skills. For example in the core section of this unit the following activities could be used.

### Suggested activities

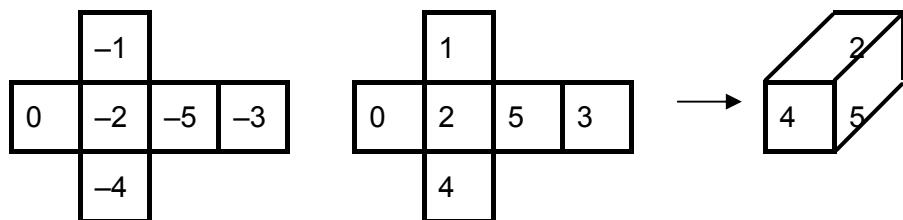
#### Directed Numbers

*Tug of war – A game using directed numbers*

- On a piece of stiff paper make the game board and counter as shown.



- Make two dice, marking the faces as shown on the nets for the cubes below.



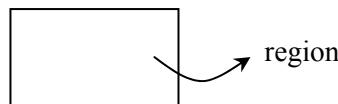
- Rules of the game
  - The game is for two players, player A (negative) and player B (positive)
  - The counter is placed on the zero mark on the board at the start of each game.
  - The two dice are thrown to decide who starts first. The person with the higher score begins (positive numbers are higher than negative numbers).
  - The game is played by each player taking turns in throwing the dice.
  - The combined score of the dice gives the movement of the counter for that throw. For example;
  - $(-3)$  and  $2 = (-1)$  – counter moves one space to the left (negative)

- 4 and  $(-1)$  = 2 – counter moves three spaces to the right
- The game is won when the counter lands on or beyond the space marked  $(-10)$  or  $10$ .

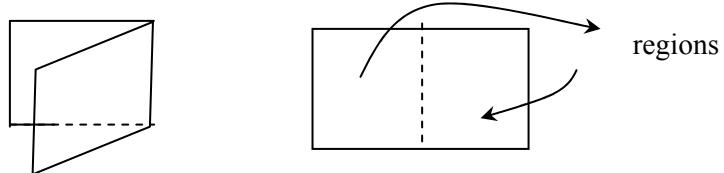
## Indices

### *Paper folding*

- Give each group of 4 students an activity sheet and paper needed for the activity (or write instructions on the board).
- Take the sheet of paper and consider the number of regions in the sheet. In the case below there is only one region (see figure below).



- Make a fold crosswise and unfold this as shown below. Again, consider the number of regions made.



- Make a second fold as shown below: Unfold to determine the number of regions made.



- Continue doing this up to the fifth fold. Take note of the number of regions formed for every fold made.
- Complete the table:

Number of folds	1	2	3	4	5
Number of regions	2				

- Study the table carefully. Without folding, determine the number of regions for any given number of folds.
- Determine the number of regions formed for each of the following number of folds without folding a sheet of paper.
  - 6 folds
  - 7 folds
  - 8 folds
  - 9 folds
  - 10 folds.

*Exponent caption game*

Directions:

- Solve for the value of the following expressions in Box A.
- Match the answers in the answer box in Box B.
- Write the corresponding word below the correct answer box.

What message is formed? The first one is an example.

**Box A**

$5^6$ WISE	$\frac{4^{17}}{4^{10}}$ TO	$8^7$ INSTRUCTIONS	$7^5$ STUDENTS
$6^8$ HIS	$3^4 3^2$ LISTENS	$\frac{(3^4)^4}{3^6}$ TEACHER'S	$(2^3)^4$ A

**Box B**

4096	15625	16807	729
16384	1679616	59049	2097157

### Research activity – Application of Indices – Red Blood Cells

Human blood contains about  $8 \times 10^4$  microlitres ( $\mu\text{L}$ ) of blood for each kilogram of body weight. One microlitre ( $\mu\text{L}$ ) is one millionth of a litre. Each microlitre of blood contains about  $5 \times 10^6$  red blood cells.

- Find the approximate number of red blood cells in a person who weighs 56 kg.
- Find your weight in kg and estimate the number of red blood cells in your body.
- Assuming the average blood donor gives about 470 mL; estimate the number of red blood cells in one donation.
- If possible carry out some research at your clinic where people can donate blood (local blood bank) and find out how many litres of each blood type are donated and used on a daily or weekly basis. Convert the volume of blood to number of red blood cells and present the information in standard form. In your report include information such as the different uses of donated blood. If there is no blood bank you can improvise numbers of people and their blood groups and give the students the information, or they can make up a hypothetical situation and determine the number of people and their blood groups.

### Teacher's notes

- Revise the concepts of squares and square roots
- Discuss the concepts of indices
- Discuss laws of indices –product law, quotient law, power law, power to a power, zero indices, negative indices

- Law 1:  $\text{am} \times \text{an} = \text{am} + \text{n}$

$$\text{– Law 2: } \frac{\text{a}^m}{\text{a}^n} = \text{am} - \text{n}$$

–

$$\text{– Law 3: } (\text{am})\text{n} = \text{amn}$$

–

$$\text{– Law 4: } \text{a}^0 = 1$$

$$\text{– Law 5: } \text{a}^{-\text{m}} = \frac{1}{\text{a}^m}$$

- Discuss the application of indices to numbers and algebraic expressions (simplifying expressions by writing the answers using positive powers only).
- Emphasise that a factor can be moved either from the denominator to the numerator simply by changing the sign of its index.
- Discuss the process of using scientific notation in writing very small and very large numbers. Extend ideas regarding solving problems involving scientific notation and estimation.

## Number pattern

### Card Game

- Divide the class into 2 groups.
- Give each group a set of number cards.
- Each member of the group must hold a number card.
- Each group will be given the same set of cards.

4	5	6	7	8	8
9	16	20	25	30	32
35	40	45	64	729	81
128	243	160	320	256	80
640	1280	2187	10	50	55

- Write the first three terms of the sequence on the board as shown below one on the left side and the other on the right side for groups 1 and 2. Instruct the students to complete the sequence by posting on the board the desired number cards until all have been posted.
  - Here are first three terms of the sequences:

i	-	1	2	5
ii	-	5	10	15
iii	-	1	2	4
iv	-	3	9	27
v	-	5	10	20

- The group that gets the most number of correct answers is the winner.

### Teacher's notes

- Introduce the ideas and concepts of sequences and series by giving their meanings and examples.
- Sequence – is a set of numbers arranged in a definite order.
- Term of a sequence – are the numbers that make up a sequence.

A sequence is usually written:

$$a_1, a_2, a_3, \dots, a_n, \dots$$

where:

$a_1$  = first term

$a_2$  = second term

$a_3$  = third term

$a_n$  =  $n$ th term (also called general term of a sequence)

The subscript of each term represents the term number.

Example: Finite and infinite sequences

0, 1, 2, 3, 4, 5, 6, 7, 8, 9. ← period indicates that the sequence ends here

The set of digits is a finite sequence. Each term is found by adding 1 to the preceding term (except the first term). It could also be written as:

– 0, 1, 2, ..., 9

– 0, 1, 2, 3, ... ← 3 dots indicate that the sequence never ends

The set of whole numbers is an infinite sequence. Each term is found by adding 1 to the preceding term(except the first term).

15, 10, 5, 0, -5, -10.. ← the sequence ends here

This is a finite sequence. Each term is found by adding -5 to the preceding term.

**Arithmetic Sequence** – also called Arithmetic Progression (AP) is a sequence in which each term after the first term is found by adding the same fixed number to the preceding term. The fixed number added is called **common difference (d)**.

Discuss by giving examples how to find the terms of a sequence given the first term and the common difference, e.g. Find the terms of a sequence whose first term is 2 and common difference (d) is 3 (Answer: 2, 5, 8, 11,... $n + 3$ ).

**Series** – is an indicated sum of a finite or infinite sequence of terms. It is a finite or an infinite series to whether the number of terms is finite or infinite.

An infinite series is usually written as:

$$a_1 + a_2 + a_3 + \dots + a_n + \dots$$

Discuss by giving examples, how to find the missing terms of a sequence, given the first term and the common difference.

*Examples of commonly used grouping symbols*

- ( ) Parentheses
- { } Braces
- [ ] Brackets
- Bar (generally used with fractions and surds)

**Performance standards**

Assessment task two must be assessed using the following performance standards based on the assessment criteria. at the beginning of the projects.

<b>Performance standards for assessment task 2 –Directed investigation</b>					<b>Total marks – 40</b>
<b>Assessment Criteria</b>	<b>Very high achievement 36–40 marks</b>	<b>High achievement 28–35 marks</b>	<b>Satisfactory achievement 20–27 marks</b>	<b>Low achievement 0–19 marks</b>	
(15 marks) Demonstrate appropriate investigation skills	14–15 marks Consistently stays focused on the task. Very self-directed. Actively collects information and creates insightful solutions to problems. Uses a wide range of resources.	11–13 marks Focused on the task most of the time. Collects information and finds standard solutions to problems. Uses at least two different resources.	7–10 marks Focused on the task some of the time. Collects information and finds solutions to problems with some assistance. Uses at least two different resources	0–6 marks Rarely focuses on the task. Collects some information without providing adequate solutions. Uses at most one resource.	
(15 marks) Choose and apply relevant mathematical techniques	14–15 marks Appropriate and efficient mathematical techniques used at all times The solution contains no mathematical errors, or almost none	11–13 marks Usually uses appropriate and effective mathematical techniques The solution contains few mathematical errors	7–10 marks Sometimes uses appropriate and effective mathematical techniques but does not do it consistently The solution contains some major mathematical errors	0–6 marks Rarely uses an appropriate mathematical techniques The solution contains many mathematical errors	
(10 marks) Make an effective communication of the project results	9–10 marks Work is presented in a well organised fashion that is easy to read or listen to and is easy to understand All project results communicated clearly	7–8 marks Work is presented in an organised fashion and is mostly easy to read and understand. Most project results communicated.	5–6 marks Work is presented in a reasonably organised fashion but is not always easy to read or understand. Some project results communicated.	0–4 marks Work appears sloppy and unorganised. It is hard to know what information goes together. Few if any project results communicated.	

## 9.3 Working with Data

### Step 1 – Interpreting the unit learning outcomes

These unit learning outcomes link to the broad learning outcomes 2, 3, 4 and 5. Note that this unit links with units in all other subjects.

**Outcome 9.3.1:** Students can represent, interpret, analyse and solve problems using discrete and continuous data.

This outcome requires you to teach students the concepts of data and statistics, methods of organising and displaying data graphically, the calculation of means, medians, modes and ranges, and the skills of reading statistical graphs. Students need to practice data analysis and statistical calculations in the context of real life situations.

**Outcome 9.3.2:** Students can estimate and calculate probabilities.

This outcome requires you to teach students the basic ideas of random (or chance) events, probability and its measurement, outcomes, sample spaces and the techniques of determining both experimental probabilities and probabilities based on symmetry properties. Students need to develop the skill of being able to estimate and recognise reasonable values for chance events in everyday life.

**Outcome 9.3.3:** Students can communicate mathematical processes and results both orally and in writing.

This outcome is assessed mainly in the options. Students must use the mathematical processes they have learnt in the core unit and communicate their findings appropriately.

**Outcome 9.3.4:** Students can undertake investigations individually and cooperatively in which mathematics can be applied to solve problems.

This outcome refers particularly to the options. It requires students to work in groups/teams of three to six to design a game of chance or conduct a statistical survey. It requires students to use the mathematical processes they have learnt in the core when undertaking their investigations.

### Step 2 – Planning for assessment

Assessment task 1 consists of a test on:

- describing statistical distributions
- production and interpretation of statistical graphs (including misleading graphs)
- calculations of means, medians, modes
- calculations of ranges
- the concepts of randomness and chance events
- operations involving large amounts of money
- calculation of probabilities in simple cases.

The test is seeking evidence that students have understood the basic ideas of statistics and probability and have developed skills in these areas.

The test can be given to the students in two parts over the term, rather than one big test at the end. You should give marks for each item in the test.

### Assessment task 2

#### Option A: Random events and simulation

This project is to be conducted in groups of three to six students.

Students present their findings to the class or other groups after:

- designing and constructing a simple game of chance
- producing a written analysis of the game including
  - the game materials (dice, spinners, coins, etc)
  - the rules of play
  - the probability of winning
- demonstrating the game and explaining it to an audience of other students or teachers.

Each student in the group should identify the part(s) of the project for which they will take primary responsibility. Some roles that individual students could take are

- designer – coordinates the game creation phase, finalises equipment and rules
- analyst – calculates the probabilities of each possible outcome (and particularly of ‘winning’)
- reporter – produces the project report
- game master – presents and explains the game to an audience.

All students in the group should be knowledgeable/familiar with all parts of the project, not just their own tasks.

This task is seeking evidence that students can use probability in designing and analysing an interesting game of chance.

#### Sample task instructions and criteria

Assessment tasks need clear instructions to help your students know what they have to do and meet the criteria. A marking guide is necessary to ensure that you mark consistently and to enable your students to see the relative importance of different parts of the task.

- Develop and make a game of chance
- Instructions
- Form groups of three and work together to research, design and construct a simple game of chance.
- Your playing materials could be dice, spinners, coins, cards or other suitable items.
- Make up some game rules (maximum 5 rules) for players to follow.
- Demonstrate your game to another group and ask them to play it for a short time.
- Hand in a written description of your game that includes calculations of the probability of winning.

Marking guide: *Group research project*

(60 marks)

- Evidence of research of games of chance (10 marks)
- Game developed is a true example of chance (10 marks)
- Probability calculations are accurate (Mathematical techniques) (20 marks)
- Demonstration and instructions are clear and easy to follow (10 marks)
- Written report describes game development process accurately (10 marks)

### Option B: Statistical surveys

This project is to be conducted in groups of three to six students. Students present their findings to the class or other groups after:

- designing a statistical survey using as few as possible relevant questions (students who need many questions/measures should narrow their research topic)
- administering the survey, with a sample of size 20–30
- collecting and organising the data
- producing relevant graphical displays
- producing a written analysis of the results including:
  - purpose of the survey
  - copy of the survey questions
  - data summary
  - graphical displays of results
  - analysis of data
  - conclusions
- making an oral presentation of the survey and its results to an audience of students and/or teachers.

Note that while many ‘surveys’ will involve questioning students or other people, they could also involve data derived from measuring a random sample (e.g. leaf length and width on two different trees of the same species).

Each student in the group should identify which part(s) of the project for they will take the primary responsibility for. Some roles that individual students could take are:

- group coordination, including the selection of the survey topic
- survey design and production
- survey administration – including sample selection
- data organisation and analysis
- preparation of the project report
- oral presentation of the project report.

This task is seeking evidence that students can form a random sample, organise and analyse data, draw statistical graphs, make conclusions based on data and communicate the results.

The performance standards and a marking guide for assessment task two are at the end of the unit.

### Step 3: Programming a learning sequence

#### Sample program

Weeks	Topics	Activities	Assessment
1–2	Recording data Sorting and organising data Measures of central tendency Measures of spread Misleading statistical graphs	Introduce statistical concepts and techniques Develop the ideas of randomness and random number generation “Which Book is Better”	Formative quiz on basic skills
3–4	Experimental probabilities Probabilities based on symmetry	Introduce the ideas and terminology of probability Discuss applications of probability “Probability experiments”	Assessment task 1 Test part 1 (20 marks)
5–6	Applications of probability	Introduce the idea of simulation Simple simulations “All the Stars”	Formative quiz on basic probability skills Assessment task 1 Test part 2 (20 marks)
7	Project preparation: discussion of examples of simulation techniques/statistical surveys		Assessment task 2 (60 marks)
8–9	Working on project: assignments, teams formation, research, preparation of written and oral presentations		
10	Project oral presentations and submission of written materials.		
<b>Resources:</b> Statistical tables and graphs in papers and magazines, mathematics text books, dice, coins, cards, light cardboard, matchsticks			

## Step 4: Elaboration of content and activities

Notice that students are required to do a project in groups. This means that:

- space should be allocated for each group including classroom display space
- students should understand their role within the group and their responsibilities to the group
- it is appropriate for students to undertake an excursion to look at aspects they are researching.

For background information to the unit see appendix for graphs on HIV/AIDS. You can come up with your own strategy on how to use this information to inform students about this disease.

Refer to Appendix for simulation of 'sports cards'.

### Teacher notes and strategies

- Explain and demonstrate graphing techniques: column graphs, histograms, cumulative frequency graphs
  - Line graphs may take the form of a smooth curve or may consist of line segments that join points plotted on the graph.
  - Bar graphs are used to show totals of information. This information can be shown for one item over a number of time periods, or for a number of items over one time period. The height of the bars indicates clearly the total of the information being shown. Bar graphs can also be used to compare totals of one or more items.
  - A circle or pie graph is a way of showing how each item of data contributes to complete picture. The 'slices' of the 'pie' are drawn proportionally in a clear, colourful way to show the percentages they represent.
- Discuss and demonstrate calculating averages, medians, modes and their interpretation.
- Discuss the ideas of 'sample' and 'random sample.'
- Give examples of random number generation techniques (lottery draw type, random number lists).

### Surveys

- A survey is a method of gathering information for a specific purpose. It may take various forms, eg traffic survey, values questionnaire, interview: To conduct a survey:
  - determine the purpose of the survey — what information do we need to obtain?
  - consider the form of survey most appropriate to gather the information needed on a topic/issue/problem.
  - be aware that if questions are used, they should be carefully formed to elicit the required information. Lower Secondary students should frame precise questions, perhaps discovering that responses to broad questions often confuse rather than clarify the purpose of the investigation.

- the need to trial a questionnaire could be explored, as well as bias in sampling methods.

### **Questionnaires**

A questionnaire is a set of questions aimed at getting the opinions of a number of people on a particular topic or issue. It can be left for people to fill out, or the questions may be asked directly in an interview situation. A questionnaire is really only useful if a large number of people take part. Supervision, safety and student protection issues, need to be considered and discussed eg when conducting a traffic survey or surveying adults. Students should not survey adults other than their immediate family without teacher or parental supervision.

- Decide with students:
  - the purpose of the survey.
  - who/what will be surveyed.
  - how the information will be gathered, e.g. by questioning, observing, individually by students, in jigsaw groups etc.
  - when and where the information will be obtained, e.g. at home from parents, on an excursion, at recess in the playground, or in the classroom.
  - the collation and final format and presentation of the data.

### **Oral Presentations**

Oral presentations involve students in presenting information and ideas to you and their peers. The work presented could be to explain a concept or theory, the results of independent research, a summary of an article or in response to a question supplied by you. They can be carried out individually, in pairs or groups.

When setting an oral task it is essential for students to be clear about what is expected of them when preparing and making the presentation. This means that you need to make some decisions including:

- Do you want students to work on the same or different topics
- Are the presentations are to be individual, pairs, or groups? If groups, limit the size to between four and six since larger groups can be unworkable.
- How much time is allowed – per group, per individual
- Is a question and answer session is to be included. If so, what are the conditions for the session?
- Will the groups be self forming or formed by the teacher?
- Will the assessment include an element of peer appraisal and if so what weighting will this get in the marking?
- What marking scheme will be used and given to the students? This means being clear about the purpose of the task in relation to the outcome/s being assessed.

In the option section of this unit a choice must be made between doing a project on using simulation in the design of a simple game of chance or on conducting a statistical survey. Simulation means assuming roles according to specified rules and procedures. These can be role-plays or games.

Simulation can also involve making working models to show how a process actually works.

It is expected that students will work in groups and use the skills learned in the core in completing their projects. For details of these projects see the previous section on assessment.

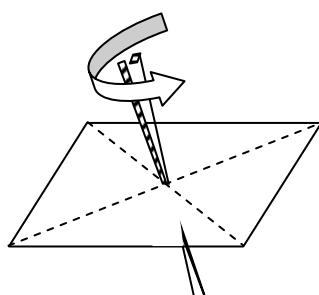
### Suggested activities

#### *Which book is better?*

- Pairs of students are supplied with two or three text books (e.g. an English novel and a Biology text) and asked to decide which is easier to read. Discuss the definition of “easier” – some possibilities are:
  - shorter words
  - shorter sentences
  - shorter paragraphs
  - fewer technical terms.
- Decide how to cope with ‘problems’ such as words written in numerals, line containing a chemical equation, etc
- Discuss how to choose a sample of pages to count. Students obtain a random sample and collect data – words, sentences, paragraphs or technical terms. Students draw statistical graphs, calculate averages and other statistics and write a summary of results and conclusions.
- Do different methods give different results?

#### *Probability experiments*

1. Make a simple ‘spinner’ by carefully cutting a 4cm×3cm rectangle from a piece of light card, mark in the two diagonals and stick a sharpened match through the centre.



- Guess the percentage of the time that the spinner will come to rest on one of its longer sides. (i.e.  $P(\text{long side})=?$ )
- Work with a partner. Make up a tally table and record the results of 50 spins. Do your results match your guess?
- Pool the class results and calculate the experimental probability. Does the class result match your guess?

2. The random process of tossing two coins has three possible outcomes – 2 heads, 2 tails, one head and one tail. Does this mean that if the coins are tossed many times that each outcome will occur one-third of the time, i.e.  $P(2H)=P(2T)=P(1H\&1T)=\frac{1}{3}$  ?

*Class game: Heads or tails?*

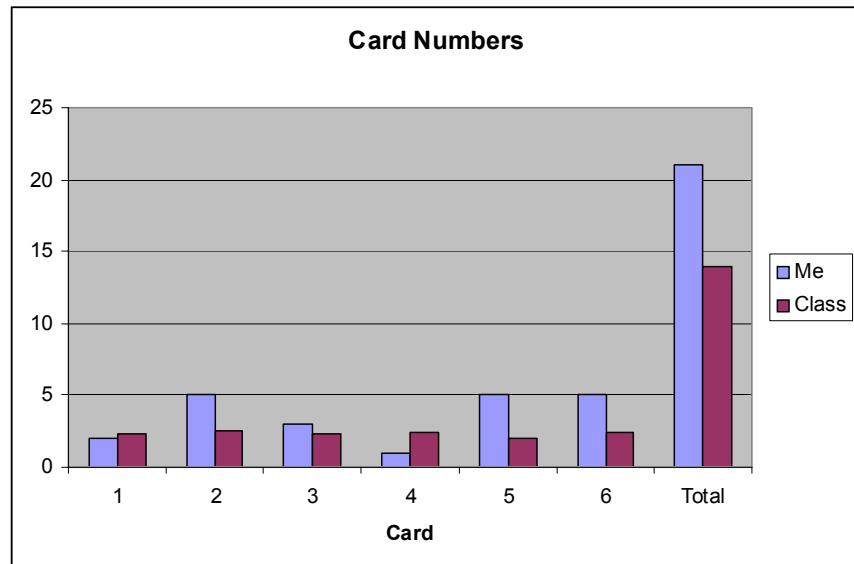
- Select a student to be the spinner and another to be an observer of the spin.
  - Everyone stand up
  - Each student decides what he/she thinks will be the result of the toss by:
    - putting both hands on their head (2 heads)
    - putting both hands on their tail (2 tails)
    - one hand on head and the other on tail (one head, one tail)
  - The spinner tosses two coins
  - The ones who were guessed correctly stay standing, the rest of the class sit down.
  - The process is repeated until there is only one person standing – he/she is the winner.
- Work with a partner. Make up a tally table and record the results of 100 tosses of two coins
- Calculate the experimental probability of each of the three results.
- Pool the results of the class and obtain a ‘class set’ of the three probabilities. Which set is likely to be more accurate – yours or the class set? Why?
- Draw up a  $2 \times 2$  grid put the possible results (H, T) for the first coin at the top of each column, and the possible results for the second coin at the left of each row. In the grid cells write the combined results, e.g. (H,H). How many different outcomes are there? Are they all equally likely to occur? So is  $P(1H \& 1T) = \frac{1}{3}$ ? Do your experimental results match the results suggested by the grid?
- Formative quiz on
  - concept of ‘probability’ and the difference between frequency, relative frequency and probability
  - the difference between situations in which symmetry can be used to calculate probabilities and those in which only experimental means can be used.
  - applications of probability – e.g. gambling, insurance, weather prediction

	H	T
H	(H,H)	
T		

*All the stars*

A brand of noodles includes a sports card hidden inside each pack. There are 6 different sports cards showing 6 different sports stars and the cards are randomly distributed in the packs.

- Predict how many packs of noodles you would need to buy in order to get a full set of 6 different cards (i.e. at least one of each)
- Simulate this process by rolling a die and using 1=Ace, 2=Bigshot, 3=Champ, 4=Demon, 5=Exciter, 6=Fantastico (use local names) Record the result of each roll in a tally table. Stop when you have one of each card. Also record the total number of rolls needed.
- Was your prediction about right? ... too low? ... too high? If your prediction was too low or too high why do you think this happened?
- Pool your results with those of the rest of the class.
- Calculate the class average for each sports card and the class average for the total number of cards needed to get a full set.
- Calculate the range of scores for the numbers of each card obtained by the class, and also for the total numbers of cards needed to obtain a full set.
- Draw a double column graph showing the numbers of each card you obtained and the total number of cards needed to get the full set, and also the class average results.



- Write one paragraph explaining the range of results obtained by the class and state the number of noodle packs that you would expect to have to buy in order to get a full set.

## Performance standards and marking guide

Sample marking guide and checklist for an oral presentation		
Component	Criteria	Marks
<b>Content</b>	<ul style="list-style-type: none"> <li>Accuracy, relevance and clarity of information presented</li> <li>Evidence used to support points made</li> <li>Coherence and organisation of ideas</li> <li>Results applied in decision making</li> </ul>	<b>10</b>
<b>Communication</b>	<ul style="list-style-type: none"> <li>Use of available time</li> <li>Use of visual and other aids effectively</li> <li>Communication with audience</li> <li>Response to audience questions (if required)</li> </ul>	<b>10</b>

Sample – Teacher/peer record sheet			
Component	Criteria	Comment	Mark
<b>Content</b>	Suitability of content for purpose and audience		
	Coherence and organisation		
	Creativity		
<b>Presentation</b>	Preparedness		
	Length		
	Use of supporting materials		
<b>Communication</b>	Suitability for purpose and audience		
	Clarity of speech		
	Posture and eye contact		
	Use of facial expressions and body language		
	Interaction with audience		

Assessment task two must be assessed using the following performance standards or marking guide based on the assessment criteria. Note that the assessment performance standards and marking guide should be made available to students at the beginning of the projects.

**Performance standards for assessment task 2 : Option A–The design and analysis of a simple game of chance, and the analysis of a given random situation or Option B –A statistical survey of a selected characteristic of a local population**

**Marks 60**

<b>Assessment Criteria</b>	<b>Very high achievement 54–60 marks</b>	<b>High achievement 42–53 marks</b>	<b>Satisfactory achievement 30–41 marks</b>	<b>Low achievement 0–29 marks</b>
(20marks) Demonstrate appropriate investigation skills	18–20 marks Consistently stays focused on the task. Very self-directed. Actively collects information and creates insightful solutions to problems. Uses a wide range of resources.	14–17 marks Focused on the task most of the time. Collects information and finds standard solutions to problems. Uses at least two different resources.	10–13 marks Focused on the task some of the time. Collects information and finds solutions to problems with some assistance. Uses at least two different resources	0–9 marks Rarely focuses on the task. Collects some information without providing adequate solutions. Uses at most one resource.
(20 marks) Choose and apply relevant mathematical techniques	18–20 marks Appropriate and efficient mathematical techniques used at all times The solution contains no mathematical errors, or almost none	14–17 marks Usually uses appropriate and effective mathematical techniques The solution contains few mathematical errors	10–13 marks sometimes uses appropriate and effective mathematical techniques but does not do it consistently The solution contains some major mathematical errors	0–9 marks Rarely uses an appropriate mathematical techniques The solution contains many mathematical errors
(20 marks) Make an effective communication of the project results	18–20 marks Work is presented in a well organised fashion that is easy to read or listen to and is easy to understand All project results communicated clearly	14–17 marks Work is presented in an organised fashion and is mostly easy to read and understand. Most project results communicated.	10–13 marks Work is presented in a reasonably organised fashion but is not always easy to read or understand. Some project results communicated.	0–9 marks Work appears sloppy and unorganised. It is hard to know what information goes together. Few if any project results communicated.

Use the following marking guide to mark the written work the students have completed for the assessment task. You can tick the appropriate box and then look at the students' overall achievement and give an on-balance assessment. If, for example, the student gets a tick in the SA (Satisfactory Achievement) box for every component of the assessment, then you would give the students a Satisfactory Achievement and a mark between 30 and 41.

Students should have access to a copy of the marking guide.

**Marking guide for assessment task 2: Option A – The design and analysis of a simple game of chance, and the analysis of a given random situation or Option B – A statistical survey of a selected characteristic of a local population**

**Marks 60**

		VHA	HA	SA	LA
<b>Investigation skills</b>  <b>20 marks</b>	Excellent investigation skills demonstrated				
	Uses a range of resources				
	Consistently stays focused on the investigation				
	Information relevant to the task				
<b>Mathematical techniques</b>  <b>20 marks</b>	Uses mathematical ideas, processes or strategies				
	Ability to analyse and/or interpret results/information				
	Uses solutions to problems suggested by others				
	Use of diagrams				
<b>Communication</b>  <b>20 marks</b>	Provided solutions/mathematical arguments and communicated them clearly and accurately using appropriate forms of representations, notations or terminology				
	Contributed positively or productively to the group's progress				
	Results communicated clearly				
	Organised materials and presentation				

## 9.4 Design in 2D and 3D Geometry

### Step 1 – Interpreting the unit learning outcomes

These unit learning outcomes link to broad learning outcomes 1, 2, 3, 4 and 5.

Note that this unit links with units in Arts and Design and Technology.

**Outcome 9.4.1:** Students can identify situations where patterns and measurement are applied traditionally.

This outcome requires you to teach students to identify situations where patterns and measurements are applied traditionally. 2D and 3D geometry can be found in many traditional items and is still out there today in our contemporary communities. Students must see a connection with what they learn in Mathematics and community artefacts and technological processes. Students must be given an opportunity to discuss their traditional patterns and measurement and compare them with what they are learning today.

**Outcome 9.4.2:** Students can classify shapes into families and their subgroups and justify reasoning.

This outcome requires you to teach students how to classify different shapes into families and other subgroups that the shape may belong to. Students need to practice classifying shapes and be given opportunities to justify their reasoning.

**Outcome 9.4.3:** Students can interpret, analyse and solve measurement problems and justify selections and applications of formulae.

This outcome requires you to teach students to interpret measurement problems and how to analyse them and solve them in the context of real life situations. Students need to develop the skill of being able to justify selections of formulae and apply the formulae correctly and confidently.

**Outcome 9.4.4** Students can communicate mathematical processes and results in writing.

This outcome refers particularly to the options. It requires students to present their findings in written form. They must communicate their use of the mathematical processes they have learnt in the core.

**Outcome 9.4.5:** Students can undertake investigations individually in which mathematics can be applied to solve problems.

This outcome requires students to work individually to construct angles, lines, regular polygons and nets and solids. They must be able to provide explanations of the deductive steps used in proving a particular result. It requires students to use the mathematical processes they have learnt in the core when drawing their constructions or when using deductive reasoning.

## Step 2 – Planning for assessment

Assessment of task one consists of a test on:

- properties of plane figures
  - triangles
  - quadrilaterals
  - other polygons
- angle sizes – estimated, measured and deduced
- surface area and volume of simple prisms – estimated and calculated.

The test is seeking evidence that students have understood the basic ideas of 2D geometry and have developed basic skills in this area. The test can be given to the students in two parts over the term, rather than one big test at the end.

During the course of the unit you should make sure students are taught these skills and that they apply them in a range of different contexts. It is recommended that formative tests and quizzes be used to help students gauge their learning

Assessment task two (Remember students do either Option A or Option B).

### Option A: Construction

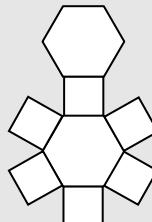
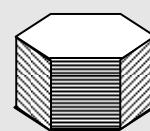
This investigation is to be conducted by students working individually. Students present their findings in writing after:

- making a scale drawing of a net for the given prism
- calculating surface area and volume for the prism
- answering some specific questions about the prism
- communicating the drawing and results in writing.

#### Sample problem

A box in the shape of a hexagonal prism is to be made from a net consisting of two hexagons and six squares, each having sides of length 6cm.

- (a) Find the surface area of the prism
- (b) Find the volume of the prism
- (c) What is the length of the longest straight stick which fits inside the box?
- (d) If the net is to be cut from a rectangular piece of card, what would be the minimum dimensions of the rectangle?
- (e) If the side length was doubled (i.e. changed from 6cm to 12cm) how would the surface area and volume change?



This task is seeking evidence that students can use mathematics in design and construction problems.

**Option B: Deductive reasoning**

This investigation is to be conducted by students working individually. Students present their findings in writing after:

- exploring a geometric figure (different students can have different figures and problems)
- answering specific questions
- giving reasons or proofs for their answers.

**Sample problem**

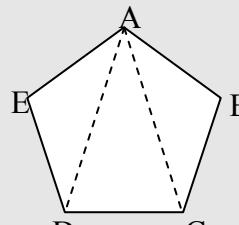
In a regular pentagon ABCDE draw in the diagonals AD and AC. Explain why  $\angle E=108^\circ$

Which triangles are isosceles?

Find all of the angles in the figure, explaining your reasoning

Is AD//BC? (give reasons for your answer)

Draw in BE. What is the obtuse angle made by the intersection of BE and AD?



This task is seeking evidence that students can use geometric properties of figures to deduce results about a specific geometric problem and that they can communicate the results.

The performance standards for the project are at the end of the unit.

### Step 3: Programming a learning sequence

#### Sample program

Weeks	Topics	Activities	Assessment
1-2	Properties of plane figures.	Define polygons Name properties of different polygons Discover the properties of a triangle Calculate the sum of the interior angles in different polygons Discuss and calculate the exterior angles of polygons Patch work	Formative quiz on basic skills
3	Angles and lines	Identify perpendicular lines Identify kinds of angles formed when lines cross Identify kinds of angles formed when 2 lines running in the same direction are crossed by a transversal (i.e. the corresponding, alternate, and co-interior angles) Discover the special case when parallel lines are crossed by a transversal Use the relationship to find the size of unknown angles. <i>Geo-bingo</i>	Test part 1 (20 marks)

4	Surface area	Calculate the perimeters and areas of polygons Investigate to discover the formula for finding the area of a circle Calculate the area of circles and sector Discuss and calculate areas or other related problems with compound shape	Formative quiz on basic skills.
5	Volume.	Discuss and define the words, prisms, pyramids, cones and volume Discuss and calculate the volume of prisms, pyramids and cones Find the relationship between surface area and volume	Test part 2 ( 20 marks)
6–7		Project preparation: discussion of examples of constructions in 2D and 3 D / deductive reasoning.	Assessment task 2: 60 marks
8–9		Working on Project: assignments, teams formation, research, preparation of written presentations	Formative assessment – Quiz on basic probability skills
10		Submission of written materials.	

**Resources:** Mathematics text books

#### Step 4 – Elaborations of content and activities

Any traditional measurement systems for the local community can be used for this unit.

#### Suggested activities – Plane and solid figures

##### *Properties of polygons*

- Discuss in groups or class the following and complete the table. This is an activity that will have information for the topics throughout the whole unit.

No. of Sides	Name
3	triangle
4	quadrilateral
5	pentagon
6	
7	
8	
9	
10	
12	
20	

- Choose each type of polygon as you go along with the topic to do as shown in the table, e.g.

## 1. Triangle

Name of Triangle	Properties		
	Sides	Angles	Lines of symmetry
i) Equilateral			
ii) Scalene			
iii) Isosceles			

## 2. Quadrilaterals

Name of quadrilateral	Properties:		
	Sides	Angles	Lines of symmetry
i) squares			
ii) rectangles			
iii) parallelogram			

*Exterior angles of polygons*

- Draw a hexagon and extend each one of the sides past the vertex to create an external angle as shown.
- Colour in the regions inside the exterior angles.
- Cut out the colour regions and place together with no overlapping edges.
- What is the size of the angle formed by adding together the regions?
- Draw a series of polygons that include regular and irregular shapes and repeat the above task.
- Copy and complete the table below to record your results

Polygon	Diagram	No. of sides	Side of each exterior angle	Sum of exterior angle
Triangle				
Quadrilateral				
Pentagon				
Hexagon		6	60	360
Octagon				

- Complete this statement: The sum of the exterior angles of a polygon is equal to ...

*Patch work*

Tessellations are often used in patchwork quilts. One popular design is the three-dimensional cube.

- Using grid paper, draw a series of tessellating parallelograms and squares.
- Colour in the shapes to give a three-dimensional effect.
- Experiment with different ways to colour in the shapes to give different effects. Cut out the parallelograms and squares from material and sew them altogether to form a section of a quilt, or use brightly coloured paper to make a poster.

This activity can be used to decorate the home room.

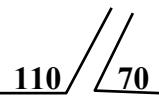
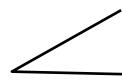
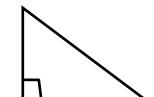
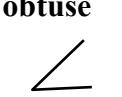
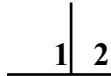
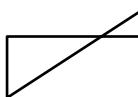
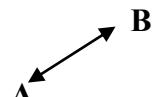
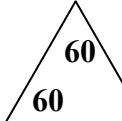
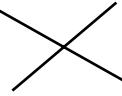
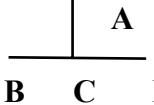
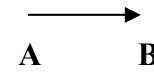
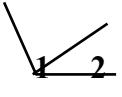
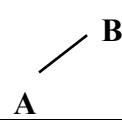
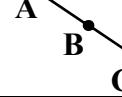
# GEO BINGO

The game is like “Bingo”.

Number of players: 5 to 10

Materials:

- 10 x 15 cm playing mats ( as shown below)
- twenty-five 5cm x 7cm “calling cards with the terms and symbols,
- markers ( button, shells or cut-out cardboard chips)

B	G I	E N	O G	O
			obtuse 	angle bisector
	perpendicular	Right 	Isosceles 	
altitude		Vertical 		
common side				intersecting planes
				median

To play the game

- Each player holds a playing mat and some markers.
- One of the players acts as the caller.
- He/she holds up a calling card and calls the term or shows the symbol on it.
- The other players look for the symbol or term corresponding to it on their cards and cover this with a marker.
- The first player to correctly cover squares in any direction—vertical, horizontal, diagonal – says “BINGO” and becomes the winner.

## Performance standards

The investigation, in either option, should be assessed using the following performance standards based on the assessment criteria.

<b>Performance standards for assessment task 2 : Option A– Construction of angles, lines, regular polygons and nets and solids or Option B– The explanation of the deductive steps given in proving a particular result</b>				<b>Marks 60</b>
<b>Assessment Criteria</b>	<b>Very high achievement 54–60 marks</b>	<b>High achievement 42–53 marks</b>	<b>Satisfactory achievement 30–41 marks</b>	<b>Low achievement 0–29 marks</b>
(20 marks) Demonstrate appropriate investigation skills	18–20 marks Consistently stays focused on the task. Very self-directed. Actively collects information and creates insightful solutions to problems. Uses a wide range of resources.	14–17 marks Focused on the task most of the time. Collects information and finds standard solutions to problems. Uses at least two different resources.	10–13 marks Focused on the task some of the time. Collects information and finds solutions to problems with some assistance. Uses at least two different resources	0–9 marks Rarely focuses on the task. Collects some information without providing adequate solutions. Uses at most one resource.
(20 marks) Choose and apply relevant mathematical techniques	18–20 marks Appropriate and efficient mathematical techniques used at all times The solution contains no mathematical errors, or almost none	14–17 marks Usually uses appropriate and effective mathematical techniques The solution contains few mathematical errors	10–13 marks sometimes uses appropriate and effective mathematical techniques but does not do it consistently The solution contains some major mathematical errors	0–9 marks Rarely uses an appropriate mathematical techniques The solution contains many mathematical errors
(20 marks) Make an effective communication of the project results	18–20 marks Work is presented in a well organised fashion that is easy to read or listen to and is easy to understand All project results communicated clearly	14–17 marks Work is presented in an organised fashion and is mostly easy to read and understand. Most project results communicated.	10–13 marks Work is presented in a reasonably organised fashion but is not always easy to read or understand. Some project results communicated.	0–9 marks Work appears sloppy and unorganised. It is hard to know what information goes together. Few if any project results communicated.

## Grade 10 units

### 10.1 Managing your Money

#### Step 1 – Interpreting the unit learning outcomes

These unit learning outcomes link to broad learning outcomes 2, 4 and 5.

Note that this unit links with units in Agriculture, Arts, Business Studies and Design and Technology. You can talk with teachers in these subject fields to see if they can integrate the topics for the benefit of their students.

**Outcome 10.1.1:** Students can apply percentages in a range of financial transactions and be aware of whether or not the result is reasonable.

This outcome requires you to teach students to use and apply percentages and basic skills to a range of financial transactions such as buying and selling at discount and calculating simple interest and compound interest to work out the real cost or benefit of financial transactions. It also requires you to teach students to use estimation to see whether their calculations are likely to be correct. Students need to practice calculating and estimation and apply them in real life situations.

**Outcome 10.1.2:** Students can determine the costs and benefits of simple credit and investment or saving schemes.

This outcome requires you to teach students how to work out simple interest and compound interest and apply these to credit and saving schemes. You will need to provide information on saving schemes such as bank accounts and term deposits, and credit schemes such as credit cards, bank loans, hire purchase and consumer credit schemes and give students the opportunities to determine the advantages of saving compared to credit.

**Outcome 10.1.3:** Students can communicate mathematical processes and results both orally and in writing.

This outcome is addressed mainly in the options. It requires students to present their findings using an oral presentation and in written form in the most appropriate way. They must use the mathematical processes they have learnt in the core.

**Outcome 10.1.4:** Students can undertake investigations individually and cooperatively in which mathematics can be applied to solve problems.

This outcome is addressed mainly in the options. It requires students to work in groups/teams of three to six and for you to give them the opportunity to investigate either personal budgeting or how to go about obtaining a mini-loan or consumer credit. It requires students to use the mathematical processes they have learnt in the core when investigating issues related to obtaining credit or to budgeting.

#### Step 2 – Planning for assessment

Assessment task one is a test on:

- calculations of percentages
- application of percentages to problems
- earning and saving money
- operations involving large amounts of money
- basic ideas of budgeting
- basic ideas of borrowing money
- calculating discounts, interest, repayments.

This test is seeking evidence that students can calculate percentages correctly; use percentages when solving problems related to real life situations, and use estimation skills to check if their solutions are likely to be accurate.

The test can be divided into two parts and given to the students over the term, rather than one big test at the end.

#### Assessment task 2

Remember students do either Option A or Option B.

#### **Option A: Three monthly budgets budgets such as personal, household, school canteen or local organisation**

This project is to be conducted in groups of three to six students. Students present their findings to the class or other groups after (e.g. household budget):

- determining household income
- producing a detailed account of estimated expenditure including
- costs of food items and how much it costs per month to feed the family,
- school fees costs averaged over a year,
- transport costs,
- clothing costs,
- housing costs such as rent, garbage, power, utilities
- maintenance costs,
- medical costs.

Each student should identify which part(s) of the project they would like to do. Some roles that individual students could take are:

- project coordination
- research
- data collection
- preparation of the written paper
- oral presentation.

The project will involve:

- an investigation of family financial commitments
- a written document or poster display of the data and its analysis
- an oral report of the budget to the class or part of the class or other groups.

This task is seeking evidence that students can use percentages and other basic skills in a real-life situation dealing with money. It aims to help students to understand the importance of budgeting.

### **Option B: Obtaining and using a mini loan (K100 – K500)**

This project is to be conducted in groups of three to six students. Students present their findings to the class or other groups.

Students should make a detailed record of the process involved in obtaining and using a mini-loan. At least two sources of loans should be compared.

The project should include:

- advertising pamphlets from banks or stores such as flyers, advertisements
- calculations showing cost of credit or loan compared to costs of saving
- documentation required
- a written account of the steps involved in obtaining a mini-loan
- financial plan showing the intended use of the funds from the loan
- completed loan application forms
- oral presentation, which could include a role play.

Each student should identify which part of the project they would like to do. Some roles that individual students could take are:

- group coordination
- financial researcher-researching of available loans
- accountant-loan cost calculations
- financial planner-designer of the loan project
- secretary-preparation of the written paper
- chairperson-oral presentation of the project report.

The project will involve:

- an investigation of available loan options
- the completion of actual loan application forms
- a financial analysis of the loan costs, and the repayment schedule.

This task is seeking evidence that students can use percentages and other basic skills in a real-life situation dealing with money. It aims to help students to understand the real cost of credit. The practice of bartering or exchanging goods for services should be emphasised and the value of such practice calculated. Students should also suggest ways budgets could be better managed and indicate effective methods of financial planning.

Note that all students in the groups should be knowledgeable/familiar with all parts of the project, not just their own task.

The performance standards for assessment task two are at the end of the unit.

### Step 3 – Programming a learning sequence

#### Sample program

Weeks	Topics	Activities	Assessment
1–2	Percentages & Money Spending Money	At the Sales" Revision and development of "percent concepts" Calculating percentages	Formative quiz on basic skills such as converting fractions to percentages
3–4	Saving Money	"At the Bank" Calculating simple and compound interest – skills development	Assessment task 1 Test 1 (20 or 25 marks)
5	Borrowing Money	"Buying on Credit" Calculating repayments	Formative quiz
6	Earning Money	"On the Job"	Assessment task 1 Test 2 (30 or 25 marks)
7	Project preparation: Option A or Option B. Discussion of examples of personal budgets/personal loans		Assessment task 2 (50 marks)
8–9	Working on Project: assignments, teams formation, research, preparation of written and oral presentations		
10	Project oral presentations, role plays and submission of written materials.		
<b>Resources:</b> Sales catalogues or advertisements; bank brochures and advertising materials; job advertisements from papers, internet; savings and loans societies; mini loan schemes; micro finance information; mathematics text books			

### Step 4 – Elaboration of content and activities

In the option section of this unit a choice must be made between doing a project on personal budgets or on obtaining a mini-loan. It is expected that students will work in groups and use investigation skills to research the option.

As part of their presentation, students could role play the process of deciding upon the need for a loan, and the process of obtaining the loan. They could also include the effects of loan repayments on the family in their role play.

For details of these projects see the previous section on assessment.

## Suggested activities

### *At the sales*

Pairs of students will be supplied with 2 or 3 large (multi page) advertising brochures and asked to analyse the sales 'bargains', answering questions like:

- If an item is reduced by 29%, how much is its sale price?
- If an item is reduced from K5.00 to K3.00, what % discount is this?
- If 40% discount results in the price being K5.00, what was the original price?
- Which item has the largest % discount (assuming both the original and the sale prices are given)
- What's the price with VAT, without VAT?

### *At the bank*

- Find out the different types of interest bearing accounts (provide pamphlets or newspaper advertisements).
- Discuss the benefits of saving.
- Use simple and compound interest calculations to work out what best to do with a spare K20 a week?

### *Borrowing money (provide pamphlets)*

- Discuss:
  - various available loan types
  - credit card
  - hire purchase.
- Practise calculating the cost of borrowing.

### *On the job*

Students research examples of different ways of getting paid.

### *Problem solving*

- Joko has been given 3 choices as a car salesman:
  - a monthly salary K3500
  - a retainer/allowance of K100/week plus a commission calculated at 0.5% of sales
  - hourly rate of K20.00/hour.
- He estimates that he will work 45 hours/week, and that he will sell 10 cars per month worth an average of K65 000 each. Which payment method should Joko choose?

## Teaching strategy

### *Role-play*

Role-play involves taking on and acting out roles of real or imaginary individuals in varied, non-threatening simulated situations in order to clarify

values and develop empathy with other people. Role-play is possible with most topics in the study of issues or current affairs.

Explain the role-play to the whole class so that they begin from a common understanding of the situation

- Cast beginning students with learners who are competent and relaxed. Acceptance of the role-play by some will give others more confidence.
- Avoid placing students in their usual life role as this can be self-defeating and will limit possible experiences for the students
- Be prepared to intervene where necessary
- Stop the drama after main behaviours and points have been observed
- Debrief role-play participants. This is an essential step as it helps players out of their roles. They must be disassociated from the role, both in their own eyes and the eyes of other students.

## Performance standards and marking guide

Assessment task two must be assessed using the following performance standards based on the assessment criteria which should be made available to students at the beginning of the project.

<b>Performance standards for assessment task 2: Option A—Presenting a personal monthly budget or Option B—Obtaining and using a mini-loan.</b>				
<b>Assessment Criteria</b>	<b>Very high achievement 45–50 marks</b>	<b>High achievement 35–44 marks</b>	<b>Satisfactory achievement 25–34 marks</b>	<b>Low achievement 0–24 marks</b>
(10 marks) Demonstrate appropriate investigation skills	9–10 marks Consistently stays focused on the task. Very self-directed. Actively collects information and creates insightful solutions to problems. Uses a wide range of resources.	7–8 marks Focused on the task most of the time. Collects information and finds standard solutions to problems. Uses at least two different resources.	5–6 marks Focused on the task some of the time. Collects information and finds solutions to problems with some assistance. Uses at least two different resources	0–4 marks Rarely focuses on the task. Collects some information without providing adequate solutions. Uses at most one resource.
(30 marks) Choose and apply relevant mathematical techniques	26–30 marks Appropriate and efficient mathematical techniques used at all times The solution contains no mathematical errors, or almost none	20–25 marks Usually uses appropriate and effective mathematical techniques The solution contains few mathematical errors	15–19 marks sometimes uses appropriate and effective mathematical techniques but does not do it consistently The solution contains some major mathematical errors	0–9 marks Rarely uses an appropriate mathematical techniques The solution contains many mathematical errors
(10 marks) Make an effective communication of the project results	9–10 marks Work is presented in a well organised fashion that is easy to read or listen to and is easy to understand All project results communicated clearly	7–8 marks Work is presented in an organised fashion and is mostly easy to read and understand. Most project results communicated.	5–6 marks Work is presented in a reasonably organised fashion but is not always easy to read or understand. Some project results communicated.	0–4 marks Work appears sloppy and unorganised. It is hard to know what information goes together. Few if any project results communicated.

## 10.2 Functions and Graphs

### Step 1 – Interpreting the unit learning outcomes

These units learning outcomes link to the broad learning outcomes 3 and 4. Note that this unit also links with units in Science and Social Science. It also models the growth of HIV/AIDS which is an issue all subject areas are addressing.

**Outcome 10.2.1:** Students can interpret and develop linear and quadratic equations from information provided in a given context.

This outcome requires you to teach students to interpret linear and quadratic equations from information provided in a given context. It also requires you to teach students to develop linear and quadratic equations. You will need to provide information on contexts where it would be appropriate to use the different equations. Students need to practice interpreting and developing linear and quadratic equations from real life situations as well as from abstract contexts.

**Outcome 10.2.2:** Students can plot and sketch graphs of linear and quadratic equations.

This outcome requires you to teach students to plot and sketch graphs of linear and quadratic equations. You will need to teach students what the labels of the axis are, the correct way to plot points on a Cartesian coordinate planes and how to draw a curve connecting the points.

**Outcome 10.2.3:** Students can communicate mathematical processes and results in writing.

This outcome requires students to present their findings in written form through, for example, an illustrated chart, a poster, a flow chart, or an article. The mathematical processes learnt in the core must be used.

**Outcome 10.2.4:** Students can undertake investigations individually in which mathematics can be applied to solve problems.

This outcome is assessed mainly in the options. Students will work individually on a directed investigation. They will investigate either drawing and interpreting a story graph from their local context or drawing and interpreting parabolic graphs. It requires students to use the mathematical processes they have learnt in the core when investigating issues related to linear or quadratic graphs.

## Step 2 – Planning for assessment

Assessment task one consists of a test on:

- operation with directed numbers
- operation with indices especially negative and zero indices
- solving problems involving scientific notation
- solving simple equations
- removing grouping symbols and simplifying expressions
- graphing linear equations
- finding the equation of a given straight line.

The test can be divided into two parts and given at two separate times during the term. Each item in the test must be marked. Test items should range from simple items to higher level thinking items. Low achievers should score up to 11 marks with outstanding students should scoring 22 marks or higher.

Assessment task 2 – remember students do either Option A or Option B.

### **Option A: Drawing and interpreting a story graph from their local context**

This is an individual directed investigation. Students present their findings through a report, an illustrated chart, a poster, a flow chart, an article or through some other written form after:

- deciding what information from their local context could be represented using a story graph
- producing a story graph
- interpreting the story graph that they have produced.

The project will involve:

- an investigation of information that can be displayed as a story graph
- poster display of the graph and its analysis.

This task is seeking evidence that students can draw and interpret a story graph. It aims to help students to understand that graphs can be interpreted in a number of ways.

### **Option B: Drawing and interpreting parabolic graphs**

This is an individual directed investigation where students present their findings in appropriate written form. Students must do a number of small investigations like the one that take five weeks to solve, write up and present.

**Sample problem**

A softball thrown by an outfielder to the pitcher followed a path described by the relationship:

$$H0 = t^2 + 6t + 1$$

Where  $h$  is the height of the ball in metres after  $t$  seconds.

- Complete a table of values for this relationship.
- Plot the graph of this relationship on graph paper.
- What was the height of the ball after 2 s?
- When was the ball first at a height of 7 m above the ground?
- During which time interval was the ball above a height of 9 m?
- What was the maximum height of the ball during its flight?
- How long was the ball in flight if it was caught at a height of 1.6 m above the ground on its downward path?

The performance standards for assessment task two are at the end of the unit.

**Step 3 – Programming a learning sequence****Sample program**

Weeks	Topics	Activities	Assessment
1–2	Directed Numbers	Revision on operations with directed numbers	Formative quiz on basic skills such as operations with directed numbers
3–4	Indices, Scientific Notation	Revision on laws of indices	Assessment task 1 Test 1 (20 or 25 marks)
5	Basic algebra	Revision on basic algebra The algebra walk	Formative quiz
6	Graphs	Experiments: Stretched spring Distance-time graph Hiring a bus Solving equations	Assessment task 1 Test 2 (30 or 25 marks)
7	Project preparation: Option A or Option B. Discussion of drawing and interpreting the two different types of graph		Assessment task 2 (50 marks)
8–9	Working on Project: assignments, research, preparation of written presentations		
10	Submission of written materials.		
Resources: Maths text books, graph paper			

In the option section of this unit a choice must be made between doing a project on ‘drawing and interpreting a story graph from their local context’ or on ‘drawing and interpreting parabolic graphs’. It is expected that students will work in groups and use investigation skills to research the option.

## Step 4 – Elaboration of content and activities

### Suggested activities

#### *The algebra walk*

Things you need:

- white sticky tape / chalk
- marking pen
- 1 meter ruler.
- Take the students to the basketball court and mark the Cartesian plane (x and y axis) by laying white sticky tape. Select around 10 students to stand on the x axis –five to stand on the positive side and five on the negative side.
- Give instructions to students to move to so that their new positions make function graphs.
  - Graph:  $y = x$
  - Multiply the number you are standing on by 1. Then move to the appropriate y value.
  - Graph:  $y = 2x$
  - Multiply the number you are standing on by 2. When you get the answer move to the appropriate y value.
  - Select other students to take part and also do other equations such as:
    - $y = x+2$
    - $y = 2x + 1$ .
  - This activity can also be done for quadratic equations or functions.

#### *Stretched spring*

- Attach different weights to a spring and each time measure the length of the spring and record it.
- Plot the graph with mass on the horizontal axes and length of spring on the vertical axes.
- Then find out the equation of the graph that you plotted. It should be a straight line.
  - What is the length of the spring before any mass was attached. Where does it show on the graph?
  - What is the gradient of the line? Where does it show on the line and what does it represent?

#### *Distance-time graphs*

- Explain the different parts of this type of graph.
- Explain what the different sections on the graph represent.

*Hiring a bus*

- The cost  $K$  (kina) of hiring a bus to take a group of Grade 10 students to their end of year function is made up of a fixed booking fee of K50 plus an additional charge of K3 for each kilometre ( $x$ ) that the bus travels to pick up students
- Complete the table of values which gives the various distances travelled.

• $x$	• 10	• 20	• 30
• $K$	•	•	•

- Plot the points whose co-ordinates are given by the values in the table
- Join the points with a straight line until it meets the vertical axis.
- Identify some points on the graph like the vertical intercept and what it means
- Find the rule that relates  $K$  and  $x$
- How many kilometres were travelled if the total cost was K215?

*Coordinate Geometry*

- Identify the four quadrants, the origin and the Cartesian plane.
- Plot points on a Cartesian plane.
- Identify independent and dependent variables.
- Interpret the different gradients.
- State the gradient and  $y$  intercept of a straight line  $y = mx + c$
- Discuss what a function is.
- Plot and sketch straight lines.
- Write equations of straight lines.
- Apply linear relations to modelling problems.

**Teacher notes**

Give many examples of linear equations and graphs to make sure students familiarise themselves with the straight line

$$\text{Gradient} = \frac{\text{rise}}{\text{run}} \text{ or } \frac{y_2 - y_1}{x_2 - x_1}$$

Interpret linear model graphs from real life situations.

*Function notation*

Rules are important in our lives because they let us live in an orderly way. In mathematics, rules are also necessary. A **function** is simply a rule that relates one number to another, e.g.

The rule is  $3m+5$ .

- If  $m$  is 4 the answer would be 17
- if  $m$  is 7 the answer would be 26 etc.

The rules have inputs and outputs:

- A linear function produces a straight line graph.
- A non-linear function produces a curve.
- A quadratic function in  $x$  has an  $x^2$  term but no greater powers of  $x$ .  
The special curve formed by a quadratic function is called a parabola.

### Option A activities

Students will have to do a number of small investigations, such as the one described below, which take five weeks in total.

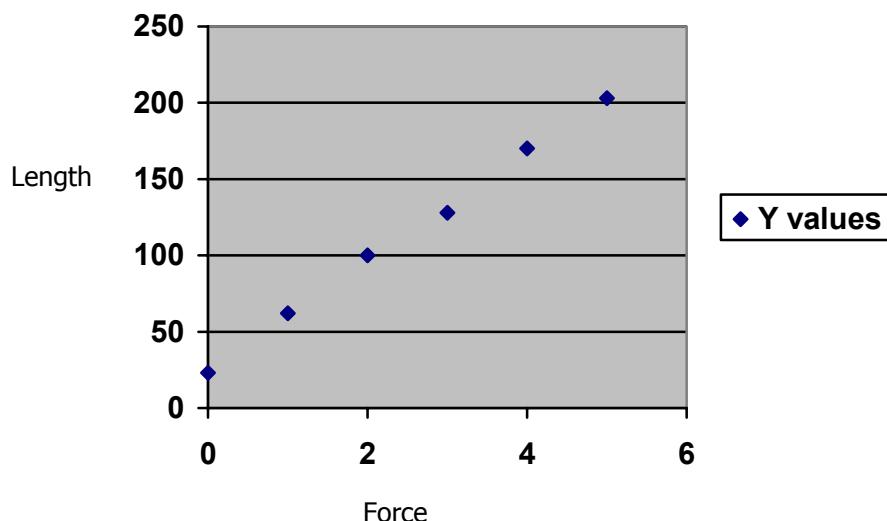
#### Sample problems

Graphs from real life situations or linear models

- The relationship between the weight  $W$  of a calf in kilograms and the time after its birth  $t$  in weeks is  $w = 10t + 40$ 
  - Draw a graph for the first 6 weeks of life.
  - From your graph, what will be the weight of the calf after 3.5 weeks?
  - What was the weight of the calf at birth?
  - How long will it take a calf to reach a weight of 65 kilograms?
- Suspend different weights from a spring and record the length of the spring

Force (Newton)      Length of spring

0	23
1	62
3	100
4	128
5	170
6	203



**Option B activities**

Drawing and interpreting parabolic graphs:

- expand and simplify binomial expressions
- square of a binomial
- factorising quadratics
- solving simultaneous equations using either substitution, elimination or a graph
- plotting and interpreting parabolic graphs.

*A research project on the statistics of HIV/AIDS*

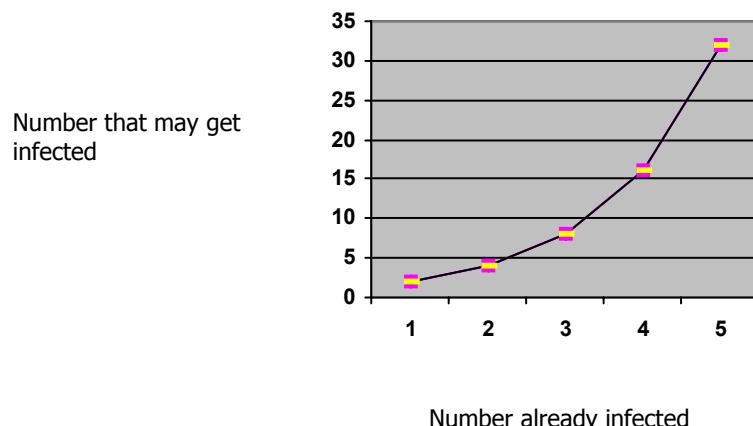
Students plot different graphs based on their findings.

There are graphs on HIV/AIDS given in the appendix which you can use to set exercises for your students.

For your information

AIDS is on the rise and it will take the young people as well as the older generation of this nation to say no to the spread of HIV/AIDS. If we are not careful this might happen. Take for instance 2 careless people are infected and they do not know it. They infect 2 other people, there are now 4 infected people; these four infect one each, there are now 8 infected and so on.

Graphically it will look like this.



## Performance standards and marking guide

The projects, in either option, should be assessed using the following performance standards based on the assessment criteria.

Note that the assessment performance standards should be made available to students at the beginning of projects.

<b>Performance standards for assessment task 2: Option A–Drawing and interpreting a story graph from their local context or Option B–Drawing and interpreting parabolic graphs</b> <b>Marks 50</b>				
<b>Assessment Criteria</b>	<b>Very high achievement 45–50 marks</b>	<b>High achievement 35–44 marks</b>	<b>Satisfactory achievement 25–34 marks</b>	<b>Low achievement 0–24 marks</b>
(10 marks) Demonstrate appropriate investigation skills	9–10 marks Consistently stays focused on the task. Very self-directed. Actively collects information and creates insightful solutions to problems. Uses a wide range of resources.	7–8 marks Focused on the task most of the time. Collects information and finds standard solutions to problems. Uses at least two different resources.	5–6 marks Focused on the task some of the time. Collects information and finds solutions to problems with some assistance. Uses at least two different resources.	0–4 marks Rarely focuses on the task. Collects some information without providing adequate solutions. Uses at most one resource.
(30 marks) Choose and apply relevant mathematical techniques	26–30 marks Appropriate and efficient mathematical techniques used at all times The solution contains no mathematical errors, or almost none	20–25 marks Usually uses appropriate and effective mathematical techniques The solution contains few mathematical errors	15–19 marks sometimes uses appropriate and effective mathematical techniques but does not do it consistently The solution contains some major mathematical errors	0–9 marks Rarely uses an appropriate mathematical techniques The solution contains many mathematical errors
(10 marks) Make an effective communication of the project results	9–10 marks Work is presented in a well organised fashion that is easy to read or listen to and is easy to understand All project results communicated clearly	7–8 marks Work is presented in an organised fashion and is mostly easy to read and understand. Most project results communicated.	5–6 marks Work is presented in a reasonably organised fashion but is not always easy to read or understand. Some project results communicated.	0–4 marks Work appears sloppy and unorganised. It is hard to know what information goes together. Few if any project results communicated.

## Marking guide

Use the following marking guide to mark the written work the students have completed for the assessment task. You can tick the appropriate box and then look at the students' overall achievement and give an on-balance assessment. If, for example, the student gets a tick in the Very High Achievement box for every component of the assessment, then you would give the students a Very High Achievement and a mark between 55 and 60.

Students should have access to a copy of the marking guide.

<b>Marking guide for assessing the performance in assessment task 2: Option A—Drawing and interpreting a story graph from their local context or Option B – Drawing and interpreting parabolic graphs</b>					
		<b>VHA</b>	<b>HA</b>	<b>SA</b>	<b>LA</b>
<b>Investigation skills</b>  <b>10 marks</b>	Excellent investigation skills demonstrated				
	Uses a range of resources				
	Works independently to successfully complete the task using previous learned knowledge				
<b>Mathematical techniques</b>  <b>30 marks</b>	Used mathematical ideas, processes or strategies				
	Ability to analyse and/or interpret results/information				
	Diagram				
	Originality				
<b>Communication</b>  <b>10 marks</b>	Provided solutions/mathematical arguments and communicated them clearly and accurately using appropriate forms of representation, notation or terminology				
	Results communicated clearly				
	Organised materials and presentation				

## 10.3 Trigonometric Applications

### Step 1 – Interpreting the unit learning outcomes

These unit learning outcomes link to broad learning outcomes 3, 4 and 5. Note that this unit links with the units in Design and Technology in association with building construction.

**Outcome 10.3.1:** Students can demonstrate understanding of the basic concepts of similar figures and trigonometric ratios.

This outcome requires you to teach students to identify similar triangles and properties that make them similar. It also requires you to teach students the trigonometric ratios. Students need to practice identifying similar triangles and naming the different sides of a right-angled triangle.

**Outcome 10.3.2:** Students can apply Pythagoras' theorem and trigonometric ratios to solve right-angle triangles and find lengths and angles in simple real problems.

This outcome requires you to teach students how to apply Pythagoras' theorem to calculate the length of a side in a right-angled triangle given the length of the other two sides. They will need to apply Pythagoras' theorem in practical situations. Students will also have to be taught to identify and apply the correct trigonometric ratio required to solve a given problem.

**Outcome 10.3.3:** Students can identify and apply calculations and be aware of whether or not the result is reasonable.

This outcome requires you to provide students with opportunities to correctly identify the different sides of a right-angled triangle and perform the correct calculations. Students must be provided opportunities to estimate whether at the beginning of the calculation or after to check whether their result is reasonable.

**Outcome 10.3.4:** Students can communicate mathematical processes and results.

This outcome is assessed mainly in the options. Students must use the mathematical processes they have learnt in the core unit and communicate their findings appropriately.

**Outcome 10.3.5:** Students can undertake investigations individually and cooperatively in which mathematics can be applied to solve problems.

This outcome requires students to work in groups to investigate and solve problems by navigating or surveying.

### Step 2 – Planning for assessment

Study the assessment requirements of the unit. These will tell you what specific knowledge and skills students will need to demonstrate that they have achieved the unit learning outcomes.

Assessment task 1 consists of a test on:

- similar triangles

- Pythagoras' theorem
- the trigonometric ratios
- right triangle trigonometry
- non right-angle triangle trigonometry.

The test is seeking evidence that students have understood the basic ideas of trigonometry and have developed basic skills in these areas.

The tests should be done on two parts over the term, rather than as one big test at the end of the term.

### Assessment task 2

#### **Option A: Surveying**

This project is to be conducted in groups of three to six students who select a non-rectangular portion of land to survey, e.g. the school grounds, part of the village etc. Students will produce field notes and rough sketches of the area being surveyed and finally an accurate map of the area, with scale, legend and all major features shown.

Each student in the group should identify which part(s) of the project for which they will take the primary responsibility. Some roles that individual students could take are

- coordinator – manages the project's progress, particularly the decision as to which piece of land to survey
- surveyors – conduct the plane table or off-set survey, producing sketches and field notes of angles/distances
- map makers – produce the finished map, and any explanatory notes.

This task is seeking evidence that students can use trigonometry and geometry in conducting a land survey.

#### **Option B: Navigation**

This project is to be conducted in groups of three to six students where students:

- plan the route between two seaports in PNG (one which requires several changes in direction, e.g. Morobe to Konos)
- calculate the bearing and distance for each leg of the total journey
- estimate the total 'sailing' time
- calculate the bearing and distance for a direct airflight between the two seaports
- estimate the time for that a direct airflight would take
- calculate the nearest three occasions that the sea route comes to land (other than the two ports) and show this on the map.

Each student in the group should identify which part(s) of the project for which they will take the primary responsibility. Some roles that individual students could take are:

- coordinator – group coordination, including making a decision on the route
- navigator 1 – calculates distances, bearings and times for the sea journey,
- pilot – calculates distance, bearing and time for the air journey,
- navigator 2 – plots and calculates the bearing and distance of the nearest three occasions that the sea route comes to land,
- captain – could present the ship's log to the audience, explaining choices for the route, time for the journey etc

This task is seeking evidence that students can use trigonometry to plan a navigation route and communicate the results.

Note that all students in the groups should be knowledgeable / familiar with all parts of the project, not just their own task.

The performance standards for the project are at the end of the unit.

### Step 3 – Programming a learning sequence

#### Sample program

Weeks	Topics	Activities	Assessment
1	Triangle properties and terminology	Naming triangles by their sides and by their angles e.g. Right –angled isosceles triangle or isosceles right- angled triangle Discuss and recognise the triangle inequality $[a < b + c]$	Formative quiz on types of triangles and their properties (revision)
	Similar triangles	Investigate and discuss similar triangles. Identifying similar triangles by proportionality of sides and congruency of angles - calculating and estimating enlargement factors	Formative quiz on similar triangles
2-3	Pythagoras Theorem	Draw square numbers Discuss and find square roots Discuss and find square roots of small numbers involving perfect squares Investigate and discuss the properties of a right-angled triangle Discover and discuss Pythagoras Theorem Illustration of Pythagoras theorem Discuss and use Pythagoras Theorem to find the hypotenuse Find the distance between points plotted on a Cartesian co-ordinate system Discuss and use Pythagoras Theorem to find the shorter sides of a right-angled triangle Pencil box  The Egyptian rope stretchers	Assessment task 1 Test part 1 (25 marks)
4-6	Trigonometry	Introduction to the trigonometric ratios Background information Who uses trigonometry and how is it used? Group discussion Investigate and discuss each trigonometric ratio Remember: SOH – CAH – TOA	Assessment task 1: Test part 2 (25 marks)
		Investigation the $30^\circ$ right angled triangle. Discuss and use trigonometric ratios to find the lengths and the angles of the right-angled triangles Solving practical problems applying trigonometric relations to modelling problems. Do practical problems applying trigonometry.  Do project 1 or project 2	Formative quiz
7	Project preparation: discussion of examples Project preparation: Option A or Option B. Construct a clinometer or plane table or continue with topics in navigation		Assessment task 2: 50 marks
8-9	Working on Project: assignments, teams formation, research, preparation of written presentations		
10	Submission of written materials		
<b>Resources:</b> Mathematics text books			

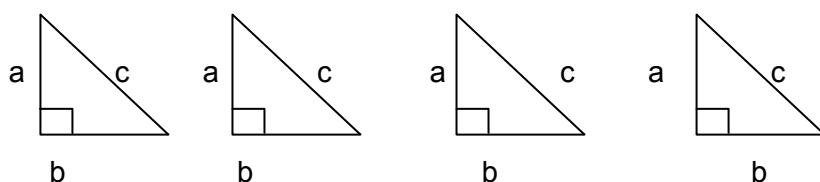
## Step 4 – Elaboration of content and activities

Study the topics and think about the learning activities which will best provide students with the opportunity to learn the content and practice the appropriate skills. For example in the core section of this unit the following activities could be used.

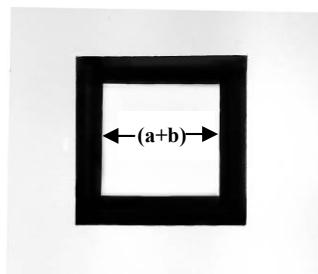
### Suggested activities

#### *Pythagoras' theorem*

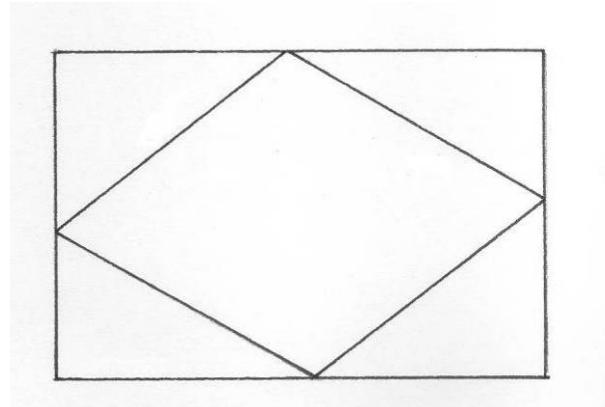
- Cut out four congruent right-angled triangles.
- Call the sides  $a$ ,  $b$  and  $c$ .
- 

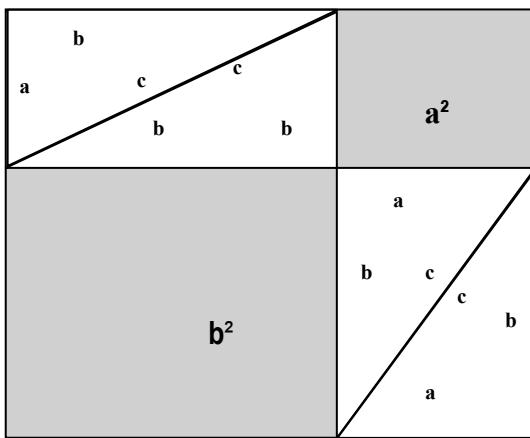


- Make a square tray with sides  $(a + b)$  units.
- square tray with sides  $(a + b)$  units.



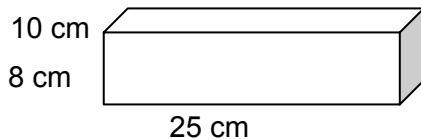
The triangles can be arranged two ways on the tray.





### Pencil box

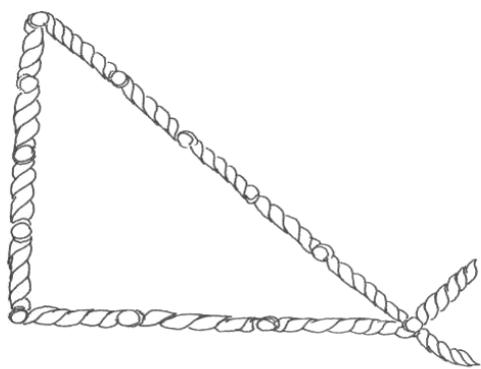
The Grade 10 class made a pencil case for their first woodwork model. It is made to the following plan.



- What is the longest pencil that can fit in the case lying across the bottom?
- What is the longest pencil that the case can hold?
- Jan wants the case to be large enough to hold her 30 cm ruler. She cannot change the size of the base (10 x 25 cm). What will be the smallest height of the case that can hold her ruler?

### The 3–4–5 Right-angled Triangle (The Egyptian Rope Stretchers)

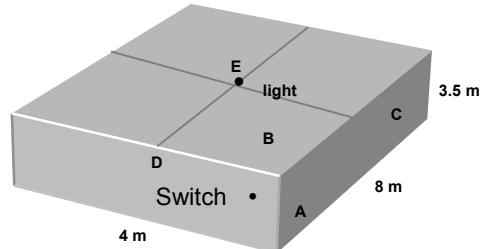
- Find a long piece of rope or string and make knots along it at equal distances.
- Arrange it in the shape of a 3–4–5 triangle and check if a right-angle is produced.
- Use your rope to check if the corners of the classroom are  $90^\circ$ , and if sports pitches have been marked out with  $90^\circ$  corners.



### Electric wiring

You are asked to run the electric wiring for a room from the switch to the light in the centre of the ceiling.

- Calculate the shortest length of wire needed for the job if the switch is 1.5 metres off the floor.



- In your report you will need to show the calculations for the different paths. For example one path could be:

A .....B then B .....C then C .....E

$2m + 4m + 2m = \text{total length needed } 8m$

- There are other points where the wire could run through that has not been shown.

### Solving problems with similar triangles

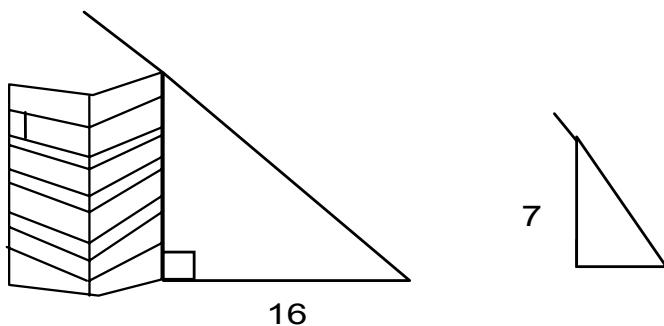
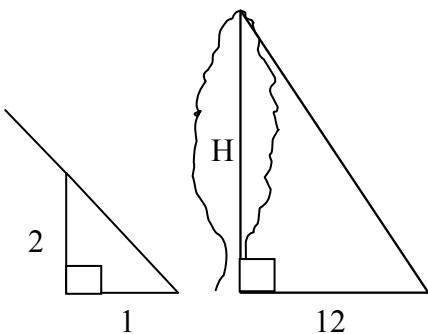
Mark out a wide ‘river’ in your school grounds, with a tree on one side.

Note: The ‘River’ could be a basketball court, or something marked out with a rope etc. The tree’ could be a real one or a pole used in surveying.

- With a partner mark out and measure the length AB, BC and CA
- Use these measurements to find the width of the ‘river’
- Check your answer by measuring the width of the ‘river’

### Group activity – Shadow stick

Activities using a shadow stick should be carried out in the early morning or late afternoon. At these times a long shadow is obtained which gives greater accuracy in calculations. From mid-morning to mid-afternoon, with the sun overhead, shadows are not long enough to be accurate.



### Trigonometry

People in professions who use trigonometry are surveyors, architects, engineers, geologists, navigators, cartographers, oceanographers, meteorologists and air traffic controllers.

- Find out what each of the above profession does and give an oral presentation in pairs or threes. Students must focus on the use of trigonometry by the above professions.

### Investigation into $30^\circ$ right – angled triangle

This is to show that the ratio of:  $\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$  for any right – angled triangle.

#### Steps

- Draw three different right-angled triangles each with a base angle of  $30^\circ$ .
- Complete the table below by accurately measuring in millimetres (mm) the sides of your three right-angled triangles.
  - Use a protractor to accurately draw the angles  $30^\circ$  and  $90^\circ$ .
  - Present orally or in written form.

Triangle	Side $AB$	Side $BC$	Side $AC$	Ratio $\frac{BC}{AB}$
1.				
2.				
3.				

- Find the sine ratio for each triangle to be 0.5? Why would there be differences?

Note:

The above activity can be done for cosine and tangent ratios as well.

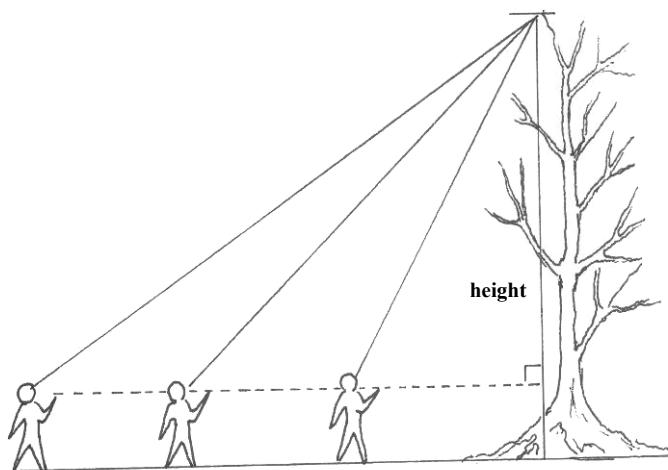
The above activity can be done either individually or in groups.

#### *Project 1*

In pairs, students make an inclinometer.

#### *Project 2*

- Select an object that to find the height of.
- In pairs or groups, measure the distance away from the base.
- Measure the angle of inclination at three different distances away from the height of the object.
- Find the average height.

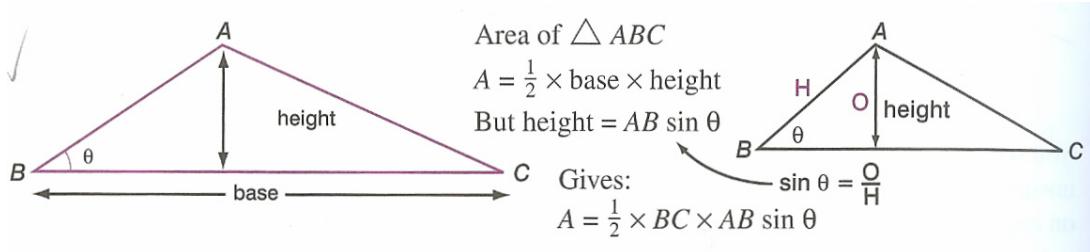


- Record information in a table as shown:

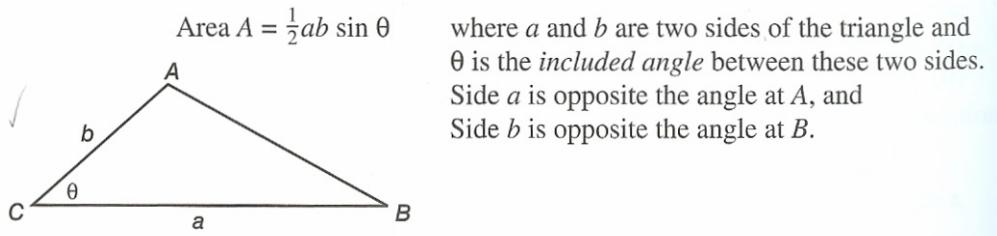
Object: -----			
My eye height: -----			
Base Length	Angle	Calculated height from eye	Total height
1.			
2.			
3.			
	Average height =		

## Areas of triangles

The area of any triangle is  $A = \frac{1}{2} \times \text{base} \times \text{height}$ . It is easy to find the base and height for a right-angled triangle - it is just the length of the sides adjacent to the right-angle. For other triangles students develop a formula to find the height.

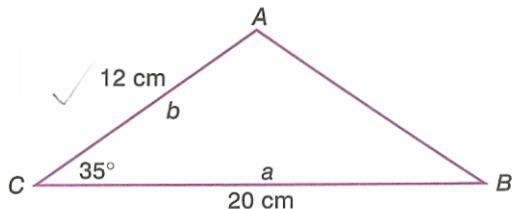


It can be simply written as



### Example

Find the area of the triangle ABC

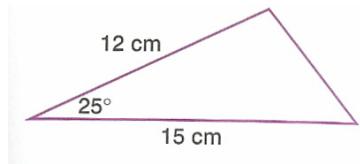


### Solution

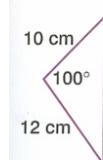
$$\begin{aligned}
 \text{Area } A &= \frac{1}{2}ab \sin \theta \\
 &= \frac{1}{2} \times 20 \times 12 \times \sin 35^\circ \\
 &= 68.83 \text{ cm}^2
 \end{aligned}$$

*Other examples*

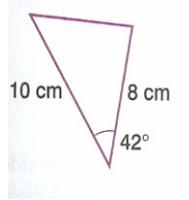
Use these to set new examples for your students:



a)



b)



c)

## Performance standards

Assessment task 2, the project in either option, should be assessed using the following performance standards based on the assessment criteria. The performance standards should be made available to students at the beginning of projects.

<b>Performance standards for assessment task 2: Option A – A survey of the local area such as the school grounds or Option B –The charting of a navigation route</b>				<b>Marks 50</b>
<b>Assessment Criteria</b>	<b>Very high achievement 45–50 marks</b>	<b>High achievement 35–44 marks</b>	<b>Satisfactory achievement 25–34 marks</b>	<b>Low achievement 0–24 marks</b>
(10 marks) Demonstrate appropriate investigation skills	9–10 marks Consistently stays focused on the task. Very self-directed. Actively collects information and creates insightful solutions to problems. Uses a wide range of resources.	7–8 marks Focused on the task most of the time. Collects information and finds standard solutions to problems. Uses at least two different resources.	5–6 marks Focused on the task some of the time. Collects information and finds solutions to problems with some assistance. Uses at least two different resources.	0–4 marks Rarely focuses on the task. Collects some information without providing adequate solutions. Uses at most one resource.
(30 marks) Choose and apply relevant mathematical techniques	26–30 marks Appropriate and efficient mathematical techniques used at all times The solution contains no mathematical errors, or almost none	20–25 marks Usually uses appropriate and effective mathematical techniques The solution contains few mathematical errors	15–19 marks sometimes uses appropriate and effective mathematical techniques but does not do it consistently The solution contains some major mathematical errors	0–9 marks Rarely uses an appropriate mathematical techniques The solution contains many mathematical errors
(10 marks) Make an effective communication of the project results	9–10 marks Work is presented in a well organised fashion that is easy to read or listen to and is easy to understand All project results communicated clearly	7–8 marks Work is presented in an organised fashion and is mostly easy to read and understand. Most project results communicated	5–6 marks Work is presented in a reasonably organised fashion but is not always easy to read or understand. Some project results communicated	0–4 marks Work appears sloppy and unorganised. It is hard to know what information goes together. Few if any project results communicated

## 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 broad learning outcomes.

To help you do this, descriptions of the levels of achievement of the broad learning outcomes are provided in the Broad 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 broad 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 broad learning outcomes.

There are four levels of achievement:

- Very high achievement
- High achievement
- Satisfactory achievement
- Low achievement.

**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 limited or very limited level of competence in the processes and skills.

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

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 – 199	100 – 139	40 – 99	0 – 39
100	90 – 100	70 – 89	50 – 69	20 – 49	0 – 19
50	45 – 50	35 – 44	25 – 34	10 – 24	0 – 9

### Sample format for recording assessment task results over two years

Grade 9			
Unit	Assessment task	Total marks	Student mark
9.1	Test	60	
9.2	Test	60	
9.3	Test	40	
9.4	Tests	40	
9.1	Research Project	40	
9.2	Directed Investigation	40	
9.3	Research Project	60	
9.4	Directed Investigation	60	
<b>Total marks for Grade 9</b>		<b>400</b>	

Grade 10			
Unit	Assessment task	Total marks	Student mark
10.1	Test	50	
10.2	Test	50	
10.3	Test	50	
10.1	Research Project	50	
10.2	Directed Investigation	50	
10.3	Research Project	50	
<b>Total marks for Grade 10</b>		<b>300</b>	
<b>Total marks for Grade 9 and 10</b>		<b>700</b>	
<b>Level of achievement</b>			

## Broad learning outcomes and levels of achievement

Levels of achievement in Grade 9 and Grade 10 are recorded and reported against the broad learning outcomes. There are five broad learning outcomes in Mathematics. The performance standards for the levels of achievement are described in the following table.

Broad Learning Outcome Performance Standards					
BLO's	Very High Achievement	High Achievement	Satisfactory Achievement	Low Achievement	Below Minimum Standard
<b>1 Demonstrate an understanding of traditional and contemporary mathematics in Papua New Guinea</b>	Demonstrate extensive knowledge and understanding of traditional and contemporary mathematics in Papua New Guinea	Demonstrate sound knowledge and understanding of traditional and contemporary mathematics in Papua New Guinea	Demonstrate knowledge and understanding of some traditional and contemporary mathematics in Papua New Guinea	Demonstrate knowledge and understanding of traditional and contemporary mathematics in Papua New Guinea with help	Failed to reach the minimum standard
<b>2 Identify and apply mathematical skills in everyday life</b>	Independently select and proficiently apply a wide range of appropriate mathematical skills in a variety of everyday situations	Independently select and apply a range of appropriate mathematical skills in a number of everyday situations	Identify and apply appropriate mathematical skills in everyday situations	Identify and apply some mathematical skills in one or two everyday situations	Failed to reach the minimum standard
<b>3 Investigate and solve mathematical problems</b>	Independently investigate and accurately solve a wide range of mathematical problems	Independently investigate and accurately solve a range of mathematical problems	Investigate and solve mathematical problems	Investigate and solve mathematical problems with help	Failed to reach the minimum standard
<b>4. Communicate mathematical processes and results both orally and in writing</b>	Communicate complex mathematical processes and results using an extensive range of written, graphic and oral forms	Communicate mathematical information using a broad range of written, graphic and oral forms.	Communicate mathematical information using a range of written, oral and graphic forms.	Communicate some mathematical information using a limited range of written, oral and graphic forms.	Failed to reach the minimum standard
<b>5 Undertake investigations individually and cooperatively in which mathematics can be applied to solve problems</b>	Can work independently and cooperatively with others to achieve team goals and meet team deadlines. Displays leadership qualities	Can work independently. Can set and meet own and group's goals and deadlines.	Works independently with direction. Contributes to group work.	Participates in team activities with direction	Failed to reach the minimum standard

**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 a 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 Broad Learning Outcomes performance descriptors**

*Student: Aki*

*Subject: Mathematics*

*School-based assessment: High achievement*

*This means Aki can:*

- Demonstrate sound knowledge and understanding of traditional and contemporary mathematics in Papua New Guinea
- Independently select and apply a range of appropriate mathematical skills in a number of everyday situations
- Independently investigate and accurately solve a range of mathematical problems
- Communicate mathematical information using a broad range of written, graphic and oral forms.
- Can work independently. Can set and meet own and group's goals and deadlines.

Note: For reporting to parents it might be necessary to translate the broad learning outcome descriptors into tokples if there is limited understanding of English.

## Resources

Learning becomes more interesting and meaningful when you use a variety of resources and materials in your teaching. You should look for existing resources and reference material in your school. Any mathematic text books can be used for new or different ideas and can be useful for planning your lessons.

You should be always trying to adapt, improvise, make or write material that will be useful for lessons in any subject. Collections of newspapers, magazines, pamphlets, brochures, old gazettes, posters can be very useful. There are many resources in schools which can be useful for more than one subject. One of the biggest resources are other teachers, especially teachers with local area knowledge.

### Selecting and using resources

Selecting and using appropriate resources to communicate information is a very important part of your task. Resources can help students learn more effectively by:

- helping to gain and maintain interest in a lesson
- encouraging mental involvement and the use of different senses while learning
- making learning more meaningful by linking in with previous knowledge
- catering for students who learn best through different senses – for example, some students learn best through listening, while others learn best through seeing, touching, tasting, or a combination of these four ways
- helping in the recall of information
- making explanations of difficult concepts and skills clearer
- encouraging independent learning.

### Types of resources

#### Print materials

- Text books, reference books
- Magazines
- Project kits
- Simulation games
- Diagrams, maps, charts, graphs
- Posters
- Worksheets, information sheets
- Pamphlets, brochures

**Audio visual material**

- Computer software, interactive video
- Overhead transparencies

**Materials and artefacts**

- Pictures, photographs
- Chalk/whiteboard, felt boards
- Models, globes
- Newspapers
- Documents and reports
- Personal items
- Equipment

**Natural and human resources**

- Banks and offices, shops, trade stores, supermarkets
- Hotels, guest houses
- Built structures – buildings, bridges, dams, power stations
- Local workers, business people, government officers
- Community elders
- Teachers
- Parents

It is important to relate people to topics being taught. For example when doing mathematics use a range of people such as a community elder who is knowledgeable about the population of the community, a carpenter who uses trigonometry in buildings and a local business person who keeps accounts of their daily transactions.

Use people who make good role models, for example a businesswoman rather than a businessman. It is important for students to know about people who are a success in non-traditional roles.

It is important to take students outside the school to expose them to the 'real world'. There is usually something in every topic which can be done outside.

**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.

- Should the resource be radio, film, video or television, introduce the program by outlining the content. You might also set some questions to guide listening or viewing. Follow-up after using the resource by discussing and drawing appropriate conclusions.

## 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, e.g. 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 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, 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.

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### Useful websites

[www.forum.swarthmore.edu/](http://www.forum.swarthmore.edu/)

NCTM – National Council of Teachers of Mathematics

[www.nilesonline1.com/stats/](http://www.nilesonline1.com/stats/)

[www.TheMathsForum.Drexel](http://www.TheMathsForum.Drexel)

[www.aamt.edu.au](http://www.aamt.edu.au)

[www.curriculum.edu.au](http://www.curriculum.edu.au)

[www.kn.pacbell.com/cgi-bin/listApps.pl?Mathematics](http://www.kn.pacbell.com/cgi-bin/listApps.pl?Mathematics)

[www.learner.org/exhibits/dailymath/](http://www.learner.org/exhibits/dailymath/)

[www.mmp/maths.org.uk/](http://www.mmp/maths.org.uk/)

[www.newhsc.schools.nsw.edu.au](http://www.newhsc.schools.nsw.edu.au)

[www.pbs.org](http://www.pbs.org)

[www.shu.ac.uk/schools/ed/mathss/model.htm](http://www.shu.ac.uk/schools/ed/mathss/model.htm)

[www.uog.ac.pg.glec](http://www.uog.ac.pg.glec)

The reference books and websites are also useful teacher resources.

# Glossaries

## 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 you and students understand what is expected in responses to examinations and assessment tasks.

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

<b>Extract</b>	Choose relevant and/or appropriate details
<b>Extrapolate</b>	Infer from what is known
<b>Identify</b>	Recognise and name
<b>Interpret</b>	Draw meaning from
<b>Investigate</b>	Plan, inquire into and draw conclusions about
<b>Justify</b>	Support an argument or conclusion
<b>Outline</b>	Sketch in general terms; indicate the main features of
<b>Predict</b>	Suggest what may happen based on available information
<b>Propose</b>	Put forward (for example a point of view, idea, argument, suggestion) for consideration or action
<b>Recall</b>	Present remembered ideas, facts or experiences
<b>Recommend</b>	Provide reasons in favour
<b>Recount</b>	Retell a series of events
<b>Summarise</b>	Express, concisely, the relevant details
<b>Synthesise</b>	Putting together various elements to make a whole

## Mathematics glossary

<b>AIDS</b>	AIDS stands for Acquired Immune Deficiency Syndrome. It is an incurable, fatal illness that has become a major problem in Papua New Guinea. It is caused by a virus called HIV that slowly destroys a person's immune system-its natural defence against common diseases like malaria, diarrhoea, or tuberculosis. The illness does not show up for 5 or more years after infection with HIV. By then, the person may have infected many others.
<b>Arbitrary units</b>	Non-formal units such as a length of stick that is repeatable
<b>Arm span</b>	Outstretched arms from finger tip to finger tip, the same as fathom as used in areas e.g. New Guinea Islands for shell money
<b>Bearing</b>	Horizontal direction of an object from an observer, expressed as an angle from a reference direction (e.g. compass bearing, true bearing, relative bearing).
<b>Diagonal</b>	An interval (line segment) joining two non-adjacent vertices of a polygon.
<b>Distance formula</b>	Gives the distance between points $(x_1, y_1)$ and $(x_2, y_2)$ . $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
<b>Expand</b>	To remove grouping symbols by multiplying each term inside the grouping symbols by the term outside.
<b>Experimental probability</b>	Determining the chance of an event occurring by observing what happens in a sample experiment. Each time we try an experiment is called a trial. The results of the trial are called outcomes. They are the scores that are counted. They are the scores that are counted.

	exp. prob = $\frac{\text{no. of times event occurred}}{\text{total number in sample}}$
<b>Factorise</b>	To write an expression as a product. The reverse of expanding.
<b>Fractional indices</b>	Another way of writing the 'root' of a number or term.
<b>Function</b>	A rule that relates one number to another. A variable quantity whose value depends upon the varying values of other quantities.
<b>Gradient</b>	the slope of a line or interval. It can be measured using the formula $\text{gradient} = \frac{\text{rise}}{\text{run}}$
<b>Gradient formula</b>	Gives the gradient of the interval joining $(x_1, y_1)$ to $(x_2, y_2)$ . $m = \frac{y_2 - y_1}{x_2 - x_1}$
<b>Gradient-intercept</b>	A way of writing the equation of a line, for example $y = 2x - 5, y = \frac{1}{2}x + 2$
<b>Form</b>	When an equation is arranged and written in the form $y = mx + c$ then $m$ is the gradient and $c$ is the y-intercept.
<b>Gross pay</b>	The amount of pay before any deductions such as income tax have been subtracted
<b>HIV</b>	The Human Immunodeficiency Virus. HIV affects the body by affecting the immune system. The immune system is the body's defence against infection by micro-organisms (bacteria and viruses) that cause disease.
<b>Income tax</b>	Tax paid to the government which is based on the level of income received
<b>Integers</b>	A whole number which may be positive, negative or zero. For example 7, -23, 0.
<b>Modelling</b>	Solving a problem by turning it into a sum.
<b>Negative indices</b>	Indicate the reciprocal of a term, for example $x^{-1} = \frac{1}{x}, x^{-n} = \frac{1}{x^n}$ . That is $5^{-1} = \frac{1}{5}, 2^{-3} = \frac{1}{8}$
<b>Net pay</b>	The amount of pay an employee receives after deductions such as income tax have been subtracted
<b>Pace</b>	Step as in walking
<b>Power</b>	Another term for an index or exponent.
<b>Salary</b>	A fixed amount paid for a year's employment. It may be paid weekly or fortnightly.
<b>Sequence</b>	A set of numbers or observations arranged in a particular order. Each member in the set is related in some way to the one before it. Thus 2, 6, 18, 54, ... is a sequence, with each member the product of the previous number multiplied by 3.

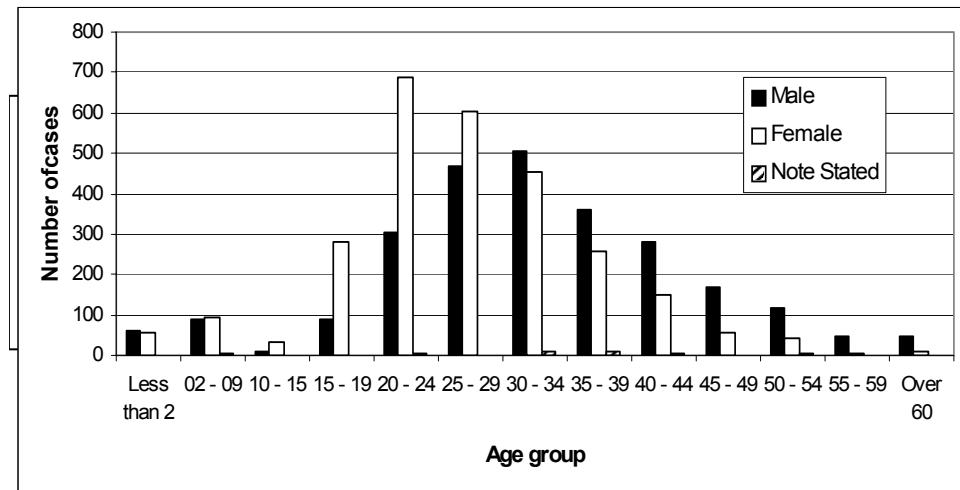
<b>Simulation</b>	A model of an experiment that would be too difficult or too time-consuming to actually perform. For example, an experiment which uses simple equipment such as cards or coins to represent a real event, Such as, using heads or tails to represent the birth of boys and girls.
<b>Standard units</b>	Usually refers to formal units like centimetre (cm) and metre (m), millilitre (mL) which have a standard such as International Metric Standards. Strictly speaking there is one e.g. metre standard unit for lengths
<b>Tessellations</b>	A pattern of shapes that fit exactly together. A regular tessellation is made up of regular polygons of one type and size only.
<b>Travel graph</b>	A line graph where distance travelled is plotted against time taken. The gradient (or slope) of the line is an indication of the speed of the motion.
<b>True bearing</b>	An angle measured clockwise from due north. It is usually written as three figures, so a direction of north-east is written as $045^\circ$ .
<b>Wages</b>	Pay given to an employee often based on an agreed hourly rate. Usually paid weekly or fortnightly.
<b>Zero indices</b>	A term or number with a zero index is equal to 1. For example $x^0 = 1, 4^0 = 1$

## Appendix

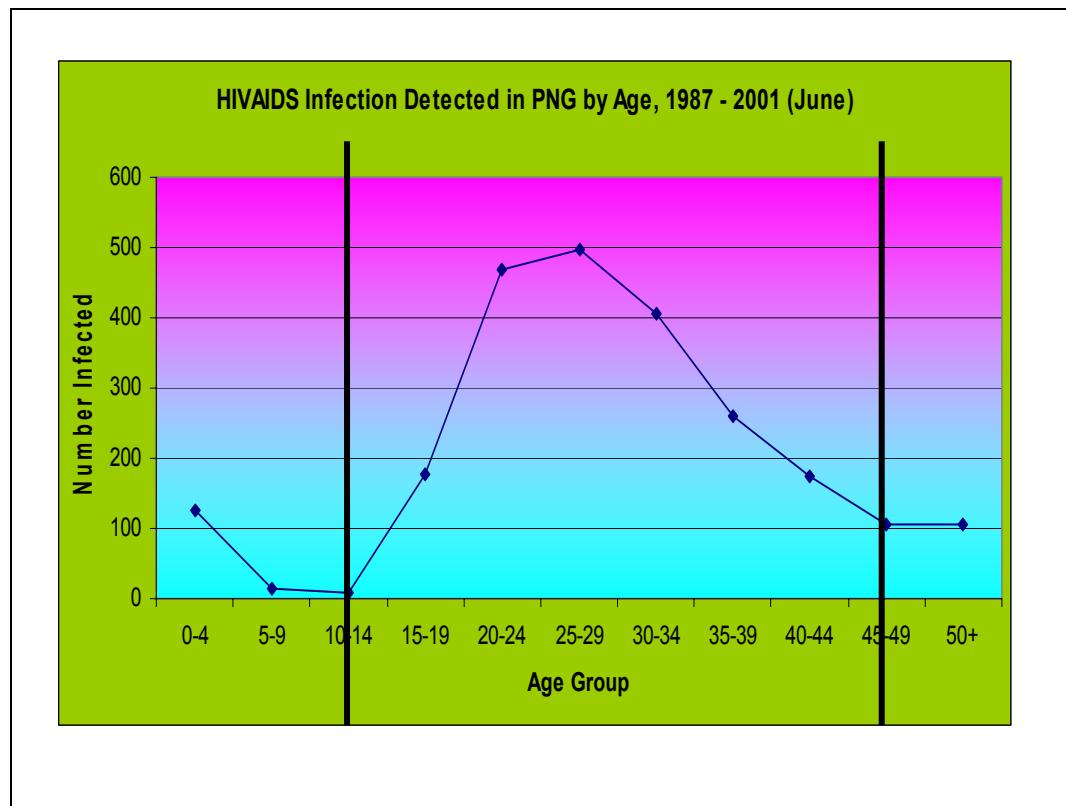
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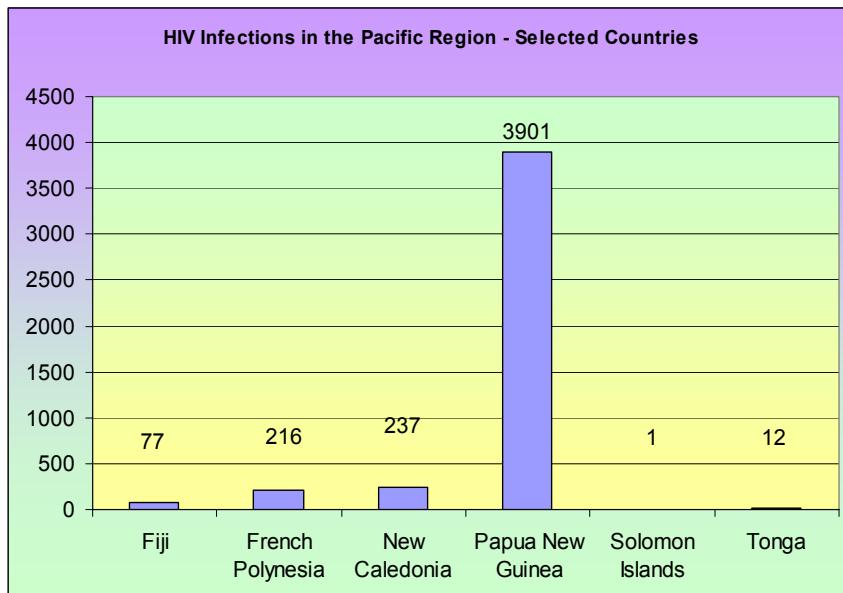
## HIV/AIDS graphs for unit 9.3

**HIV/AIDS infection detected in Papua New Guinea, 1987 - 31/12/2003**



Girls represent over double the number of cases as boys in age group 20–24.





### Relationship between HIV and development in PNG

- 40% of Port Moresby General Hospital bed occupancy is due to HIV related illnesses
- Over 70 % of infections in 15–24 year olds are in young women in PNG
- The worst affected age group is the next generation of professionals, i.e. 16 – 30 years olds
- With an estimated HIV prevalence of 2%, it is estimated that 600 teachers are already infected.

High HIV related bed occupancy puts stress on the whole health system: malaria/maternal morbidity and other illnesses have not reduced but the capacity (HR) to deal with them is being undermined by HIV.

The highest rates of infection are in young women between 14 and 19. Judging by high unmet contraceptive need, access and acceptability of sexual health and reproductive health services is unacceptably low.

With an estimated 600 teachers already infected what plans exist to meet the gaps in service delivery as a result?

## **SPORTSCARDS**

Press F9 for a new set of results, in Row 9 record how many rolls needed to get a full set.

ROLL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
RESULT	4	4	1	6	1	5	6	3	2	4	3	6	2	6	5	5	3	2	4	3	4	5	4	3	5	5	5	3	6	3	1	4	3	1	1	4	2	

### No of ROLLS NEEDED

AVERAGE  
13.8

## Unit 10.1 Cash flow

In finance, cash flow refers to the amounts of cash being received and spent by a business during a defined period of time, sometimes tied to a specific project.

Most of the time cash flows are being used to determine gaps in the liquid position of a company. For this reason only the total amount of cash flowing in and out of a company matters. However when using cash flows as a benchmark tool (for example when calculating the internal rate of return) it is better to separate the total cash flow into separate cash flows streams.

Another reason for separating the different types of flows is that it makes it much easier to read cash flows statements and to determine when earnings are being manipulated.

There are multiple types of flows of incoming and outgoing cash that are included in the total cash flow amount:

- Operational cash flows: Cash received or spent during the company's core business.
- Investment cash flows: Cash received or spent by buying or selling capital expenditures, investment or acquisitions.
- Financing cash flows: Cash received or spent during the moving of cash between the company and the debtors and creditors.

### Example of a positive cash flow of \$40

Transaction	In	Out
Incoming Loan	+K50.00	
Sales (which were paid for in cash)	+K30.00	
Materials		-K10.00
Labor		-K10.00
Purchased Capital		-K10.00
Loan Repayment		-K5.00
Taxes		-K5.00
Total	+K40.00	

In this example the following types of flows are included:

- Incoming loan: financial flow
- Sales: operational flow
- Materials: operational flow
- Labor: operational flow
- Purchased Capital: Investment flow
- Loan Repayment: financial flow
- Taxes: financial flow

## For use in unit 10.1

Number of years	Interest rate pa.		
	5%	10%	20%
1	1.05	1.10	1.20
2	1.10	1.21	1.44
3	1.16	1.33	1.73
4	1.22	1.46	2.07
5	1.28	1.61	2.49
6	1.34	1.77	2.99
7	1.41	1.95	3.58
8	1.48	2.14	4.30
9	1.55	2.36	5.16
10	1.63	2.59	6.19
11	1.71	2.85	7.43
12	1.80	3.14	8.92
13	1.89	3.45	10.70
14	1.98	3.80	12.84
15	2.08	4.18	15.41
16	2.18	4.59	18.49
17	2.29	5.05	22.19
18	2.41	5.56	26.62
19	2.53	6.12	31.95
20	2.65	6.73	38.34
21	2.79	7.40	46.01
22	2.93	8.14	55.21
23	3.07	8.95	66.25
24	3.23	9.85	79.50
25	3.39	10.83	95.40
26	3.56	11.92	114.48
27	3.73	13.11	137.37
28	3.92	14.42	164.84
29	4.12	15.86	197.81
30	4.32	17.45	237.38

## Sample mountain climbing map for a unit

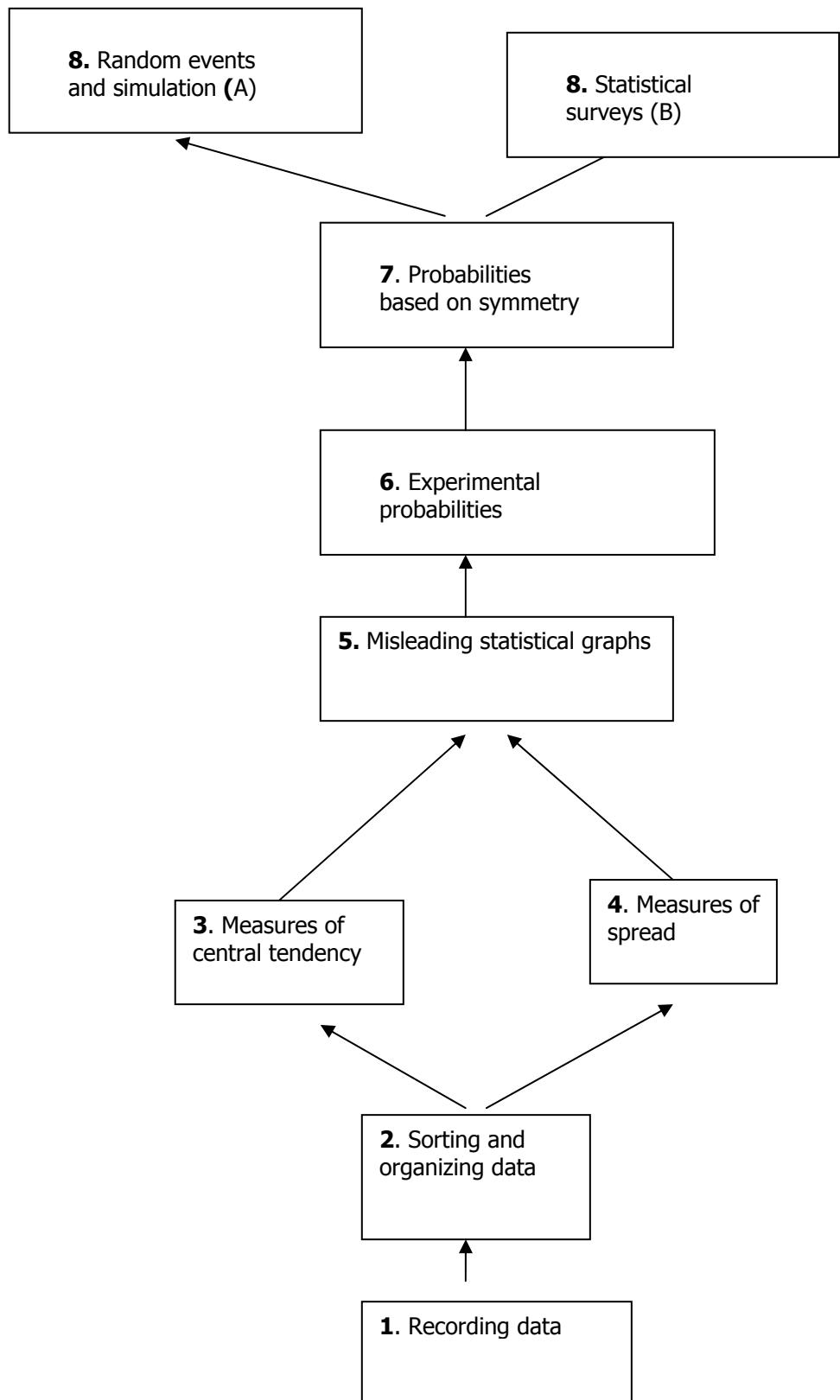
A concept map or mountain climbing map is something you can help students develop for a unit, one in grade 9 and one in grade 10. With your guidance students can work out the links between concepts or topics and also learn to fill in a self evaluation form about what they are learning. Students must also state reason for the link.

### Unit 9.3      Working with data

- Recording data
- Sorting and organising data
- Measures of central tendency
- Measures of spread
- Misleading statistical graphs
- Experimental probabilities
- Probabilities based on symmetry
- Random events and simulation (Option A)
- Statistical surveys (Option B)

Photocopy and give to students at the beginning of a unit

## Unit 9.3 Working with data



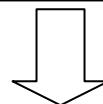
**Self-evaluation table**

Name

Class

**Unit 9.3 Working with data**

<input type="radio"/> ...I understood well	<input type="radio"/> ...I understood a little	<input type="triangle"/> ....I was not able to understand
--	--	---



Learning element	Self-evaluation	<ul style="list-style-type: none"> <li><b>I felt it was wonderful</b></li> <li><b>I would like to investigate more deeply</b></li> </ul>
1. Recording data		
2. Sorting and organising data		
3. Measures of central tendency		
4. Measures of spread		
5. Misleading statistical graphs		
6. Experimental probabilities		
7. Probabilities based on symmetry		
8. Random events and simulation (Option A)		
8. Statistical surveys (Option B)		

**Reason of the Arrow Line table****Unit 9.3 Working with data**

Arrow line	Reasoning for relationship between two learning elements
1 → 2	
2 → 3	
2 → 4	
3 → 5	
4 → 5	
5 → 6	
6 → 7	
7 → 8	