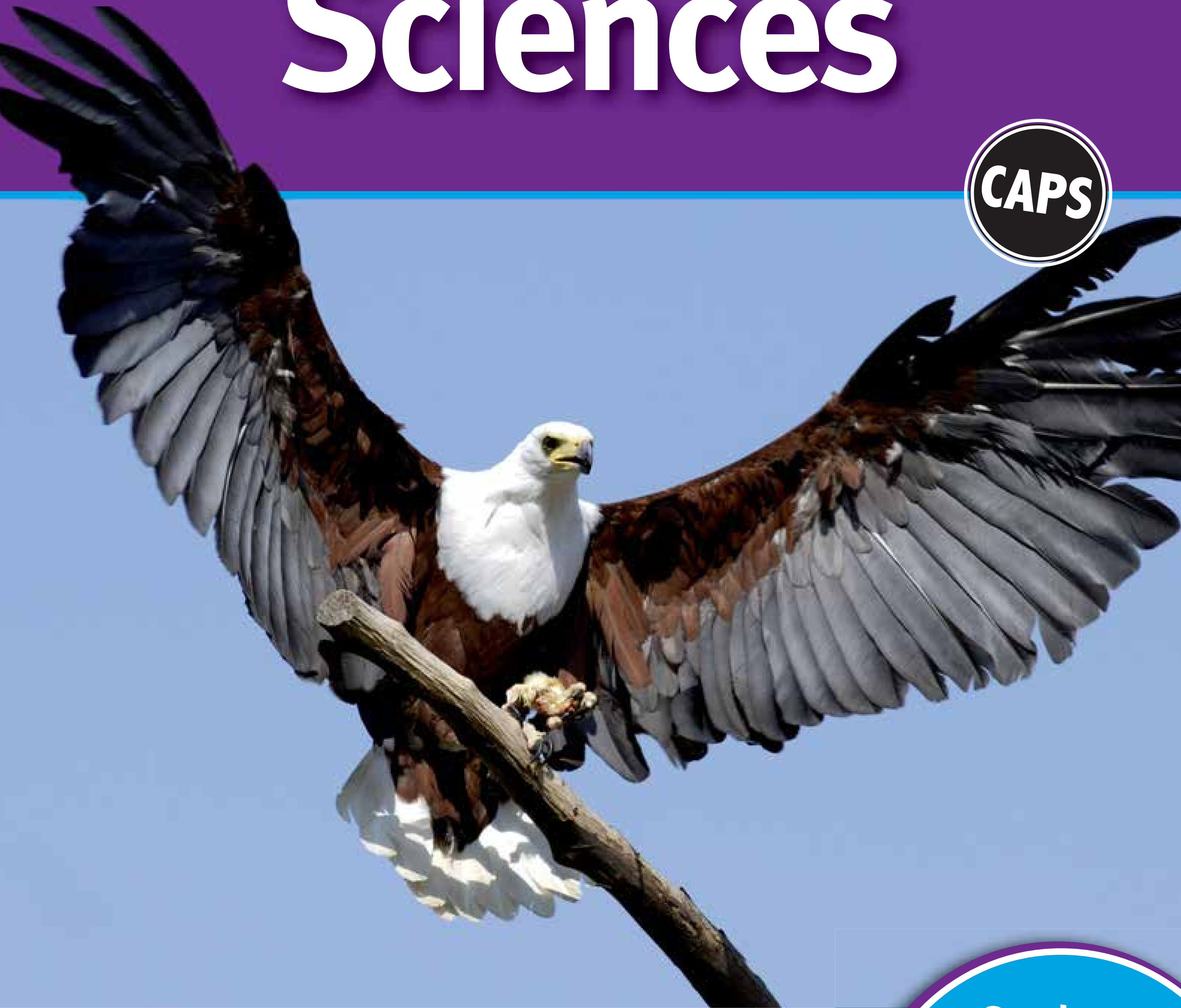
Study & Master

Physical Sciences

CAPS



Teacher's Guide

Grade 10

Karin H Kelder

Study & Master

Physical Sciences

Grade 10

Teacher's Guide

Karin H Kelder

CAMBRIDGE UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town,
Singapore, São Paulo, Delhi, Tokyo, Mexico City

Cambridge University Press
The Water Club, Beach Road, Granger Bay, Cape Town 8005, South Africa

www.cup.co.za

First published 2012

ISBN 978-1-107-38092-9

Cover image: *Haliaeetus vocifer*, commonly known as African Fish Eagle
© Ausloos Henry, FOTOSTOCK

Editor: Penny Adnams
Proofreader: Louis Botes
Typesetter: Baseline Publishing Services
Illustrators: Imar Krige, Tina Nel and James Whitelaw

Acknowledgements
The publishers and author would like to thank the following people at the University of
Stellenbosch who reviewed the text and acted as consultants:
Chemistry section: Dr D Haynes; Dr M Blackie
Physics section: Mr JJ van Zyl; Mr CH Dreyer; Dr S Wyngaardt

The publishers and author would like to thank Dr D Haynes for the photograph of the X-ray
diffusion on page D43.

If you want to know more about this book or any other Cambridge University Press publication,
phone us at +27 21 4127800, fax us at +27 21 419-8418 or send an e-mail to capetown@cambridge.org

Table of contents

Welcome to *Study & Master Physical Sciences* Grade 10. This course includes a Learner's Book and Teacher's File that provide the core material you need to cover the contents required by the Curriculum and Assessment Policy Statement for Grade 10 Physical Sciences.

In the Introduction you will find information about the core features of the National Curriculum and detailed advice on the Physical Sciences course in particular. Assessment is covered in Section B and explains how and when assessment should be done. Section B also contains three control tests with memoranda that can be used at the end of each term. Section C (Planning) contains a detailed phase plan, work schedule and lesson plan. The answers to all activities can be found in Section D. These include rubrics and checklists for formal and informal assessment of prescribed practical work. Section E contains photocopiable rubrics and sheets to record marks, and in Section F you can file your copy of the Curriculum and Assessment Policy Statement. You can also file your own documents in this section.

As a teacher at the Further Education and Training (FET) level, your two main resources are:

- your expertise in the subject
- your teaching experience – knowing how to help learners master the skills and knowledge of this subject.

The new Curriculum and Assessment Policy Statement (CAPS) makes two core demands on you as the teacher:

- to follow a learning programme that enables learners to develop all the skills, knowledge, values and attitudes relevant to Physical Sciences
- to have a sound, up-to-date knowledge of the content and methods of your subject, and a clear understanding of its social relevance, so that you can act as a guide, facilitator and subject expert in the classroom.

This handbook helps you to meet these demands in the following ways:

- It provides a structure for your teaching programme for the year and a work schedule that is in line with the CAPS requirements.
- It provides solutions to all the activities in the Learner's Book.
- It explains all the assessment requirements of the curriculum and provides practical activities with their rubrics and checklists that are required by CAPS.
- It contains examples of generic rubrics, checklists and assessment sheets that you can use or adapt for your assessment work throughout the year.

SECTION A

INTRODUCTION

The National Curriculum Statement Grades R to 12 (NCS), which stipulates policy on curriculum and assessment in the schooling sector, was amended, and the amendments begin to come into effect in January 2012. A single comprehensive **National Curriculum and Assessment Policy Statement** (CAPS) was developed for each subject to replace the old Subject Statements, Learning Programme Guidelines and Subject Assessment Guidelines in Grades R to 12.

General aims of the South African Curriculum

The National Curriculum Statement Grades R to 12 gives expression to knowledge, skills and values that are regarded to be worth learning. This statement will ensure that children acquire and apply knowledge and skills in ways that are meaningful to their own lives. In this regard, the curriculum promotes the idea of grounding knowledge in local context, while being sensitive to global imperatives.

The purpose of the National Curriculum Statement Grades R to 12

The National Curriculum Statement aims to:

- equip learners, irrespective of their socio-economic background, race, gender, physical ability or intellectual ability, with the knowledge, skills and values necessary for self-fulfilment and meaningful participation in society as citizens of a free country
- provide access to higher education
- facilitate the transition of learners from education institutions to the workplace
- provide employers with a sufficient profile of a learner's competences.

The principles of the National Curriculum Statement Grades R to 12

The principles of the National Curriculum Statement are:

- social transformation
- active and critical learning
- high knowledge and high skills
- progression
- human rights, inclusivity, environmental and social justice
- valuing indigenous knowledge systems
- credibility, quality and efficiency.

Social transformation

The Constitution of the Republic of South Africa forms the basis for social transformation in our post-apartheid society. Social transformation in education is aimed at ensuring that the educational imbalances of the past are redressed, and that equal educational opportunities are provided for all sections of our population.

What does this mean in your classroom? Your learners will come from families and communities that have been affected in diverse ways by South Africa's past. They will have many different ideas about the kind of future career they want and the kind of society they want to live in. In the learning programme that you plan for the year, you need to provide opportunities for the learners to analyse, research and come to understand the role that this particular subject plays in shaping the kind of society we want to create in South Africa and in offering them possibilities for their future.

For example: Create opportunities for learners to research and discuss questions such as how many people in their families have studied Physical

Sciences, and to what levels? How does access to Physical Sciences education relate to access to different kinds of employment? What factors influence people's access to and success in the subject?

Active and critical learning

The National Curriculum Statement encourages an active and critical approach to learning, rather than rote and uncritical learning of given truths. What does this mean in your classroom? Many of the laws and principles in Physical Sciences have been developed and formulated over centuries. You need to explain the background of how these laws and principles were developed and the meaning and application of their formulation. Make the learners aware that scientific models are man-made ideas to explain scientific phenomena. These models can change when new discoveries are made.

For example: The Law of Conservation of Mechanical Energy makes more sense when it is explained by using the transformation of energy in a pendulum or an object that falls vertically to the ground.

High knowledge and high skills

The National Curriculum Statement aims to develop a high level of knowledge and skills in learners. It specifies the minimum standards of knowledge and skills at each grade and sets high, achievable standards in all subjects.

What does this mean in your classroom? You, as a subject expert, should inspire your learners with relevant knowledge and activities that will encourage them to want to explore science in depth. Encourage them to relate what they learn to their lives outside school and to possible future career paths. Strive to develop a high level of knowledge and skills in this subject in all your learners.

For example: Relate the study of particular Physical Sciences topics to future career paths such as electrical, chemical, and mechanical engineering, astronomy, medical sciences, electrical and telecommunications technology and agriculture. Where possible, create opportunities for learners to meet professional practitioners in these and other relevant fields. Set projects that challenge learners to apply their science skills outside the school context. Inform them about what they can expect to learn if they enrol for higher education in related scientific subjects.

Progression

Progression refers to the process of developing more advanced and complex knowledge and skills. The content and context of each grade show progression from simple to complex.

What should this mean in your classroom? This Physical Sciences course contains material at the appropriate level to meet the criteria required for Grade 10. If you plan a learning programme using this course, you will ensure that your learners progress appropriately through the levels of knowledge and skills that the curriculum requires.

Human rights, inclusivity, environmental and social justice

The National Curriculum Statement is infused with the principles and practices of social and environmental justice and human rights as defined by the Constitution of the Republic of South Africa. In particular, they are sensitive to issues of diversity such as poverty, inequality, race, gender, language, age and disability.

What should this mean in your classroom? In all activities that you organise and facilitate, create opportunities to relate Physical Sciences to the broader social goal of promoting human rights, environmental justice and social justice. Take into account that some of your learners might grapple with issues such as poverty, language and disability in their daily lives. Encourage them to explore these issues in ways that relate to this subject.

For example: Identify a social issue of relevance in the learners' community and help them design a small research project to gather and analyse information about this issue. This could relate to the availability of basic services such as fresh water and the removal of waste.

Valuing indigenous knowledge systems

In the 1960s, the theory of multiple-intelligences forced educationists to recognise that there are many ways of processing information to make sense of the world. Now people recognise the wide diversity of knowledge systems through which people make sense of and attach meaning to the world in which they live.

Indigenous knowledge systems in the South African context refer to a body of knowledge embedded in African philosophical thinking and social practices that have evolved over thousands of years. The National Curriculum Statement acknowledges the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution.

What should this mean in your classroom? This Physical Sciences course contains material that draws on indigenous knowledge systems and encourages learners to take these systems into account in their research and practical work. You should also draw on the expertise in your subject that may be available in your local community. Compile information about individuals and organisations in your region that can support your classroom work by means of relevant indigenous knowledge to which they have access. Encourage learners to recognise sources of relevant indigenous knowledge in their own communities, and to include these sources in their research and practical project work.

For example: People from indigenous cultures have always found ways to collect and preserve uncontaminated water. By researching such water collection practices, we can learn how to minimise contamination of water resources.

Credibility, quality and efficiency

The National Curriculum Statement aims to achieve credibility through providing an education that is comparable in quality, breadth and depth to the curricula of other countries. We live in a world community in which knowledge and people are circulated all the time. It is important that other countries in the world recognise the qualifications acquired in the South African school system.

Qualities and skills of learners

The National Curriculum Statement aims to produce learners who are able to:

- identify and solve problems and make decisions using critical and creative thinking
- work effectively as individuals and with others as members of a team

- organise and manage themselves and their activities responsibly and effectively
- collect, analyse, organise and critically evaluate information
- communicate effectively using visual, symbolic and/or language skills in various modes
- use science and technology effectively and critically showing responsibility towards the environment and the health of others
- demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.

Inclusivity

Inclusivity should become a central part of the organisation, planning and teaching at each school. This can only happen if all teachers have a sound understanding of how to recognise and address barriers to learning and how to plan for diversity.

Inclusive education and training should:

- acknowledge that all children and youth can learn and that all children and youth need support
- accept and respect the fact that all learners are different and have different learning needs, which are equally valued
- enable education structures, systems and learning methodologies to meet the needs of the learner
- acknowledge and respect differences in children, whether due to age, gender, ethnicity, language, class, disability, HIV status, etc.
- maximise the participation of all learners in the culture and the curriculum of educational institutions and uncover and minimise barriers to learning.

What should this mean in your classroom? In this series of books the learners work together in groups and pairs, which gives them the opportunity to learn from each other, as well as at their own pace. The learning methodologies cater for learners with different learning abilities. We have included a wide range of activities in this series. This allows you to decide, based on your particular situation and the skills levels of your learners, which activities should be done by which learners. You could use some of the activities as extension work for more advanced learners and others as remedial work for learners requiring additional support. Gender is also addressed as both boys and girls are able to participate in all the activities. Learners also have the opportunity to learn about diversity within the subject matter covered.

Learners with physical barriers can work in groups or with a partner so they can be assisted where necessary. The teacher must therefore group learners with disabilities together with learners with other disabilities or no disabilities so they can support each other.

Special needs

In many classrooms, learners with special needs require additional attention; some learners require very little attention while others need more extensive help. As a teacher, be especially sensitive towards these learners without drawing too much attention to the learner's possible barrier to learning. Discretely make the fellow learners aware of the need to treat each other with respect without exception. This vital life skill should be engrained in all young people so that it becomes part of their personalities for the rest of their lives. The information that follows will assist you in addressing some of these special needs in your classroom in an inclusive way. Be aware of these and other special needs of learners in your classroom.

Partial sight or blindness: For partially sighted learners who find it difficult to read text, you could enlarge the text by using a photocopy machine. Also, ensure that these learners sit in the middle at the front of the class so that their poor eyesight does not become a barrier to their learning.

Alternatively – and especially in group work – read the text aloud to these learners. Remind the learners to read loudly, clearly and slowly as partially sighted and blind learners rely heavily on their memories. When doing experiments, these learners might not be able to see results. Train a few fellow learners with excellent social skills to convey results to their peers. It is also a good idea to let these learners stay in the groups where there are learners you have trained specially to help their challenged classmates.

Hard of hearing: Once again, these learners should sit in the front of the class. When giving instructions, or when reading text to these learners, the speaker or reader should face the learner directly and speak loudly and clearly, but without exaggerating. Learners who are hard of hearing learn to lip-read very early in life.

Impaired social skills: The nature of these difficulties varies, but could, in some cases, become a serious barrier to learning.

- Learners who are very shy or highly-strung might find class presentation extremely stressful. Although you should encourage them to develop this life skill, remember that you can never change someone's nature completely. Work gently with these learners – their shyness or nervousness may be the result of negative circumstances at home. Let them present their 'class presentations' in written form at first, and then move slowly as the year progresses, at first letting them present their work to one classmate only, then to a small group, and finally to the whole class.
- Children with ADS (Attention Deficit Syndrome, also known as ADD – Attention Deficit Disorder) will find it extremely difficult to work in groups or to sit still and concentrate for very long – in some cases having to listen for two minutes is too long. Learners with ADS could affect the class atmosphere and class discipline in a negative way, and although everyone will agree that the deficiency is no fault of their own, they should not be allowed to ruin their fellow learners' education.

The school should have a policy that parents must inform the school confidentially if their child suffers from ADS. If learners have been diagnosed, they could be on medication. It is essential that teachers are informed, otherwise the learner could be branded as 'extremely naughty', which would be unfair and result in inappropriate handling. Teachers should be very careful not to judge a 'naughty' learner too soon. ADS is quite common, and in some cases may not have been diagnosed.

Look out for a learner who:

- finds it difficult or even impossible to concentrate
- frequently interrupts the teacher with irrelevant or seemingly 'stupid' questions
- fidgets all the time to the point of irritating peers

- jumps up frequently and asks to go to the bathroom (or somewhere else) at inappropriate times
- shouts out answers or remarks when the class has been asked to put up their hands
- is unable to deal with group work or pair sessions – these periods are interpreted as a 'free for all'
- shows signs of aggression when fairly disciplined
- argues with the teacher when asked to keep quiet.

Please note that:
- the disorder is more prolific among boys than among girls
- diet could play role in controlling the disorder – fast foods and junk foods should be kept to a minimum.

Extreme poverty: This barrier to learning requires extreme sensitivity from the teacher. If you know that there are one or more learners in your class who come from poverty-stricken backgrounds, you could handle the situation as follows: Learners are often required to bring resources from home, especially in practical learning areas like Physical Sciences. Some learners may be unable to afford additional resource materials: magazines for research and making posters; cereal boxes; colour pencils or koki pens; paper plates; their own scissors; plastic straws; rulers; calculators. Keep a supply of these items in your classroom without informing your learners and unobtrusively give them to those learners you know have difficulty in acquiring them. Be careful not to encourage 'forgetters' to make use of this offer! You could ask community groups in your area, such as churches, to provide support in collecting supplies of materials for you to keep in your classroom.

The key to managing inclusivity is ensuring that barriers are identified and addressed by all the relevant support structures within the school community, including teachers, District-based Support Teams, Institutional-level Support Teams, parents and Special Schools as resource centres. To address barriers in the classroom, teachers should use various curriculum differentiation strategies such as those included in the Department of Basic Education's *Guidelines for Inclusive Teaching and Learning* (2010).

Time allocation

The instructional time in Grade 10 is shown in the table:

Subject		Time allocation per week (hours)
I	Home Language	4,5
II	First Additional Language	4,5
III	Mathematics	4,5
IV	Life Orientation	2
V	Three electives	12 (3 × 4 h)

Use the allocated time per week only for the minimum required NCS subjects as specified above, and not for any additional subjects added to the list of minimum subjects. Should a learner wish to take additional subjects, additional time must be allocated for these subjects.

Physical Sciences

Physical Sciences investigate physical and chemical phenomena. This is done through scientific inquiry, application of scientific models, theories and laws to explain and predict events in the physical environment.

This subject also deals with society's need to understand how the physical environment works to benefit from it and responsibly care for it. All scientific and technological knowledge, including Indigenous Knowledge Systems (IKS), is used to address challenges facing society. Indigenous knowledge is knowledge that communities have held, used or are still using. This knowledge has helped protect the environment for millennia. Some indigenous knowledge lends itself to science, but those examples that do not lend themselves to science are still knowledge. Physical Sciences challenges aspects such as the safe disposal of chemical waste, responsible utilisation of resources and the environment and addresses alternative energy sources.

Specific aims of Physical Sciences

Physical Sciences aims to equip learners with investigative skills that relate to physical and chemical phenomena such as investigating lightning or solubility. Examples of some of the skills that are relevant for the study of Physical Sciences are classifying, communicating, measuring, designing an investigation, drawing and evaluating conclusions, formulating models, hypothesising, identifying and controlling variables, inferring, observing and comparing, interpreting, predicting, problem-solving and reflective skills.

Physical Sciences aims to promote knowledge and skills in these fields:

- scientific inquiry and problem-solving
- the construction and application of scientific and technological knowledge
- an understanding of the nature of science and its relationships to technology, society and the environment.

The three specific aims are aligned to the three Learning Outcomes with which teachers are familiar. Within each aim, specific skills or competences have been identified. It is not advisable to try to assess each of the skills separately, nor is it possible to report on individual skills separately. However, well-designed assessments must show evidence that, by the end of the year, all of the skills have been assessed at a grade-appropriate level. There must be a clear link between the aims and the outcomes of learning. The processes of teaching, learning and assessment will provide the links between the specific aims and the achievement of the outcomes.

Physical Sciences prepare learners for future learning, specialist learning, employment, citizenship, holistic development, socio-economic development, and environmental management. Learners choosing Physical Sciences as a subject in Grades 10 to 12 can have improved access to academic courses in Higher Education as well as professional career paths related to applied science courses and vocational career paths. The Physical Sciences plays an increasingly important role in the lives of all South Africans owing to its influence on scientific and technological development, which are necessary for the country's economic growth and the social well-being of its people.

There are six main knowledge areas in the subject Physical Sciences. These are:

- Mechanics
- Waves, sound and light
- Electricity and magnetism
- Matter and materials
- Chemical change
- Chemical systems.

Developing language skills: Reading and writing

Teachers of Physical Sciences should be aware that they are also engaged in teaching language across the curriculum. This is particularly important for learners for whom the language of learning and teaching is not their home language. It is important to provide learners with opportunities to develop and improve their language skills in the context of learning Physical Sciences. It will therefore be critical to afford learners opportunities to read scientific texts, to write reports, paragraphs and short essays as part of the assessment, especially in the informal assessments for learning.

Time allocation of Physical Sciences in the curriculum

The teaching time for Physical Sciences in Grade 10 is 4 hours per week, with 40 weeks in total. The time allocated for teaching of the content, concepts and skills includes the practical work. These are an integral part of the teaching and learning process.

Number of weeks allocated	Content, concepts and skills (weeks)	Formal assessment (weeks)
40	30	10

Overview of topics

Topic	Grade	Content
Mechanics	Grade 10	**Introduction to vectors and scalars. Motion in one dimension** (reference frame; position; displacement and distance; average speed; average velocity; acceleration; instantaneous velocity; instantaneous speed). **Description of motion** (in words, diagrams, graphs and equations). **Energy** (gravitational potential energy; kinetic energy; mechanical energy; conservation of mechanical energy in the absence of dissipative forces) **30 hours**
	Grade 11	**Vectors in two dimensions** (resultant of perpendicular vectors; resolution of a vector into its parallel and perpendicular components). **Newton's Laws and application of Newton's Laws** (Newton's First, Second and Third Laws and Newton's Law of Universal Gravitation; different kinds of forces: weight, normal force, frictional force, applied (push, pull) tension (strings or cables); force diagrams, free body diagrams and application of Newton's Laws (equilibrium and non-equilibrium)) **27 hours**

Topic	Grade	Content
Mechanics	Grade 12	**Momentum and impulse** (momentum; Newton's Second Law expressed in terms of momentum; conservation of momentum and elastic and inelastic collisions; impulse). **Vertical projectile motion in one dimension (1D)** (vertical projectile motion represented in words, diagrams, equations and graphs). **Work, energy and power** (work; work-energy theorem; conservation of energy with non-conservative forces present; power). **28 hours**
Waves, sound and light	Grade 10	**Transverse pulses on a string or spring** (pulse; amplitude; superposition of pulses). **Transverse waves** (wavelength; frequency; amplitude; period; wave speed). **Longitudinal waves** (on a spring; wavelength; frequency; amplitude; period; wave speed; sound waves). **Sound** (pitch; loudness; quality (tone); ultrasound). **Electromagnetic radiation** (dual (particle/wave) nature of electromagnetic (EM) radiation; nature of EM radiation; EM spectrum; nature of EM as particle – energy of a photon related to frequency and wavelength). **16 hours**
	Grade 11	**Geometrical optics** (refraction; Snell's Law; critical angles and total internal reflection). **2D and 3D Wave fronts** (diffraction). **13 hours**
	Grade 12	**Doppler effect** (either moving source or moving observer) (with sound and ultrasound; with light – red shifts in the universe). **6 hours**
Electricity and magnetism	Grade 10	**Magnetism** (magnetic field of permanent magnets; poles of permanent magnets; attraction and repulsion; magnetic field lines; Earth's magnetic field; compass). **Electrostatics** (two kinds of charge; force exerted by charges on each other (descriptive); attraction between charged and uncharged objects (polarisation); charge conservation; charge quantisation). **Electric circuits** (emf; potential difference (pd); current; measurement of voltage (pd) and current; resistance; resistors in parallel). **14 hours**
	Grade 11	**Electrostatics** (Coulomb's Law; electric field). **Electromagnetism** (magnetic field associated with current-carrying wires; Faraday's Law). **Electric circuits** (energy; power). **20 hours**
	Grade 12	**Electric circuits** (internal resistance and series-parallel networks). **Electrodynamics** (electrical machines (generators, motors); alternating current). **12 hours**

Topic	Grade	Content
Matter and materials	Grade 10	Revise **matter and classification** (materials; heterogeneous and homogeneous mixtures; pure substances; names and formulas; metals and non-metals; electrical and thermal conductor and insulators; magnetic and non-magnetic materials). **States of matter and the Kinetic Molecular Theory**. Atomic structure (models of the atom; atomic mass and diameter; protons, neutrons and electrons; isotopes; energy quantisation and electron configuration). **Periodic Table** (position of the elements; similarities in chemical properties in groups; electron configuration in groups). **Chemical bonding** (covalent bonding; ionic bonding; metallic bonding). Particles substances are made of (atoms and compounds; molecular substances and ionic substances). **28 hours**
	Grade 11	**Molecular structure** (a chemical bond; molecular shape; electronegativity and bond polarity; bond energy and bond length). Intermolecular forces (chemical bonds revised); types of intermolecular forces; states of matter; density; kinetic energy; temperature; three phases of water (macroscopic properties related to sub-microscopic structure). **Ideal gases** (motion and kinetic theory of gases; gas laws; relationship between T and P). **24 hours**
	Grade 12	**Optical phenomena and properties of materials** (photo-electric effect; emission and absorption spectra). **Organic chemistry** (functional groups; saturated and unsaturated structures; isomers; naming and formulae; physical properties; chemical reactions (substitution, addition and elimination). **Organic macromolecules** (plastics and polymers). **16 hours**
Chemical systems	Grade 10	**Hydrosphere. 8 hours**
	Grade 11	**Lithosphere.** (mining; energy resources). **8 hours**
	Grade 12	**Chemical industry.** (fertiliser industry). **6 hours**
Chemical change	Grade 10	**Physical and chemical change** (separation by physical means; separation by chemical means; conservation of atoms and mass; Law of Constant Composition; conservation of energy). **Representing chemical change** (balanced chemical equations). **Reactions in aqueous solution** (ions in aqueous solutions; ion interaction; electrolytes; conductivity; precipitation; chemical reaction types). **Stoichiometry** (mole concept). **24 hours**

Topic	Grade	Content
Chemical change	Grade 11	**Stoichiometry** (molar volume of gases; concentration; limiting reagents; volume relationships in gaseous reactions). **Energy and chemical change** (energy changes related to bond energy; exothermic and endothermic reactions; activation energy). **Types of reactions** (acid-base; redox reactions; oxidation numbers). **28 hours**
	Grade 12	**Reaction rate** (factors affecting rate; measuring rate; mechanism of reaction and of catalysis). **Chemical equilibrium** (factors affecting equilibrium; equilibrium constant; application of equilibrium principles). **Acids and bases** (reactions; titrations; pH; salt hydrolysis). **Electrochemical reactions** (electrolytic and galvanic cells; relation of current and potential to rate and equilibrium; standard electrode potentials; oxidation and reduction half-reaction and cell reactions) oxidation numbers; application of redox reactions). **28 hours**

Overview of practical work

Integrate practical work with theory to strengthen the concepts you are teaching. These may take the form of simple practical demonstrations or even an experiment or practical investigation. There are several practical activities in the Learner's Book. Some of these practical activities will be done as part of formal assessment and others can be done as part of informal assessment.

Overview of formal assessment and recommended informal experiments

For Grade 10 two prescribed experiments are done as formal assessment per year – there is one physics experiment and one chemistry experiment (one experiment per term for Terms 1 and 2). One project is done per year as formal assessment either in physics or in chemistry or an integrated chemistry/physics project (started in Term 1 and assessed in Term 3). The learners can do any one of the projects described in the Learner's Book, any one of the experiments described as a practical investigation or any other topic of choice as a project. It is recommended that the teacher gives the learners the project topic early in the first term so that learners can start the project. The final assessment of the project is done and recorded in the third term.

There are four recommended informal experiments for Grade 10.
The table lists prescribed practical activities for formal assessment as well as recommended practical activities for informal assessment.

Term	Prescribed practical activities for formal assessment	Recommended practical activities for informal assessment
1	Experiment 1 (Chemistry): Heating and cooling curve of water	Practical demonstration (Physics): Use a ripple tank to demonstrate constructive and destructive interference of two pulses OR Experiment (Chemistry): Flame tests to identify some metal cations and metals
2	Experiment 2 (Physics): Electric circuits with resistors in series and parallel – measuring potential difference and current	Investigation (Physics): Pattern and direction of the magnetic field around a bar magnet OR Experiment (Chemistry): Prove the conservation of matter experimentally
3	Project: Chemistry: Purification and quality of water OR Physics: Acceleration	Experiment (Physics): Roll a trolley down an inclined plane with a ticker-tape attached to it and use the data to plot a position versus time graph OR Experiment (Chemistry): Reaction types; precipitation, gas-forming, acid–base and redox reactions
4		Experiment (Chemistry): Test water samples for carbonates, chlorides, nitrates, nitrites, pH and look at water samples under the microscope

Weighting of topics (40 week programme)

Mechanics	18,75 %
Waves, sound and light	10,00 %
Electricity and magnetism	8,75 %
Matter and materials	17,50 %
Chemical change	15,00 %
Chemical systems	5,00 %
Total teaching time (theory and practical work)	75,00 %
Total time for examinations and control tests	25,00 %

SECTION B

ASSESSMENT



Assessment is a continuous planned process of identifying, gathering and interpreting information about the performance of learners, using various forms of assessment. It involves four steps:
1. Generating and collecting evidence of achievement.
2. Evaluating this evidence.
3. Recording the findings.
4. Using this information to understand and thereby assist the learner's development in order to improve the process of learning and teaching.

Assessment should be both informal (assessment for learning) and formal (assessment of learning). In both cases regular feedback should be provided to learners to enhance the learning experience.

Assessment is a process that measures individual learners' attainment of knowledge (content, concepts and skills) in a subject by collecting, analysing and interpreting the data and information obtained from this process to:
- enable the teacher to make reliable judgements about a learner's progress
- inform learners about their strengths, weaknesses and progress
- assist teachers, parents and other stakeholders in making decisions about the learning process and the progress of the learners.

Assessment should be mapped against the content, concepts, skills and aims specified for Physical Sciences and in both informal and formal assessments it is important to ensure that in the course of a school year:
- all of the subject content is covered
- the full range of skills is included
- a variety of different forms of assessment are used.

Informal or daily assessment

Assessment for learning has the purpose of continuously collecting information on a learner's achievement that can be used to improve their learning. Informal assessment is a daily monitoring of the learners' progress. This is done through observations, discussions, practical demonstrations, learner-teacher conferences, informal classroom interactions, etc. Informal assessment may be as simple as stopping during the lesson to observe learners or to discuss with learners how learning is progressing. Use informal assessment to provide feedback to the learners and to inform planning for teaching. Do not view informal assessment as separate from learning activities taking place in the classroom. The results of the informal daily assessment tasks are not formally recorded unless the teacher wishes to do so.

Learners or teachers can mark informal assessment tasks. Self-assessment and peer assessment actively involves learners in assessment. This is important as it allows learners to learn from and reflect on their own performance. Informal assessment also helps learners to take responsibility for their own learning and for the learning of their peers. In this way they develop a sense of self-discipline and commitment to each other's wellbeing.

The results of daily assessment tasks are not taken into account for promotional and certificate purposes. Use informal, ongoing assessments to structure the acquisition of knowledge and skills and as a precursor to formal tasks in the Programme of Assessment.

Using group work

Many teachers in South Africa work in overcrowded classrooms, which make learning difficult. You can overcome some of these problems by getting a class to work in groups. Practical work is normally done in groups, while many activities lend themselves to work in pairs. Smaller groups are easier to handle and learners will also start to feel more positive about themselves.

Teamwork is an important aspect of learning skills and constructing knowledge. Sharing the workload and being aware of personal contributions to the community is important for every learner. In a group, the different roles and responsibilities people take on are essential to the success of the activity. At the FET level, learners should become aware of the roles and responsibilities that are likely to be combined in 'professional' teams working in your particular subject areas in the real working world.

Setting up

Certain learning tasks are better approached through a whole class session; others lend themselves to group work. Working in pairs and in groups of three to six learners, learners have a chance to express themselves more often than when they are part of a class of forty or more. They learn to work in a team, helping each other freely when their knowledge or skill is strong, and being helped when it is weak. Some learners might be too shy to ask a question in front of a whole class, but feel at ease asking a small group of friends.

There are many ways of organising learners into groups. Here are some ideas.

- Language groups
  If you have learners with different home languages, you can put the speakers of each language into their own language group. Same-language groups enable all the learners to develop their understanding of a new concept in their own language. At other times you can create mixed-language groups. Learners working in their second language or third language can be helped with translation and have a greater chance to contribute than they would in a large class.

- Ability groups
  There are times when it is useful to divide learners into groups according to how well they achieve in the learning area. The top achievers in the class are grouped together, the average learners form a group, and the slowest learners are grouped together. Top achievers can do enrichment activities while you attend to the slower learners.

- Remediation groups
  When you have finished assessing some aspects of the learners' work, you may often find a few learners from different groups with the same problem. There may be a new concept they haven't quite grasped, or a few learners may have been absent at the same time while you were dealing with new work. You can then group them together temporarily while you help them sort out the problem.

- Mixed-ability groups
  These groups work well on their own while you circulate between them. Vary the members of these groups so that learners have experience in working with different classmates. For instance, new groups can be formed each time a new unit of work is started.

Guidelines for using group work

- When planning group work, you should decide on the composition of each group and not always leave it to learners to cluster together with those they work with most easily.
- Divide tasks fairly among the members of each group and each member must understand his role.
- Give the learners clear and concise instructions.
- Define the work to be done clearly so that the group can go ahead without constantly referring to you.
- Learners must be settled and attentive when instructions are given.
- You must monitor progress at all times and should not only take the end result into consideration. You should focus attention on how the group has interacted and progressed through each step. This will only be possible if you circulate amongst the groups and give information and guidance where and when it is required.
- Allow time for feedback so that learners have an opportunity to present evidence of their progress at the end of a session.
- Regular reminders of time limits and what progress should have been made at a particular stage are valuable when facilitating group work.
- Place groups as far apart as possible so that they enjoy a sense of privacy. Allow a certain amount of interaction as this often assists learners in solving problems or coping with complex areas.

Pair work

Pair work is easier to control than group work, particularly in large classes where it is difficult to re-arrange the seating. It is a very useful strategy for task-based teaching as it frees the teacher to be a facilitator, support guide and evaluator.

Pair work also allows for differentiation: faster working pairs can be given extra tasks; some pairs can be given more challenging tasks; in mixed ability pairing, one partner can assist the other.

Solving problems related to pair and group work

- Noise can become a problem. Differentiate between 'good learning noise' and 'disruptive chatter'. Firmly, remind learners that they might be disturbing neighbouring classes and that they should keep their voices down.
- Certain learners dominate a group, while others are idle and not actively involved. Each individual must understand his or her role or task, which should be constantly monitored. Use the report-back to assess each learner's involvement and progress.
- Learners may not like the partners they are paired or grouped with. There is no quick-fix solution to this problem. You must, however, use your knowledge of the learners and avoid grouping personalities or characters that are likely to clash.

Formal assessment

All assessment tasks that make up the formal programme of assessment for the year are regarded as formal assessment. Formal assessment tasks are marked and formally recorded by the teacher for progression and certification purposes. All formal assessment tasks are subject to moderation for the purpose of quality assurance and to ensure that appropriate standards are maintained.

Formal assessment provides teachers with a systematic way of evaluating how well learners are progressing in a grade and in a particular subject. Examples of formal assessments include tests, examinations, practical tasks, projects, oral presentations, demonstrations and performances. Formal assessment tasks form part of a year-long formal Programme of Assessment in each grade and subject.

Control tests and examinations

Control tests and examinations are written under controlled conditions within a specified period of time. Questions in tests and examinations should assess performance at different cognitive levels with an emphasis on process skills, critical thinking, scientific reasoning and strategies to investigate and solve problems in a variety of scientific, technological, environmental and everyday contexts. Examinations papers and control tests in the Physical Sciences in Grade 10 should adhere to the weighting of cognitive levels given in the table below. A detailed description of the cognitive levels follows on page B8.

Cognitive level	Description	Paper 1 (Physics)	Paper 2 (Chemistry)
1	Recall	15%	15%
2	Comprehension	35%	40%
3	Analysis, application	40%	35%
4	Evaluation, synthesis	10%	10%

Note: A control test and its memorandum for Terms 1, 2 and 3 can be found at the end of this section.

Practical investigations and experiments

Focus practical investigations and experiments on the practical aspects and the process skills required for scientific inquiry and problem-solving. Design assessment activities so that learners are assessed on their use of scientific inquiry skills such as planning, observing and gathering information, comprehending, synthesising, generalising, hypothesising and communicating results and conclusions. Practical investigations should assess performance at different cognitive levels and a focus on process skills, critical thinking, scientific reasoning and strategies to investigate and solve problems in a variety of scientific, technological, environmental and everyday context.

The difference between a practical investigation and an experiment is that an experiment is conducted to verify or test a known theory whereas an investigation is an experiment that is conducted to test a hypothesis, i.e. the result or outcome is not known beforehand.

For example: The effect of resistors in series and in parallel is known and the prescribed experiment on page 207 of the Learner's Book verifies the theory. The investigation to determine the effect of water depth on wave speed is a practical investigation because the outcome is not known beforehand. This practical investigation can be found on page 112 of the Learner's Book.

Projects

A project can take the form of one of the following activities:

- Making a poster (see recommended topics for Grade 10 in the table below).
- Construction of a device, e.g. an electric motor.
- Building a physical model of a concept in the FET Physical Sciences curriculum, e.g. the atomic model.
- Practical investigation.

Note: The assessment tools used, specifying the assessment criteria for each task, will be dictated by the nature of the task and the focus of the assessment. Assessment tools could be one or a combination of rubrics, checklists, observation schedules and memoranda. Photocopiable generic rubrics, checklists and assessment sheets can be found on pages E1 to E14 of this Teacher's File.

Recommended topics for Grade 10 posters

Physics topics	Chemistry topics
• Wave energy • Tsunamis • Solar energy • *Aurora borealis*	• The discovery of radioactivity • The purpose and applications of atmospheric chemistry • Chromatography

Requirements for Grade 10 practical work

In Grade 10 learners will do two prescribed experiments for formal assessment (one physics and one chemistry experiment) and one project on either physics or chemistry. This gives a total of three formal assessments in practical work in Physical Sciences.

It is recommended that learners do four experiments for informal assessment (two physics and two chemistry experiments). This gives a total of four informal assessments in practical work in Physical Sciences.

Practical work	Physics	Chemistry
Prescribed experiments (formal assessment)	1	1
Project (formal assessment)	1 in either physics or chemistry	
Experiments (informal assessment)	2	2
Total	7 practical activities	

The forms of assessment that the teachers uses should be appropriate for the age of the learners and their developmental level. The design of these tasks should cover the content of the subject and include a variety of tasks designed to achieve the objectives of the subject.

Assessment tools

Checklists

Checklists consist of separate statements describing how the teacher can expect the learners to perform in a particular task. These statements are the criteria that the learners must meet to succeed. When you observe that the learner has satisfied each statement on the list by doing what it describes, tick it off the statement. To work well, the statements on the list need to describe in clear, concrete terms what the expected performance actions are for the task.

Rubrics

Rubrics are a combination of rating codes and descriptions of standards, i.e., what the learner must do, the level of competence, etc., to be rated with a particular code. The rubric describes the range of acceptable performance in each band of the rating scale. Rubrics require teachers to know exactly what the learner must achieve, the level of competence, etc., to meet the particular outcome being assessed.

To design a rubric, you need to decide on the following:

- Which outcomes are being targeted?
- What kind of evidence should be collected?
- What are the different parts of the performance that will be assessed?
- What different assessment instruments best suit each part of the task?
- What knowledge should the learners demonstrate?
- What skills should learners apply or what actions should they take?

It is crucial that you share the criteria in the rubric for the task with the learners before they do the required task. The rubric clarifies both what the learners should do and what they should be learning as they carry out the task. It becomes a powerful tool for self-assessment.

When the learners have completed the task and you are assessing their performance, you need to be sure that:

- the learner is assessed only once for each criterion within the rubric
- you add comprehensive comments where necessary for later moderation purposes.

Rubrics and checklists in the Physical Sciences

The generic rubrics and checklists are in Section E: Photocopiable resources. Modify them for your needs and use them as a guideline to help you develop rubrics specifically for your activities and projects.

Programme of Formal Assessment

The Programme of Assessment is designed to spread formal assessment tasks in all subjects in a school throughout a term. In addition to daily assessment, teachers should develop a year-long formal Programme of Assessment for each grade. The learner's performance in this Programme of Assessment will be used for promotion purposes to Grade 11. Assessment is school-based or internal. The marks achieved in each of the assessment tasks that make up the Programme of Assessment must be reported to parents. The table illustrates an assessment plan and weighting of tasks in the Programme of Assessment for Physical Sciences Grade 10.

Programme of Assessment for Grade 10						
Assessment tasks (25%)						End-of-year assessment (75%)
Term 1		Term 2		Term 3		Term 4
Type	Marks	Type	Marks	Type	Marks	Final exam (2 × 150 marks)
Experiment	20	Experiment	20	Project	20	
Control test	10	Mid-year exam	20	Control test	10	
Total: 30 marks		Total: 40 marks		Total: 30 marks		Total: 300 marks
Total 400 marks						
Final mark = 25% assessment tasks + 75% final exam = 100%						

Note: Rubrics and checklists for prescribed experiments and projects are in Section D: Teaching guidelines

End-of-year examination

The end-of-year examination papers for Grade 10 will be internally set, marked and moderated, unless otherwise instructed by provincial Departments of Education. The internally set, marked and moderated examination will consist of two papers. The table below shows the weighting of questions across cognitive levels and the specification and suggested weighting of the content for Grade 10 end-of-year examinations across two papers.

Paper	Content	Marks	Total marks/ paper	Duration (hours)	Weighting of questions across cognitive levels			
					Level 1	Level 2	Level 3	Level 4
Paper 1: Physics focus	Mechanics	75	150	2	15%	35%	40%	10%
	Waves, sound and light	40						
	Electricity and magnetism	35						
Paper 2: Chemistry focus	Matter and materials	70	150	2	15%	40%	35%	10%
	Chemical change	60						
	Chemical systems	20						

Recording and reporting

Recording is a process in which the teacher documents the level of a learner's performance in a specific assessment task. It indicates learner progress towards the achievement of the knowledge and skills as prescribed in the Curriculum and Assessment Policy Statements. Records of learner performance should provide evidence of the learners' conceptual progression within a grade and their readiness to progress or be promoted to the next grade. Records of learner performance should also be used to verify the progress made by teachers and learners in the teaching and learning process.

Reporting is a process of communicating learner performance to learners, parents, schools and other stakeholders. Learner performance can be reported in a number of ways. These include report cards, parents' meetings, school visitation days, parent-teacher conferences, phone calls, letters, class or school newsletters, etc. Teachers in all grades report in percentages for the subject. The various achievement levels and their corresponding percentage bands are shown in the table on the next page.
Note: The seven point scale should have clear descriptions that give detailed information for each level. Teachers will record actual marks for the task by using a record sheet and report percentages for the subject on the learner's report card.

Rating code	Description of competence	Percentage
7	Outstanding achievement	80–100
6	Meritorious achievement	70–79
5	Substantial achievement	60–69
4	Adequate achievement	50–59
3	Moderate achievement	40–49
2	Elementary achievement	30–39
1	Not achieved	0–29

Schools are required to provide quarterly feedback to parents on the Programme of Assessment using a formal reporting tool, such as a report card. The schedule and the report card should indicate the overall level of performance of a learner.

Moderation of assessment

Moderation refers to the process that ensures that the assessment tasks are fair, valid and reliable. Moderation should be implemented at school, district, provincial and national levels. Comprehensive and appropriate moderation practices must be in place for the quality assurance of all subject assessments. All Grade 10 tasks are internally moderated. The subject head or head of department for Physical Sciences at the school will generally manage this process.

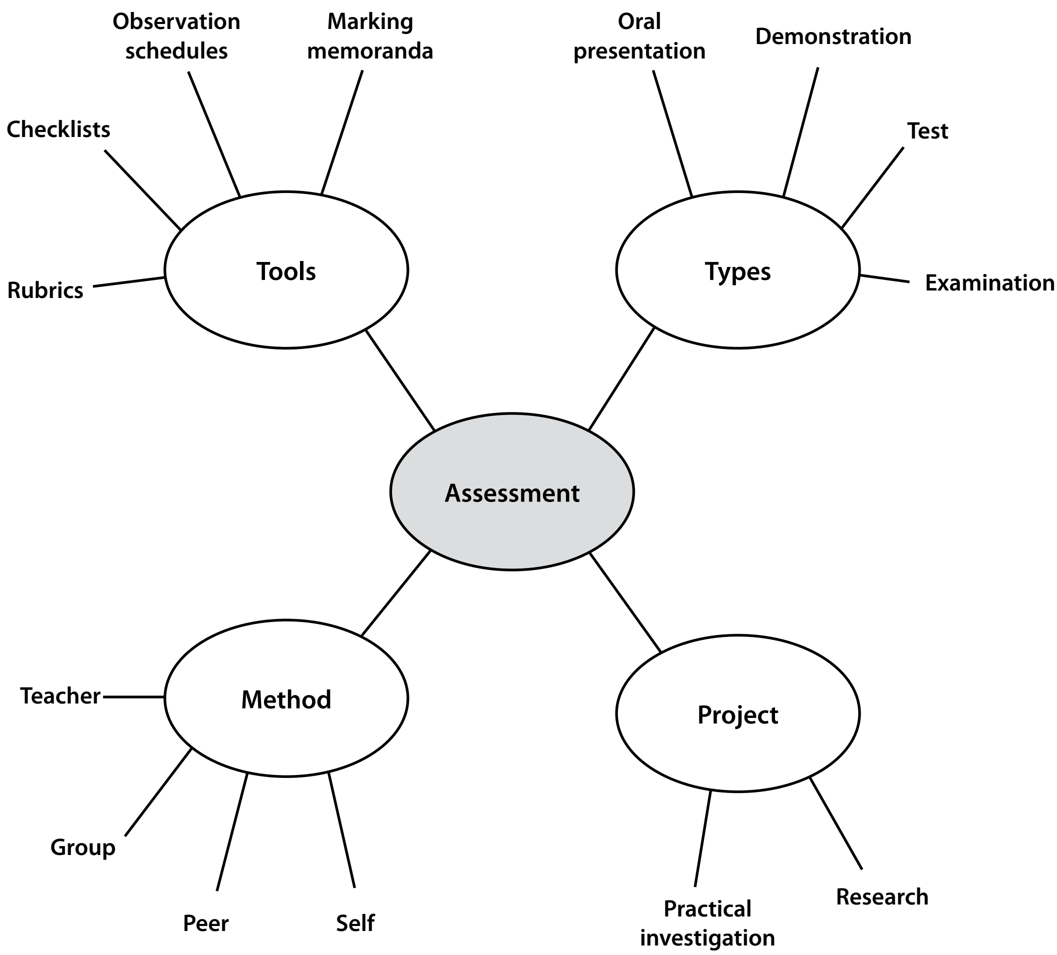
Physical sciences assessment taxonomy

The following table provides a possible hierarchy of cognitive levels that the teacher can use to ensure tasks include opportunities for learners to achieve at various levels and tools for assessing the learners at various levels. The verbs given in the fourth column could be useful when formulating questions associated with the cognitive levels given in the first column.

Description of cognitive	Level	Explanation	Skills demonstrated	Action verbs
Evaluation	4	At the extended abstract level, the learner makes connections not only within the given subject, but also beyond it, and generalises and transfers the principles and ideas underlying the specific instance. The learner works with relationships and abstract ideas.	• Compares and discriminates between ideas. • Assesses value of theories, presentations. • Makes choices based on reasoned arguments. • Verifies value of evidence. • Recognises subjectivity.	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarise, critique, appraise, interpret, justify
Synthesis	4	The learner works at the extended abstract level (see level 4 above) but makes errors because they are insufficiently informed at more modest levels.	• Uses old ideas to create new ones. • Generalises from given facts. • Relates knowledge from several areas. • Predicts and draws conclusions.	Combine, integrate, modify, rearrange, substitute, plan, create, design, invent, compose, formulate, prepare, generalise, rewrite, categorise, combine, compile, reconstruct, generate, organise, revise, what if?

Description of cognitive	Level	Explanation	Skills demonstrated	Action verbs
Analysis	3	The learner appreciates the significance of the parts in relation to the whole. Various aspects of the knowledge becomes integrated, the learner acquires deeper understanding and the ability to break down a whole into its component parts. Elements embedded in the whole are identified and the relations among the elements are recognised.	• Sees patterns and the organisation of parts. • Recognises hidden meaning. • Identifies components.	Analyse, separate, order, explain, connect, classify, arrange, divide, compare, select, infer, break down, contrast, distinguish, diagram, illustrate, identify, outline, point out, relate
Application	3	The learner establishes a relational construct (see level 3 above) but which has errors. The learner has the ability to use (or apply) knowledge and skills in new situations.	• Uses information, methods, concepts and theories in new situations. • Solves problems using required skills or knowledge.	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover, construct, manipulate, prepare, produce
Comprehension	2	A number of connections may be made but the meta-connections are missed, as is their significance for the whole. The learner has first level understanding, recalls and understands information and describes meaning.	• Understands information and grasps meaning. • Translates knowledge into new contexts and interprets facts. • Compares, contrasts, orders, groups and infers causes and predicts consequences.	Summarise, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend, comprehend, convert, defend, explain, generalise, give example, rewrite, infer
Recall	1	Simple and obvious connections are made. The learner recalls and remembers facts.	• Observes and recalls information.	List, define, tell, describe, identify, show, know, label, collect, select, reproduce, match, recognise, examine, tabulate, quote, name

Summary of assessment



Module 1: Matter and materials Units 1–5: 25 marks
Module 2: Waves, sound and light Units 1–5: 25 marks

1 Study the boiling points and melting points of the compounds listed in the table.

	Melting point (°C)	Boiling point (°C)
Nonane	–53	151
Propyne	–23	–103
Octadecane	28	317
Cyclohexene	–104	83

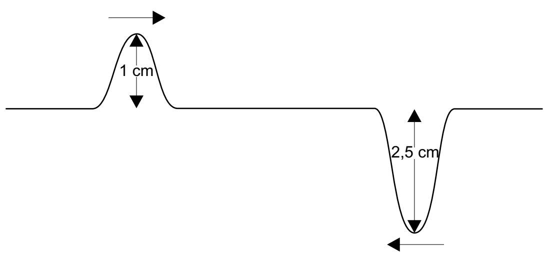
a) Identify which compounds are solids, liquids and gases at room temperature (25 °C). (4)
b) Give three properties of solids according to the Kinetic Molecular Theory. (3)
[7]

2 Magnesium has three stable isotopes.

Isotope	Percentage abundance
^{24}Mg	78,99
^{25}Mg	10,00
^{26}Mg	11,01

a) In what respect is the nuclear structure of these atoms the same? (1)
b) In what respect, and to what extent, does the nuclear structure of these atoms differ? (2)
c) What is the name given to atoms with such a relationship? (1)
d) Calculate the relative atomic mass of magnesium. (3)
e) Draw the orbital box diagram of the magnesium atom. (2)
f) In which orbital will you find the valence electrons of the magnesium atom? (1)
g) Write down the symbol of the magnesium ion. (1)
h) Name the type of bond that forms when magnesium reacts with iodine. (1)
i) Indicate the formation of the bond by making use of Lewis dot diagrams. (3)
j) Name three properties of this type of bond. (3)
[18]

3 Two wave pulses in a string approach each other, as shown in the diagram.



a) Draw the resultant pulse that forms when they meet. (1)
b) What will the magnitude of the resultant amplitude be? (2)
c) Name this phenomenon. (1)
[4]

4 Doctors use ultrasound scans to examine the foetus during pregnancy.
a) What type of wave is used in ultrasound scans? (1)
b) An ultrasound scan sends out a wave with a frequency of 8 MHz. The speed of the wave through bone is 3 400 $m \cdot s^{-1}$. (MHz = 10^6 Hz)
i) Calculate the wavelength of the ultrasound wave as it passes through bone. (3)
ii) Will the speed of the wave decrease or increase when it moves through soft tissue? Give a reason for your answer. (2)
iii) Will the wavelength of the waves increase, decrease or stay the same through soft tissue? (2)
c) Doctors also use X-rays to examine internal bones and organs.
i) What type of wave is an X-ray? (1)
ii) Give the main features of the type of wave mentioned in the previous question. (4)
iii) Calculate the energy of a photon in an X-ray if its wavelength is 0,05 nm. (1 nm = 10^{-9} m). (5)
d) Explain why doctors prefer to use ultrasound scans when examining the foetus during pregnancy. (3)
[21]

Total: 50

1 a) Solid: octadecane ✓
Liquids: nonane ✓; cyclohexene ✓
Gas: propyne ✓ (4)

b) Particles in solids are bonded in fixed positions. ✓
There are strong forces between particles. ✓
Solids have high density with small spaces between particles. ✓
Particles vibrate about their rest positions.
Solids are not compressible. (3)

[7]

2 a) All the magnesium atoms have 12 protons. ✓ (1)

b) Mg-24 has 12 neutrons, Mg-25 has 13 neutrons and Mg-26 has 14 neutrons. ✓✓ (2)

c) These are isotopes. ✓ (1)

d) Relative atomic mass $= \frac{(24 \times 78{,}99) + (25 \times 10{,}00) + (26 \times 11{,}01)}{100}$ ✓✓
$= 24{,}32$ ✓ (3)

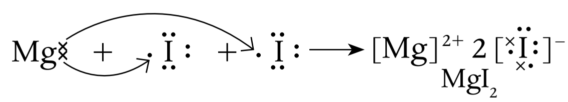
e) (↑↓) 3s
(↑↓) (↑↓) (↑↓) 2p
(↑↓) 2s
(↑↓) 1s
Mg ✓✓ (2)

f) Valence electrons are in the 3s orbital. ✓ (1)

g) Mg^{2+} ✓ (1)

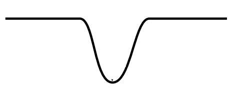
h) Ionic bond ✓ (1)

i) ✓✓ ✓ (3)



j) In an ionic bond:
Electrons are transferred from the metal to the non-metal. ✓
The metal forms a positive ion and the non-metal forms a negative ion. ✓
The ions pack into a crystal lattice and are held together by ionic bonds (electrostatic forces). ✓ (3)

[18]

3 a)  ✓ (1)

b) Resultant amplitude: 2,5 cm – 1 cm = 1,5 cm ✓✓ (2)

c) Superposition: destructive interference ✓ (1)

[4]

4 a) Longitudinal waves ✓ (1)

b) i) $\lambda = \frac{v}{f}$ ✓ $= \frac{3\,400 \text{ m}\cdot\cancel{\text{s}^{-1}}}{8 \times 10^{6}\ \cancel{\text{Hz}}}$ ✓ $= 4{,}25 \times 10^{-4}$ m ✓ (3)

ii) Decrease ✓; soft tissue is less dense than bone and waves will move more slowly though it. ✓ (2)

iii) Decrease ✓; $\lambda \propto v$; f is determined by the frequency of the source and stays constant. (2)

c i) Electromagnetic wave ✓ (1)

ii) Electric ✓ and magnetic fields ✓ oscillate at right angles ✓ to each other and to the direction of propagation of the wave. They carry energy and move at 3×10^8 m·s^{-1} through a vacuum. ✓ (4)

iii) $E = \frac{hc}{\lambda}$ ✓ $= \frac{(6{,}63 \times 10^{-34}\ \text{J}\cdot\cancel{\text{s}})\ ✓\ (3 \times 10^8\ \cancel{\text{m}}\cdot\cancel{\text{s}^{-1}})\ ✓}{0{,}05 \times 10^{-9}\ \cancel{\text{m}}\ ✓} = 3{,}98 \times 10^{-15}$ J ✓ (5)

d) Ultrasound waves carry little energy ✓ and cannot damage ✓ the foetus. It is a safe procedure. X-rays are high-energy waves ✓ and they can damage the cells of living tissues and cause mutations, cancer and cell death. (3)

[21]

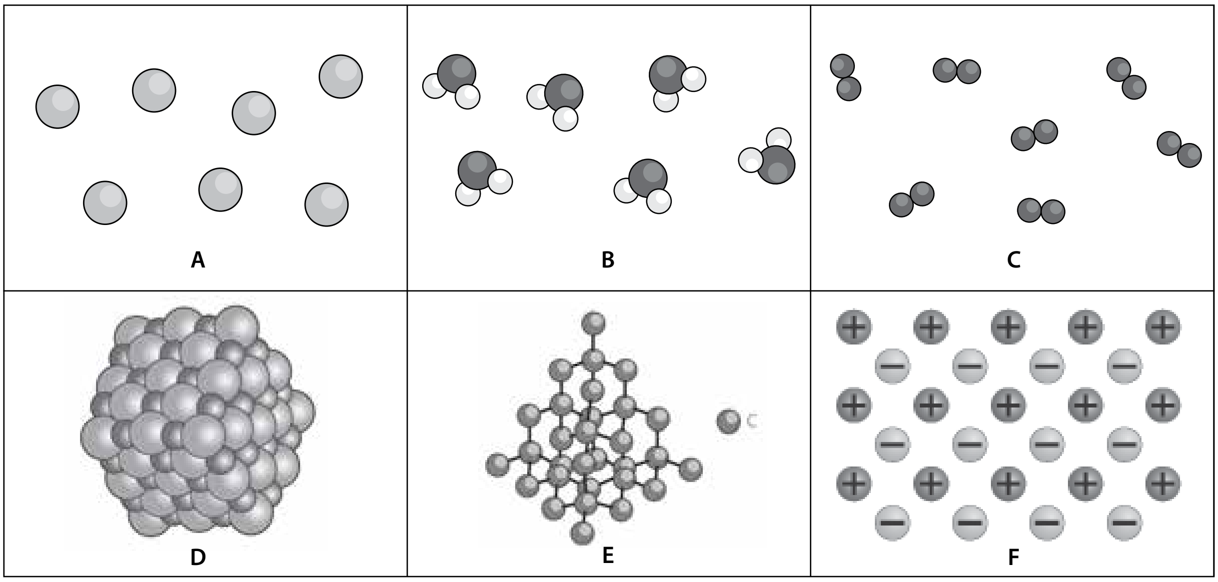
Total: 50

Formal assessment task — Control test

TERM 2

Module 1: Matter and materials Unit 6: 13 marks
Module 3: Chemical change Units 1–2: 12 marks
Module 4: Electricity and magnetism Units 1–3: 25 marks

1 Atoms are the building blocks of elements and compounds. The diagrams show different ways of combining atoms.



a) Copy and complete the table below by choosing the correct grouping of atoms. Use only the given symbol.

The atoms are arranged to form	Symbol
Diatomic molecules	
A metal	
A noble gas	
A covalent network structure	
An ionic salt	
A covalent molecular substance	

(6)

b) Name a substance that would look like the compounds in B. (1)

c) D, E and F show solid structures. Complete the table below.

	D	E	F
Electron arrangement during bonding process			
Example			

(6)

[13]

2 When sulfur dioxide gas dissolves in rain water, acid rain is formed. This is a form of air pollution that causes widespread damage to the environment.

a) Write a balanced equation for the dissolution process of sulfur dioxide in water. Include the state symbols. (5)

b) Is this a physical or chemical change? Explain your answer. (3)

c) Represent the equation using circles for atoms to show that atoms are conserved and molecules are not. (4)

[12]

3 Two bar magnets are placed close together with their north poles facing each other. Draw the field lines that show the magnetic field between the two magnets. [4]

4 Two small, identical, conducting balls on insulated stands carry charges of +9 nC and +2 nC respectively.

a) Will the charges attract or repel each other? (1)

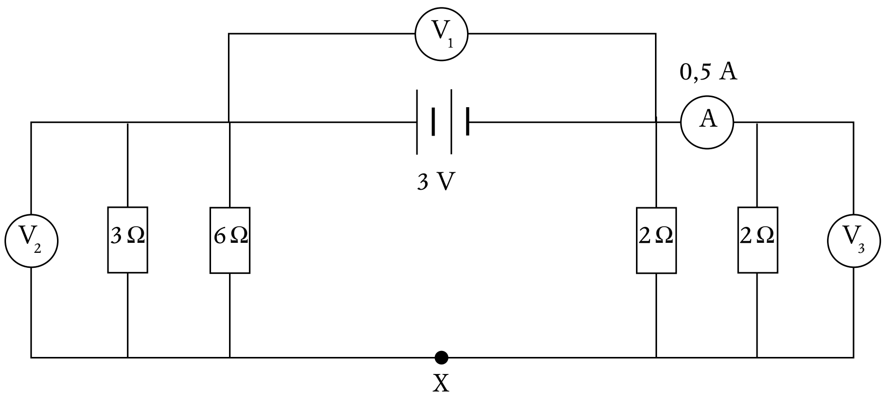
b) The balls are allowed to touch. Calculate the new charges on the balls. (2)

c) Did the +9 nC ball lose or gain electrons to reach its new charge in Question 4b)? (1)

d) How many electrons were transferred to/from the +9 nC ball in Question 4b)? (4)

[8]

5 In the circuit below four resistors are connected as shown. Ignore the resistances of the battery, ammeter and voltmeters.



a) Give the emf of the battery. (1)

b) Calculate the equivalent resistance of the circuit. (4)

c) Give the strength of the current at point X. (2)

d) Calculate the charge that flows past point X in 3 minutes. (3)

e) Give the reading on V_3 if the reading on V_2 = 2 V. (3)

[13]

Total: 50

1 a)

The atoms are arranged to form	Symbol
Diatomic molecules	C ✓
A metal	F ✓
A noble gas	A ✓
A covalent network structure	E ✓
An ionic salt	D ✓
A covalent molecular substance	B ✓

(6)

b) Water or sulfur dioxide ✓ (1)

c)

	D	E	F
Electron arrangement during bonding process	Electrons are transferred ✓	Electrons are shared ✓	Electrons are delocalised ✓
Example	NaCl or any other ionic substance ✓	Diamond ✓	Cu, Na or any other metal ✓

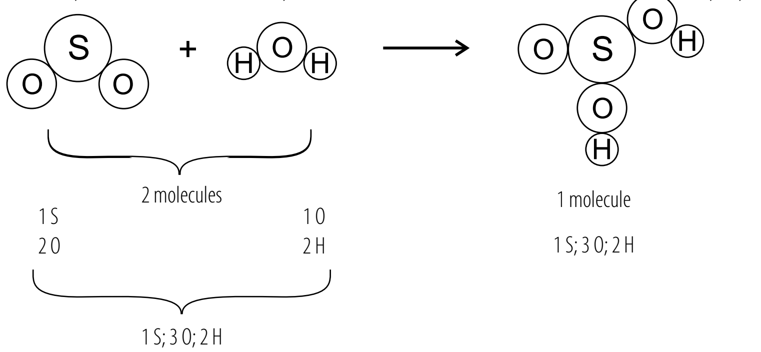
(6)

[13]

2 a) $SO_2(g)$ ✓✓ + $H_2O(\ell)$✓ → $H_2SO_3(aq)$ ✓✓ (5)

b) This is a chemical change ✓ because new products form ✓ and the reaction is not reversible ✓ by physical methods. (3)

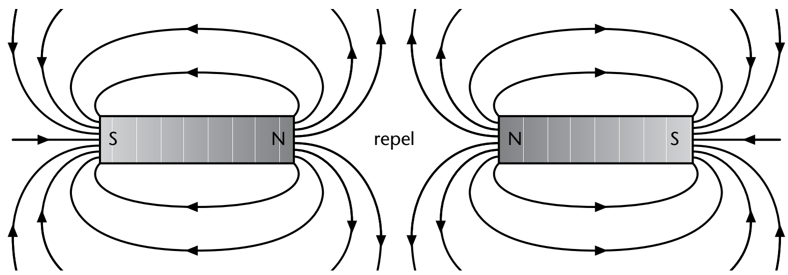
c) ✓ ✓ ✓✓



(4)

[12]

3



✓✓✓✓

[4]

4 a) They will repel each other. ✓ (1)

b) new charge $= \frac{(+9\text{ nC}) ✓ + (+2\text{ nC})}{2} = +5{,}5\text{ nC}$ ✓ on each ball (2)

c) It gained electrons. ✓ (1)

d) 9 nC – 5,5 nC = 3,5 nC transferred ✓

$n = \frac{Q}{q_e} = \frac{3{,}5 \times 10^{-9}\ \cancel{C} ✓}{1{,}6 \times 10^{-19}\ \cancel{C}}$ ✓ $= 2{,}19 \times 10^{10}$ electrons ✓ (4)

[8]

5 a) emf = 3 V ✓ (1)

b) equivalent resistance of left branch $= \frac{3 \times 6}{3 + 6}$ ✓ $= 2\ \Omega$ ✓

equivalent resistance of right branch $= \frac{2 \times 2}{2 + 2} = 1\ \Omega$ ✓

total resistance $= 2 + 1 = 3\ \Omega$ ✓ (4)

c) current at X is main current = 0,5 A + 0,5 A ✓ = 1 A ✓ (2)

d) $Q = It = 1$ A ✓ $\times (3 \times 60)$ ✓ s = 180 C ✓ (3)

e) $V_1 = V_2 + V_3$ ✓ $\therefore V_3 = 3$ V ✓ – 2 V = 1 V ✓ (3)

OR $V = IR = 1\text{ A} \times 1\ \Omega = 1\text{ V}$ [13]

Total: 50

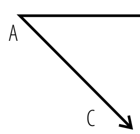
Module 3: Chemical change Units 3–4: 22 marks
Module 5: Mechanics Units 1–3: 28 marks

1 Your teacher makes up a silver nitrate solution using silver nitrate crystals and tap water.
   a) Is the solution clear? (1)
   b) Explain your answer to Question 1a) fully by also making use of a balanced equation. (3)
   c) Explain why tap water conducts an electric current but purified water does not? (2)
   [6]

2 Write balanced equations for these reactions. Include the state symbols of the compounds.
   a) copper sulfate and barium nitrate (3)
   b) hydrochloric acid and sodium carbonate (4)
   [7]

3 5 dm^3 nitrogen gas react with 15 dm^3 hydrogen at STP to form ammonia.
   a) Give a balanced equation for the reaction that takes place. (3)
   b) Determine how many moles of ammonia are formed. (2)
   c) Calculate the number of ammonia molecules that formed. (2)
   d) Calculate the total volume of ammonia that formed. (2)
   [9]

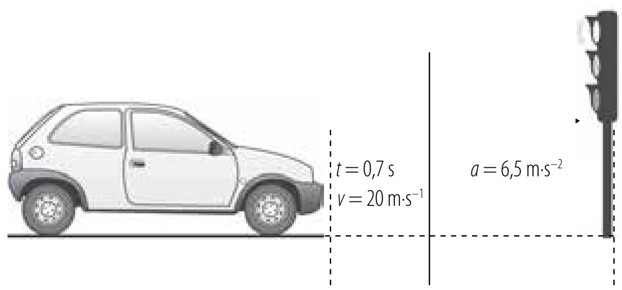
4 AB and AC are two forces that act on the same point. Redraw the vectors and use the parallelogram method (tail-to-tail method) to show how you would determine the resultant of the two forces.



(2)
[2]

5 A baby crawls 4,8 m at a bearing of 90° and then 3,6 m in direction 180°.
   a) Draw a sketch graph of the vectors and their resultant. (2)
   b) Calculate the magnitude of the resultant displacement of the baby. (3)
   [5]

6 A car is travelling at a constant speed of 20 $m \cdot s^{-1}$ when the driver notices that the traffic lights ahead have changed to red. The driver is alert and his reaction time is 0,7 s. (It takes 0,7 s from when he sees the red robot until he applies the brakes.) He applies the brakes and maintains a deceleration of 6,5 $m \cdot s^{-2}$ to stop at the robot.



a) Draw a velocity–time graph for the total motion of the car. Show the values of 20 $m \cdot s^{-1}$ and 0,7 s on your graph. (4)

b) Calculate how far the driver travels in the time from when he sees the traffic light until he applies the brakes. (3)

c) Use an equation of motion to calculate the total distance that the driver will need to stop the car in time. (6)

d) Use the graph or an equation of motion to determine the total time that the driver takes to bring the car to a halt. (5)

e) Draw an acceleration–time graph for the motion of the car. (3)

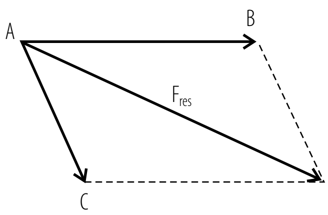
[21]

Total: 50

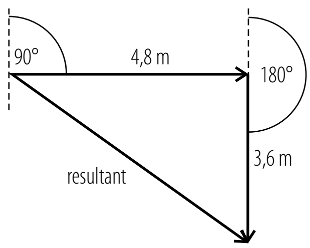
1 a) No ✓ (1)
b) There are ions such as chloride ions present ✓ in tap water that will form a precipitate ✓ with silver ions. (3)
$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ ✓
c) Tap water contains dissolved salts ✓ in the form of ions, which can act as charge carriers ✓ to conduct a current in a liquid. Purified water only contains water molecules. (2)
[6]

2 a) $CuSO_4(aq)$ ✓ + $Ba(NO_3)_2(aq) \rightarrow Cu(NO_3)_2(aq)$ ✓ + $BaSO_4(s)$ ✓ (3)
b) $2HCl(aq)$ ✓ + $Na_2CO_3(aq) \rightarrow 2NaCl(aq)$ ✓ + $CO_2(g)$ ✓ + $H_2O(\ell)$✓ (4)
[7]

3 a) $3H_2(g)$ ✓ + $N_2(g)$ ✓ $\rightarrow 2NH_3(g)$ ✓ (3)
b) 10 mol NH_3 ✓✓ (2)
c) $10 \times 6{,}03 \times 10^{23} = 6{,}03 \times 10^{24}$ ✓✓ (2)
d) $10 \times 22{,}4\ dm^3 = 224\ dm^3$ ✓✓ (2)
[9]

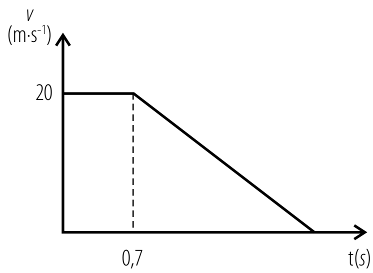
4 

✓✓ [2]

5 a) 

✓✓ (2)

b) $\text{resultant}^2 = (4{,}8\ m)^2$ ✓ + $(3{,}6\ m)^2$ ✓ $= 36\ m^2$
$\text{resultant} = \sqrt{36} = 6\ m$ ✓ (3)
[5]

6 a) 

✓✓✓✓ (4)

b) Distance = area under graph ✓ of rectangle = $l \times b$
$= 20\ m{\cdot}s^{-1} \times 0{,}7\ s$ ✓ $= 14\ m$ ✓
OR $v = \frac{D}{\Delta t} \therefore D = v\Delta t$ ✓
$= 20\ m{\cdot}s^{-1} \times 0{,}7\ s$ ✓ $= 14\ m$ ✓ (3)

c) $v_f^2 = v_i^2 + 2a\Delta x$ ✓

$(0\ \text{m·s}^{-1})^2$ ✓ $= (20\ \text{m·s}^{-1})^2 + (2 \times (-6{,}5\ \text{m·s}^{-2})$ ✓ Δx

$0\ \text{m}^2\text{·s}^{-2} = 400\ \text{m}^2\text{·s}^{-2} - 13\ \text{m·s}^{-2}\ \Delta x$

$\Delta x = \frac{-400\ \text{m}^{\cancel{2}}\text{·}\cancel{\text{s}^{-2}}}{-13\ \text{m·}\cancel{\text{s}^{-2}}} = 30{,}77\ \text{m}$ ✓

Total distance = 14 m ✓ + 30,77 m = 44,77 m ✓ (6)

d) $v_f = v_i + a\Delta t$ ✓

$0\ \text{m·s}^{-1}$ ✓ $= 20\ \text{m·s}^{-1} + (-6{,}5\ \text{m·s}^{-2})$ ✓ Δt

$\Delta t = 3{,}08\ \text{s}$ ✓

Total time = 3,08 s + 0,7 s

= 3,78 s ✓

OR area under graph $= l \times b + \frac{1}{2}b \times h$ ✓

44,77 m ✓ $= 14\ \text{m} + \frac{1}{2} \times b \times 20\ \text{m·s}^{-1}$ ✓

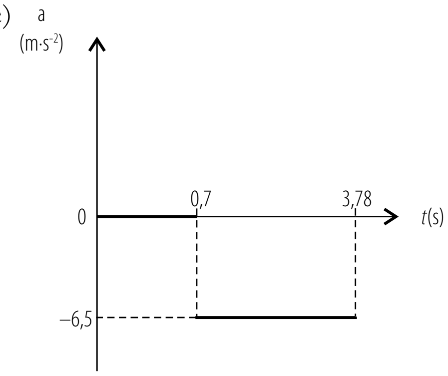
$b = \frac{44{,}7\ \text{m} - 14\ \text{m}}{10\ \text{m·s}^{-1}}$

$\therefore \Delta t = 3{,}08\ \text{s}$ ✓

Total time = 3,08 s + 0,7 s

= 3,78 s ✓ (5)

e)



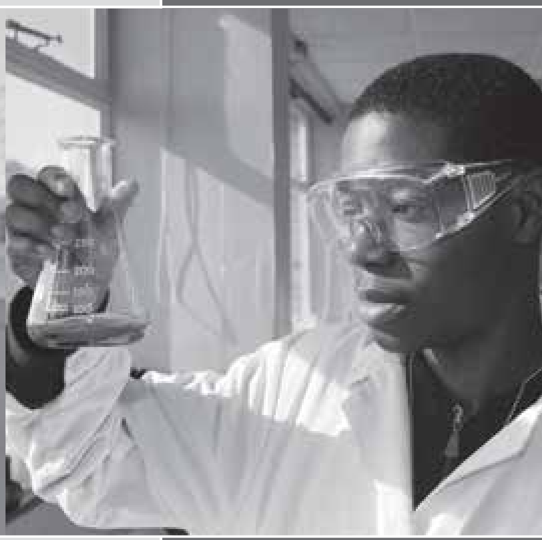
✓✓✓ (3)

[21]

Total: 50

SECTION C

PLANNING



Teachers are involved in different levels of planning for each subject. These different levels of planning make up the learning programme for that subject. A learning programme consists of a subject framework, work schedules and lesson plans.

Phase programme and work schedule

The phase programme or subject framework specifies the scope of learning and assessment for the three grades in a phase of the FET band. An overview of the knowledge areas and topics for the Physical Sciences FET phase appears in the work schedule on page C3 of this Teacher's File.

The Curriculum and Assessment Policy Statement (CAPS) specifies the core knowledge and concepts to be covered during the FET phase, as well as the amount of time in hours to be devoted to each topic.

Lesson plan

A lesson plan is a more detailed plan for a particular section of work, a period of time during the year or a particular lesson. It describes what and how learning is going to take place. In addition to the information in the work schedule, it explains how the activities and assessment will take place as well as the use of resources. The lesson plan also refers to prior and future learning.

You will need to prepare your own lesson plan for your class. Your lesson plan will indicate when and how you will introduce each activity, each section of new knowledge, each assessment activity, and so on, using and expanding the information from the work schedule. We have included a blank lesson plan form in Section E: Photocopiable resources, and an example of a completed lesson plan in this section to help you with your planning.

Phase programme

Core knowledge area	Grades	Percentage of time (per grade)	Knowledge concepts
Mechanics	10	18,75%	1. Vectors and scalars 2. Motion in one dimension 3. Description of motion 4. Energy
	11	16,87%	1. Vectors in two dimensions 2. Newton's laws and their application
	12	17,50%	1. Momentum and impulse 2. Vertical projectile motion in 1D 3. Work, energy and power
Waves, sound and light	10	10,00%	1. Transverse pulses on a string or spring 2. Transverse waves 3. Longitudinal waves 4. Sound 5. Electromagnetic radiation
	11	8,13%	1. Geometrical optics 2. 2D and 3D wavefronts
	12	3,75%	1. Doppler effect

Core knowledge area	Grades	Percentage of time (per grade)	Knowledge concepts
Electricity and magnetism	10	8,75%	1. Magnetism 2. Electrostatics 3. Electric circuits
	11	12,50%	1. Electrostatics 2. Electromagnetism 3. Electric circuits
	12	7,50%	1. Electric circuits 2. Electrodynamics
Matter and materials	10	17,50%	1. Classification of matter 2. States of matter and the Kinetic Molecular Theory 3. The atom 4. The Periodic Table 5. Chemical bonding 6. Particles making up substances
	11	15,00%	1. Atomic combinations: molecular structure 2. Intermolecular forces 3. Ideal gases and thermal properties
	12	3,75% 11,50%	Physics 1. Optical phenomena and properties of materials Chemistry 2. Organic chemistry 3. Organic macromolecules
Chemical change	10	15,00%	1. Physical and chemical change 2. Representing chemical change 3. Reactions in aqueous solution 4. Quantitative aspects of chemical change
	11	17,50%	1. Quantitative aspects of chemical change 2. Energy and chemical change 3. Types of reactions
	12	17,50%	1. Reaction rate 2. Chemical equilibrium 3. Acids and bases 4. Electrochemical reactions
Chemical systems	10	5,00%	1. The hydrosphere
	11	5,00%	1. The lithosphere
	12	3,50%	1. The chemical industry

Work schedule

TERM 1						
MODULE 1: Matter and materials						
Hours	**Units**	**Topics**	**LB page**	**Content, concepts and skills**	**Planned date**	**Completion date**
0,25	Unit 1: Classification of matter	Materials of which an object is composed	27	• Revise the properties of material, e.g. - strength - thermal and electrical conductivity - brittle, malleable or ductile - magnetic or non-magnetic - density (lead/aluminium) - melting points and boiling points.		
0,25		Mixtures	29	• Revise the properties of a mixture. • Revise the properties of a homogeneous mixture. • Revise the properties of a heterogeneous mixture. • Give examples of heterogeneous and homogeneous mixtures.		
0,25		Pure substances	32	• Revise the microscopic and symbolic representations for elements, compounds and mixtures. • Revise the definition of an element. • Revise the definition of a compound. • Revise the definition of pure substances. • Revise the classification of substances as pure, as compounds or as elements. • Revise criteria for purity. Use melting point and boiling points as evidence of purity. Use chromatography as evidence of purity.		
0,25		Names and formulae of substances	36	• Revise the names of compounds using the names of the elements from which they are made. • Revise the cation and anion table. • Revise writing the names when given the formulae. • Revise the meaning of the name endings like -ide, -ite and -ate. • Understand the meaning of the prefixes di-, tri- etc. • Revise writing the formulae when given the names.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
0,25	Unit 1: Classification of matter	Metals, metalloids and non-metals	43	• Revise the classification of substances as metals using their properties. • Identify the metals, their position on the Periodic Table and their number in comparison to the number of non-metals. • Revise the classification of non-metals using their properties. • Identify the non-metals and their position on the Periodic Table. • Describe metalloids as having mainly non-metallic properties. • Revise the classification of metalloids by their characteristic property of increasing conductivity with increasing temperature (the reverse of metals), e.g. silicon and graphite. • Identify the metalloids and their position on the Periodic Table.		
0,25		Electrical conductors, semiconductors and insulators	44	• Revise the classification of materials as electrical conductors, semiconductors and insulators. • Give examples of electrical conductors, semiconductors and insulators. • Identify the substances and the appliances or objects that are in common daily use in homes and offices, that are specifically chosen because of their electrical properties (conductors, insulators and semiconductors).		
0,25		Thermal conductors and insulators	45	• Revise how to test and classify materials as thermal conductors and insulators. • Give examples of materials that are thermal conductors and insulators.		
0,25		Magnetic and non-magnetic materials	47	• Revise how to test and classify materials as magnetic and non-magnetic. • Give examples of materials that are magnetic and non-magnetic. • Give examples of how we can use magnets in daily life (in speakers, in telephones, electric motors and compasses).		
1,0	Unit 2: States of matter and the Kinetic Molecular Theory	Three states of matter	48	• Verify the particulate nature of matter by investigating diffusion and Brownian motion. • List and characterise the three states of matter. • Define freezing point, melting point and boiling point. • Identify the physical state of a substance at a specific temperature, given the melting point and the boiling point of the substance. • Define melting, evaporation, freezing, sublimation and condensation as changes in state. • Demonstrate these changes of state.		
1,0		Kinetic Molecular Theory	51	• Describe a solid, a liquid and a gas according to the Kinetic Molecular Theory in terms of particles of matter.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
0,5	Unit 3: The atom	The atomic model	56	• Given a list of key discoveries (or hypotheses), match these to the description of the atom that followed the discovery. Be able to do this for the period starting with the Greek suggestion that atoms constituted matter, through the electrical experiments of the 19th century, to the discovery of radioactivity, Rutherford's gold foil experiment and the Bohr model. • Identify five major contributions to the current atomic model used today. • What is the purpose of a model of the atomic structure?		
0,5		Atomic mass and diameter	58	• Give a rough estimate of the mass and diameter of an atom. • Show that the atom is mainly an empty space with the nucleus occupying a very small space in any atom (explain the α-particle scattering experiment). • Describe and use the concept of relative atomic mass.		
1,0		The structure of the atom	60	• Given a Periodic Table or suitable data: - Define the atomic number of an element and give its value. - Give the number of protons present in an atom of an element. - Give the number of electrons present in a neutral atom. - Show that by removing electrons from an atom the neutrality of the atom is changed. - Determine charge after removing electrons from the atom. - Calculate the number of neutrons present. - Calculate the mass number for an isotope of an element.		
1,0		Isotopes	61	• Explain the term isotope. • Calculate the relative atomic mass of naturally occurring elements from the percentage of each isotope in a sample of the naturally occurring element and the relative atomic mass of each of the isotopes. • Represent atoms (nuclides) using the notation ${}^{A}_{Z}E$.		
1,0		Electron configuration	63	• Give electronic arrangement of atoms (up to Z = 20) according to the orbital box diagrams (notation ↑↓) and the spectroscopic electron configuration notation ($1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2$) (sometimes called the Aufbau principle). • Describe atomic orbitals and the shapes of the *s*-orbitals and the *p*-orbitals. • State Hund's Rule and Pauli's Exclusion Principle.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
2,0	Unit 4: The Periodic Table	Periods and groups	69	• Understand that elements in the PT are arranged in order of ascending atomic number. • Appreciate the PT as a systematic way to arrange elements. • Define the group number and the period number of an element in the PT.		
		Electron configuration and the Periodic Table	70	• Relate the position of an element in the PT to its electronic structure and vice versa.		
		Patterns in the Periodic Table	73	• Understand periodicity by looking at these properties from the elements Li to Ar: density, melting points and boiling points, atomic radius, periodicity in formulae of halides, periodicity in formulae of oxides and ionisation energy. • What is the influence of periodicity on electron affinity and electronegativity? • Define atomic radius, ionisation energy, electron affinity and electronegativity.		
2,0		Similarities in chemical properties among elements	82	• Relate the electronic arrangements to the chemical properties of Group 1, 2, 17 and 18 elements. • Describe the differences in reactivity of Group 1, 2 and 17 elements. • Predict chemical properties of unfamiliar elements in Groups 1, 2, 17 and 18 of the PT. • Indicate where metals are to be found on the PT. • Indicate where non-metals are to be found on the PT. • Indicate where transition metals are to be found on the PT.		
8,0	Unit 5: Chemical bonding	Lewis dot diagrams	89	• Draw Lewis dot diagrams of elements. • Revise the cation and the anion table. • Revise the names of compounds.		
		Covalent bonding	90	• Covalent bonding: - sharing of electrons in the formation of covalent bond - single, double and triple bonds - electron diagrams of simple covalent molecules - names and formulae of covalent compounds.		
		Ionic bonding	93	• Ionic bonding: - transfer of electrons in the formation of ionic bonding - cations and anions - electron diagrams of simple ionic compounds - ionic structure as illustrated by sodium chloride.		
		Metallic bonding	95	• Metallic bonding: - sharing a delocalised electron cloud among positive nuclei in the metal.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
	Unit 5: Chemical bonding	Relative molecular and formula masses	96	• Revise relative molecular mass for covalent molecules. • Revise relative formula mass for ionic compounds.		
MODULE 2: Waves, sound & light						
2,0	Unit 1: Transverse pulses on a string or spring	Pulse and amplitude	102	• Define a pulse. • Amplitude • Define amplitude as maximum disturbance of a particle from its rest (equilibrium) position. • Define a transverse pulse • Know that for a transverse pulse the particles of the medium move at right angles to the direction of propagation of the pulse.		
2,0		Superposition of pulses	103	• Explain that superposition is the addition of the amplitudes of two pulses that occupy the same space at the same time. • Define destructive interference. • Define constructive interference. • Explain (using diagrams) how two pulses that reach the same point in the same medium superpose constructively and destructively and then continue in the original direction of motion. • Apply the Principle of Superposition to pulses.		
2,0	Unit 2: Transverse waves	Wavelength, frequency, amplitude, period and wave speed	106; 107	• Define a transverse wave as a succession of transverse pulses. • Define wavelength, frequency, period, crest and trough of a wave. • Explain the wave concepts: in phase and out of phase. • Identify the wavelength, amplitude, crests, troughs, points in phase and points out of phase on a drawing of a transverse wave. • Know the relationship between frequency and period, i.e. $f = 1/T$ and $T = 1/f$. • Define wave speed as the product of the frequency and wavelength of a wave: $v = f\lambda$ • Use the speed equation, $v = f\lambda$, to solve problems involving waves.		
1,0	Unit 3: Longitudinal waves	Longitudinal waves on a spring	114	• Generate a longitudinal wave in a spring. • Draw a diagram to represent a longitudinal wave in a spring, showing the direction of motion of the wave relative to the direction in which the particles move.		
2,0		Wavelength, frequency, amplitude, period and wave speed	115	• Define compression and rarefaction. • Define the wavelength and amplitude of a longitudinal wave. • Define the period and frequency of a longitudinal wave and the relationship between the two quantities ($f = 1/T$). • Use the equation for wave speed $v = f\lambda$, to solve problems involving longitudinal waves.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
1,0	Unit 3: Longitudinal waves	Sound waves	114	• Explain that sound waves are created by vibrations in a medium in the direction of propagation. The vibrations cause a regular variation in pressure in the medium. • Describe a sound wave as a longitudinal wave. • Explain the relationship between wave speed and the properties of the medium in which the wave travels (gas, liquid or solid).		
1,0	Unit 4: Sound	Pitch, loudness and quality of sound	120; 121	• Relate the pitch of a sound to the frequency of a sound wave. • Relate the loudness of a sound to both the amplitude of a sound wave and the sensitivity of the human ear.		
1,0		Ultrasound	127	• Describe sound with frequencies higher than 20 kHz as ultrasound, up to about 100 kHz. • Explain how an image can be created using ultrasound based on the fact that when a wave encounters a boundary between two media, part of the wave is reflected and part is transmitted. • Describe some of the medical benefits and uses of ultrasound, e.g. safety, diagnosis, treatment, pregnancy.		
0,5	Unit 5: Electromagnetic radiation	Dual nature of electromagnetic radiation	129	• Explain that some aspects of the behaviour of EM radiation can best be explained using a wave model and some aspects can best be explained using a particle model.		
1,0		Nature of electromagnetic radiation	130	• Describe the source of electromagnetic waves as an accelerating charge. • Use word and diagrams to explain how an EM wave propagates when an electric field oscillating in one plane produces a magnetic field oscillating in a plane at right angles to it, which produces an oscillating electric field, and so on. • State that these mutually regenerating fields travel through space at a constant speed of 3×10^8 m/s represented by c. • Indigenous knowledge systems (IKS) - Discuss qualitatively animal behaviour related to natural disasters across at most two different cultural groups and within current scientific studies.		
1,0		Electromagnetic spectrum	132	• Given a list of different types of EM radiation, arrange them in order of frequency or wavelength. • Given the wavelength of EM waves, calculate the frequency and vice versa, using the equation: $c = f\lambda$ • Give an example of the use of each type of EM radiation, i.e. gamma rays, X-rays, ultraviolet light, visible light, infrared, microwave and radio and TV waves. • Indicate the penetrating ability of the different kinds of EM radiation and relate it to energy of the radiation. • Describe the dangers of gamma rays, X-rays and the damaging effect of ultraviolet radiation on skin. • Discuss radiation from cell phones.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
1,5	Unit 5: Electromagnetic radiation	Particle nature of electromagnetic radiation	140	• Define a photon. • Calculate the energy of a photon using $E = hf = \frac{hc}{\lambda}$ where $h = 6{,}63 \times 10^{-34}$ J·s is Planck's constant, $c = 3 \times 10^{8}$ m·s^{-1} is the speed of light in a vacuum and λ is the wavelength.		

TERM 2						
MODULE 1: Matter and materials						
Hours	**Units**	**Topics**	**LB page**	**Content, concepts and skills**	**Planned date**	**Completion date**
8,0	Unit 6: Particles making up substances	Atoms and compounds	146	• Describe atoms as very small particles of which all substances are made. • State that the only substances found in atomic form are the noble gases at ambient conditions. • Describe a compound as a group of two or more atoms that are attracted to each other by relatively strong forces or bonds. The atoms are combined in definite proportions.		
		Molecular substances	146	• When atoms share electrons they are bonded covalently and the resulting collection of atoms are called a molecule. As a general rule molecular substances are almost always composed of non-metallic elements. • Give examples of molecules based on the above description, e.g. - Covalent molecular structures consist of separate molecules: oxygen, water, petrol, CO_2, S_8, C_{60} (buckminsterfullerene or buckyballs). - Covalent network structures consist of giant repeating lattices of covalently bonded atoms: diamond, graphite, SiO_2, some boron compounds.		
		Ionic substances	149	• When the electrons of atoms are transferred from one atom to another atom to form positive and negative ions, the ions bond with ionic bonds and the resulting solid is called an ionic substance (or salt or ionic compound). As a general rule ionic substances are usually composed of both metallic elements (usually forming positive ions) and non-metallic elements (usually forming negative ions). • Give examples of ionic substances (solids, salts, ionic compounds) based on the above description, e.g. a sodium chloride crystal, potassium permanganate crystal.		
		Metallic substances	151	• When metal atoms lose their outer electrons to form a lattice of regularly spaced positive ions and the outer electrons form a delocalised pool of electrons that surround the positive ions, the atoms are bonded by metallic bonding and the resulting collection of atoms is called a metal. • Give examples of metals based on the above description, e.g. a metal crystal like a piece of copper or zinc or iron.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
	Unit 6: Particles making up substances	Representing compounds	154	• Recognise molecules from models (space filling, ball and stick). • Draw diagrams to represent molecules using circles to represent atoms. • Represent molecules using: - molecular formulae for covalent network structures, e.g. O_2, H_2O, C_8H_{18}, $C_{12}H_{22}O_{11}$ - empirical formulae for covalent network structures, e.g. C as diamond, graphite and SiO_2 as quartz, glass or sand. • Give the formula of a molecule from a diagram of the molecule and vice versa.		
MODULE 3: Chemical change						
3,0	Unit 1: Physical and chemical change	Rearrangement of particles	163	• Describe that the rearrangement of molecules occurs during physical changes, e.g. describe - molecules as separated when water evaporates to form water vapour - disordering of water molecules when ice melts due to breaking of intermolecular forces - energy change (as small) in relation to chemical changes - mass, numbers of atoms and molecules as being conserved during these physical changes. • Describe examples of a chemical change that could include - the decomposition of hydrogen peroxide to form water and oxygen - the synthesis reaction that occurs when hydrogen burns in oxygen to form water. (Why do we consider these reactions to be chemical changes?) • Describe - the energy involved in these chemical changes as much larger than those of the physical change, i.e. hydrogen is used as a rocket fuel - mass and atoms are conserved during these chemical changes but the number of molecules is not. Show this with diagrams of the particles.		
1,0		Conservation of matter	168	• Illustrate the conservation of atoms and non-conservation of molecules during chemicals reactions using models of reactant molecules. • Draw diagrams representing molecules at a sub-microscopic level to show how particles rearrange in chemical reactions and atoms are conserved.		
		Constant composition	171	• State the Law of Constant Composition. • Explain that the ratio in a particular compound is fixed as represented by its chemical formula.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
4,0	Unit 2: Representing chemical change	Writing balanced chemical equations	173	• Represent chemical changes using reaction equations, i.e. translate word equations into chemical equations with formulae with subscripts to represent phases (*s*), (ℓ), (*g*) and (*aq*). • Balance reaction equations by - using models of reactant molecules and rearranging the 'atoms' to form the products while conserving atoms - representing molecules at a sub-microscopic level using coloured circles and simply rearranging the pictures to form the product molecules while conserving atoms - inspection using reaction equations.		
		Interpret balanced reaction equations	176	• Interpret balanced reaction equations in terms of - conservation of atoms - conservation of mass (use relative atomic masses) - energy transferred.		
MODULE 4: Electricity and magnetism						
0,5	Unit 1: Magnetism	Magnetic field	181	• Explain that a magnetic field is a region in space where another magnet or ferromagnetic material will experience a force (non-contact).		
1,0		Poles of a magnet	182	• Describe a magnet as an object that has a pair of opposite poles, called north and south. Even if the object is cut into tiny pieces, each piece will still have both a N and a S pole. • Apply the fact that like magnetic poles repel and opposite poles attract to predict the behaviour of magnets when they are brought close together.		
		Field lines	182	• Show the shape of the magnetic field around a bar magnet and a pair of bar magnets placed close together, e.g. using iron filings or compasses. Sketch magnetic field lines to show the shape, size and direction of the magnetic field of different arrangements of bar magnets.		
0,5		Earth's magnetic field	184	• Compare the magnetic field of Earth to the magnetic field of a bar magnet using words and diagrams. • Explain the difference between the geographical north pole and the magnetic north pole of Earth. • Explain how a compass indicates the direction of a magnetic field.		
		Effects of Earth's magnetic field	185	• Give examples of phenomena that are affected by Earth's magnetic field, e.g. *Aurora borealis* (northern lights), magnetic storms. • Discuss qualitatively how Earth's magnetic field provides protection from solar winds.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
0,5	Unit 2: Electrostatics	Electrical charge	190	• Know that all materials contain positive charges (protons) and negative charges (electrons). • Know that an object has an equal number of electrons and protons and is neutral (no net charge). • Know that positively charged objects are electrons deficient and negatively charged objects have an excess if electrons. • Describe how objects (insulators) can be charged by contact (or rubbing).		
0,5		Force charges exert on each other	191	• Recall that like charges repel and opposite charges attract.		
		Polarisation	192	• Explain how charged objects can attract uncharged insulators because of the movement of polarised molecules in insulators.		
1,0		Charge conservation	194	• State the Law of Conservation of Charge: The net charge of an isolated system remains constant during any physical process, e.g. two charges making contact and then separating. • Apply the Law of Conservation of Charge. • Know that when two objects having charges Q_1 and Q_2 make contact, each will have the same final charge: $Q = \frac{Q_1 + Q_2}{2}$ after separation. Note this equation is only true of identically sized conductors on insulating stands.		
1,0		Charge quantisation	195	• State the Principle of Charge Quantisation. • Apply the Principle of Charge Quantisation.		
1,0	Unit 3: Electric circuits	Potential difference and electromotive force	198	• Know that the voltage measured across the terminals of a battery when no current is flowing through the battery is called the emf. • Know that the voltage measured across the terminals of a battery when current is flowing through the battery is called potential difference (pd). • Know that emf and pd are measured in volts (V).		
1,0		Electric current	199	• Define current I as the rate of flow of charge. It is measured in ampere (A), which is the same as coulomb per second. • Calculate the current flowing using the equation $I = \frac{Q}{\Delta t}$. • Indicate the direction of the current in circuit diagrams (conventional).		
1,0		Measuring voltage and current	202	• Draw a diagram to show how to correctly connect an ammeter to measure the current through a given circuit element. • Draw a diagram to show how to correctly connect a voltmeter to measure the voltage across a given circuit element.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
1,0	Unit 3: Electric circuits	Resistance	203	• Define resistance. • Explain that resistance is the opposition to the flow of electric current. • Define the unit of resistance; one ohm (Ω) is one volt per ampere. • Give a microscopic description of resistance in terms of electrons moving through a conductor colliding with the particles of which the conductor (metal) is made and transferring kinetic energy. • Explain why a battery in a circuit eventually goes flat by referring to the energy transformations that take place in the battery and the resistors in a circuit.		
2,0		Resistors connected in series	204	• Know that current is constant through each resistor in a series circuit. • Know that series circuits are called voltage dividers because the total potential difference is equal to the sum of the potential differences across all the individual components. • Calculate the equivalent (total) resistance of resistors connected in series using: $R_s = R_1 + R + \ldots$		
2,0		Resistors connected in parallel	205	• Know that voltage is constant across resistors connected in parallel. • Know that a parallel circuit is called a current divider because the total current in the circuit is equal to the sum of the branch currents. • Calculate the equivalent (total) resistance of resistors connected in parallel using: $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$ • Know that for two resistors connected in parallel the total resistance can be calculated using: $R_p = \frac{\text{product}}{\text{sum}} = \frac{R_1 R_2}{R_1 + R_2}$		

TERM 3						
MODULE 3: Chemical change						
Hours	**Units**	**Topics**	**LB page**	**Content, concepts and skills**	**Planned date**	**Completion date**
2,0	Unit 3: Reactions in aqueous solution	Ions in aqueous solution	214	• Explain using diagrams representing interactions at the sub-microscopic level, with reference to the polar nature of the water molecule, how water is able to dissolve ions. • Represent the dissolution process using balanced reaction equations using the abbreviations (*s*) and (*aq*) appropriately, e.g. when salt is dissolved in water ions form according to the equation: $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$. • Define the process of dissolving (solid ionic crystals breaking up into ions in water). • Define the process of hydration where ions become surrounded with water molecules in water solution.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
1,0	Unit 3: Reactions in aqueous solution	Electrolytes and extent of ionisation	217	• Describe a simple circuit to measure conductivity of solutions. • Relate conductivity to - the concentration of ions in an ion solution and this in turn to the solubility of particular substances, however - the type of substance, since some substances, like sugar, dissolve but this does not affect conductivity; conductivity will not always be a measure of solubility.		
3,0		Precipitation reactions	219	• Write balanced reaction equations to describe precipitation of insoluble salts. • Explain how to test for the presence of these anions in solution: - chloride – using silver nitrate and nitric acid - bromide – using silver nitrate and nitric acid - iodide – using silver nitrate and nitric acid - sulfate – using barium nitrate and nitric acid - carbonate – using barium nitrate and acid (precipitate dissolves in nitric acid). • Identify an ion or ions in a solution from a description of the reactants mixed and the observations of the products.		
2,0		Other types of chemical reactions in aqueous solution	225	• Ion exchange reactions: - precipitation reactions - gas-forming reactions - acid–base reactions - redox reactions, which are an electron transfer reaction. Use the charge of the atom to demonstrate how losing or gaining electrons affect the overall charge of an atom.		
1,0	Unit 4: Quantitative aspects of chemical change	Atomic mass and the mole concept	234	• Describe the mole as the SI unit for amount of substance. • Relate amount of substance to relative atomic mass. • Describe the relationship between mole and Avogadro's number. • Conceptualise the magnitude of Avogadro's number using appropriate analogies. • Write out Avogadro's number with all the zeros to get a better concept of the amount. • Define molar mass. • Describe the relationship between molar mass and relative molecular mass and relative formula mass. • Calculate the molar mass of a substance given its formula.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
2,0	Unit 4: Quantitative aspects of chemical change	Molecular and formula masses	237	• Reason qualitatively and proportionally the relationship between number of moles, mass and molar mass. • Calculate mass, molar mass and number of moles according to the relationship $n = m/M$. • Determine the empirical formula for a given substance from percentage composition. • Determine the number of moles of water of crystallisation in salts like $AlCl_3{\cdot}nH_2O$.		
2,0		Determining the composition of substances	243	• Determine percentage composition of an element in a compound. • Define and determine concentration as moles per volume.		
1,0		Amount of substance, molar volume, concentration of solutions	246	• Calculate the number of moles of a salt with given mass. • Definition of molar volume is stated as: 1 mole of gas occupies 22,4 dm^3 at 0 °C (273 K) and 1 atmosphere (101,3 kPa). • Calculate the molar concentration of a solution.		
2,0		Basic stoichiometric calculations	250	• Do calculations based on concentration, mass, moles, molar mass and volume. • Determine the theoretical yield of a product in a chemical reaction, when you start with a known mass of reactant.		
MODULE 5: Mechanics						
4,0	Unit 1: Vectors and scalars	Vectors and scalars	257	• List physical quantities, for example, time, mass, weight, force and charge. • Define a vector and a scalar quantity. • Differentiate between vector and scalar quantities. • Graphical representation of vector quantities.		
		Properties of vectors	258	• Properties of vectors like equality of vectors, negative vectors, addition, subtraction and multiplication of vectors using the force vector as an example. • Define resultant vector. • Find resultant vector graphically (tail-to-head and tail-to-tail method) and by calculation using a maximum of four vectors.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
3,0	Unit 2: Motion in one dimension	Reference frame, position, displacement and distance	264	• Describe the concept of a frame of reference. • Explain that a frame of reference has an origin and a set of directions, e.g. east and west or up and down. • Define one-dimensional motion. • Define position relative to a reference point and understand that position can be positive or negative. • Define distance and know that distance is a scalar quantity. • Define displacement as a change in position. • Know that displacement is a vector quantity that points from initial to final position. • Know and illustrate the difference between displacement and distance. • Calculate distance and displacement from one-dimensional motion.		
5,0		Average speed, average velocity, acceleration	266	• Define average speed as the distance travelled divided by the total time and know that average speed is a scalar quantity. • Define average velocity as the displacement (or change in position) divided by the time taken and know that average velocity is a vector quantity. • Calculate average speed and average velocity for one-dimensional motion. • Convert between different units of speed and velocity, e.g. $m \cdot s^{-1}$, $km \cdot h^{-1}$. • Define average acceleration as the change in velocity divided by the time taken. • Differentiate between positive acceleration, negative acceleration and deceleration. • Understand that acceleration provides no information about the direction of motion; it only indicates how the motion (velocity) changes.		
		Instantaneous speed and velocity	276	• Define instantaneous velocity as the displacement (or change in position) divided by an infinitesimal (very small) time interval. • Know that instantaneous velocity is a vector quantity. • Define instantaneous speed as the magnitude of the instantaneous velocity.		
8,0	Unit 3: Description of motion	Describing motion in words	278	• Describe in words and distinguish between motion with uniform velocity and uniformly accelerated motion.		
		Describing motion in graphs	278	• Describe the motion of an object given its position versus time, velocity versus time and acceleration versus time graph. • Determine the velocity of an object from the gradient of the position versus time graph. • Know that the slope of a tangent to a position versus time graph yields the instantaneous velocity at that particular time. • Determine the acceleration of an object from the gradient of the velocity versus time graph. • Determine the displacement of an object by finding the area under a velocity versus time graph.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
	Unit 3: Description of motion	Equations of motion	287	• Use the kinematics equations to solve problems involving motion in one dimension (horizontal only). $v_f = v_i + a\Delta t$ $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $v_f^2 = v_i^2 + 2a\Delta x$ $\Delta x = (\frac{v_i + v_f}{2})\Delta t$		
		Road safety and stopping distance	289	• Demonstrate an understanding of motion of a vehicle and safety issues, such as the relationship between speed and stopping distance.		

TERM 4						
MODULE 5: Mechanics						
Hours	**Units**	**Topics**	**LB page**	**Content, concepts and skills**	**Planned date**	**Completion date**
1,5	Unit 4: Energy	Gravitational potential energy	296	• Define gravitational potential energy of an object as the energy it has because of its position in the field relative to some reference point. • Determine the gravitational potential energy of an object using $E_P = mgh$.		
1,5		Kinetic energy	297	• Define kinetic energy as the energy an object possess as a result of its motion. • Determine the kinetic energy of an object using $E_K = \frac{1}{2}mv^2$.		
1,0		Mechanical energy	298	• Define mechanical energy as the sum of the kinetic energy and the gravitational potential energy. Use the equation: $E_M = E_K + E_P$		
4,0		Conservation of mechanical energy	298	• State the Law of Conservation of Energy. • State that in the absence of air resistance, the mechanical energy of an object moving in the Earth's gravitational field is constant (conserved). • Apply the Principle of Conservation of Mechanical Energy to various contexts, i.e. objects dropped or thrown vertically upwards, the motion of a pendulum bob, roller coasters and inclined plane problems. Use equation: $E_{K1} + E_{P1} = E_{K2} + E_{P2}$.		

Hours	Units	Topics	LB page	Content, concepts and skills	Planned date	Completion date
MODULE 6: Chemical systems						
8,0	Unit 1: The hydrosphere	The composition of the hydrosphere	306	• Identify the hydrosphere.		
		The water cycle	307			
		Interaction of the hydrosphere with other global systems	308	• Give an overview of hydrosphere's interaction with the atmosphere, the lithosphere and the biosphere. Water moves through: - air (atmosphere) - rocks and soil (lithosphere) - plants and animals (biosphere) dissolving and depositing, cooling and warming.		
		Water supplies in South Africa	309	• Explain how the building of dams affects the lives of the people and the ecology in the region.		
		Water quality	312	• Examine the purification and quality of water		
		Human effects on water quality	314			
		Water consumption in South Africa	320			

Example of a completed lesson plan

Lesson plan		
Teacher:	**Grade:** 10	**School:** A. Nother Secondary School
Time	3 hours/4 lessons	
Knowledge area	Electrostatics	
Knowledge/prior beliefs	The concepts of negative electron and positive proton; electrostatic attraction in everyday life, e.g. hair and comb, cling wrap, conductors and insulators	
Core knowledge and concepts	Electrical charge; force charges exert on each other; polarisation; charge conservation; charge quantisation	

Teacher activities	**Learner activities**	**Resources**	**Assessment methods**
• Revise static electricity concepts • Prepare and demonstrate Activity 1 in Learner's Book, page 192: Testing the charge on different materials • Explain separation of charges and polarisation • Explain charge conservation and charge sharing • Background information on Millikan's experiment • Explain the concept of quantisation in general and charge quantisation in particular	• List examples of static electricity in everyday life • Summarise observations of teacher demonstration (Activity 1) in a table in workbook • Do Activity 2 in Learner's Book, page 197, for homework	• Apparatus for demonstration of Activity 1 in Learner's Book, page 192 • Polystyrene balls for demonstrations of sharing of charge	• Informal baseline assessment of prior knowledge • Peer assessment on homework task • Teacher assessment of tables for Activity 1 in workbooks

Updating your knowledge

As a professional educator, you should constantly update your knowledge on your subject. The aim of this section is NOT to provide a complete list of all the available resources for South African teachers in the Physical Sciences. This is an impossible task, so we will give you ideas and contacts to make it easy for you to locate resources in your own area. Here is a list of addresses, websites and other resources that you may find useful for this purpose:

Careers

http://www.pacecareers.com
http://www.saip.org.za/careers/CareersWithPhysics.html

Education

http://education.pwv.gov.za

Organisations

Academy of Science of South Africa (ASSAf)
PO Box 72135, Lynwood Ridge, 0400; Tel: 012 349-5461
Cambridge University Press: *http://uk.cambridge.org/africa/*
Chevron/Caltex Oil: *http://www.caltex.com*
PO Box 4907, Johannesburg, 2000; Tel: 011 280-2000
Chamber of Mines: *http://www.bullion.org.za*
PO Box 61809, Marshalltown, 2107; Tel: 011 498-7421
Council for Scientific and Industrial Research (CSIR): *http://www.csir.co.za*
PO Box 395, Brummeria, Pretoria (Tshwane), 0184; Tel: 012 841-2911
Department of Mineral and Energy Affairs *http://www.energy.gov.za*
Private Bag X59, Pretoria (Tshwane), 0001
Department of National Education Film Library
Private Bag X239, Pretoria (Tshwane), 0001; Tel: 012 322-6625
Department of Environmental Affairs and Tourism:
http://www.environment.gov.za
Private Bag X447, Pretoria (Tshwane), 0001; Tel: 012 310-3911
Department of National Health and Planning *http://www.doh.gov.za*
Private Bag X828, Pretoria (Tshwane), 0001; Tel: 012 312-0000
Department of Water Affairs and Forestry *http://www.dwaf.gov.za*
Private Bag X313, Pretoria (Tshwane), 0001; Tel: 012
229-0111 **Earthlife Africa**: *http://www.earthlife.org.za*
PO Box 32131, Braamfontein, 2107; Tel: 011 339-3662
Environmental Education Centres:

- **Abe Bailey Nature Reserve**, Box 13, Carletonville, 2500; Gauteng; Tel: 018 788-3290
- **Ben Lavin Nature Reserve**, Box 782, Makhado, 0920; Limpopo; Tel: 015 516-4534, 078 477-3118
- **South African Education and Environment Project**: *http://www.saep.org* B14 Waverley Court, Kotzee Road, Mowbray, 7700; Tel: 021 447-3610
- **Delta Park Environmental Centre**: *http://www.deltaenviro.org.za* Road No. 3, Victory Park, Johannesburg, 2001; Tel: 011 888-4831
- **Umgeni Valley Project**: PO Box 394, Howick, 3290; KwaZulu-Natal; Tel: 033 330-3931

Environmental Education and Resources Unit: *http://www.uwc.ac.za*
Encyclopaedia Britannica online: *http://www.britannica.com/*
Environmental Education Association of Southern Africa (EEASA)
http://www.eeasa.org.za
PO Box 394, Howick, 3290

Eskom: *http://www.eskom.co.za*
PO Box 1091, Johannesburg, 2000; Tel: 011 800-5401
Exploratorium: Dock Road, V & A Waterfront, Cape Town
Institute for Natural Resources: *http://www.inr.org.za*
PO Box 100396, Scottsville, 3209; Tel: 033 346-0796
Keep South Africa Beautiful
PO Box 1514, Randburg, 2125; Tel: 011 787-1080
Libraries
Find out about local municipal libraries, community health libraries, university and college libraries.
Museums
Museums provide a range of useful education resources, e.g. collections, books, outreach programmes, courses. There are many different types of museums in South Africa. Find the correct one by searching on *http://www.museumsonline.co.za*
MTN Science Centres: *http://www.ctsc.org.za*
Gateway, Durban
National Advisory Council on Innovation (NACI): *http://www.naci.org.za*
The Secretary (NACI), Box 1758, Pretoria (Tshwane), 0001;
Tel: 012 392-9352
Quest: Science for South Africa (science magazine and website):
http://www.questinteractive.co.za
Published by the Academy of Science of South Africa (ASSAf - see p. C20)
Research and Development in Mathematics, Science and Technology (RADMASTE): *http://www.radmaste.org.za*
SASOL: *http://www.sasol.com*
Science in Africa online science magazine: *http://www.scienceinafrica.co.za*
Science Education Centre: *http://www.sec.org.za*
Funda Centre, Diepkloof, Soweto; Tel: 011 938-1760
Society of South African Geographers: *http://www.ssag.co.za*
PO Box 128, P O Wits, 2050; Tel: 011 339-1951
Shell Education Service
PO Box 747, Saxonwold, Johannesburg, 2123; Tel: 011
441-7000 **Shell South Africa**: *http://www.shell.com*
Education Program Organiser, Box 2231, Cape Town, 8000;
Tel: 021 213-1111
South African Agency for Science and Technology Advancement (SAASTA): *http://www.saasta.ac.za*
PO Box 1758, Pretoria (Tshwane), 0001; Tel: 012 392-9300
South African Institute of Physics (SAIP): *http://www.saip.org.za*
The Secretary, Postnet Suite 228, Private Bag X10, Musgrave 4062
South African Traditional Healers Association:
http://www.traditionalhealth.org.za
PO Box 3722, Johannesburg, 2001
Southern African Association of Science and Technology Centres:
http://www.saastec.co.za
Statistics on Africa and social issues: *www.afdb.gov* *www.fao.int*
www.sadc.int *www.statssa.gov.za* *www.worldbank.org*
Teachers' centres
Most areas in the country are supported by teachers' centres. They have a range of resources for you to borrow, as well as facilities for making your own teaching aids.
Universities and colleges
Approach various departments at your nearest university and college regarding a wide range of resources, e.g. visits, teaching aids, specimens, courses and speakers.

University of the Western Cape
Private Bag X17, Bellville, 7530; Tel: 021 959-2498
University of the Witwatersrand, PO Wits, 2050; Tel: 011 716-1111
Wilderness Leadership School: *http://www.wildernesstrails.org.za*
Box 87230, Houghton, 2041; Tel: 031 462-8642
Wildlife Environmental Society of South Africa (**WESSA**): *http://www.wessa.org.za*
Box 394, Howick, 3290; Tel: 033 330-3931
Worldwide Fund for Nature (**WWF**): *http://www.wwf.org.za*
PO Box 456, Stellenbosch, 7599; Tel: 021 887-2801

SECTION D

TEACHING GUIDELINES

List of activities

Module	Unit	Activity	Page
Module 2: Waves, sound and light	Unit 1: Transverse pulses on a string or spring	1 Test yourself: Demonstrating superposition in pulses	D30
		2 Demonstration: Observing superposition	D30
	Unit 2: Transverse waves	1 Test yourself: Calculating wave speed	D32
		2 Test yourself: Testing yourself on waves	D32
		3 Practical investigation: Investigating the effect of water depth on wave speed	D33
		4 Practical investigation: Investigating the pendulum	D34
	Unit 3: Longitudinal waves	1 Test yourself: Applying the properties of longitudinal waves	D35
		2 Project: Making a string telephone	D36
		3 Experiment: Measuring the speed of sound in air	D36
	Unit 4: Sound	1 Case study: Investigating the *vuvuzela*	D37
		2 Case study: Investigating noise pollution	D37
		3 Test yourself: Testing yourself on sound	D37
	Unit 5: Electromagnetic radiation	1 Investigation: Investigating cell phone radiation	D38
		2 Test yourself: Interpreting the electromagnetic spectrum	D39
		3 Practical investigation: Discussing the uses and effects of certain light rays	D39
		4 Test yourself: Calculating energy, frequency and wavelength	D40
		Summative assessment	D40
		Control test Term 1	B11
Term 2			
Module 1: Matter and materials (continued)	Unit 6: Particles making up substances	1 Research project: Investigating the allotropes of carbon	D42
		2 Case study: Investigating sodium chloride	D42
		3 Research project: Researching and demonstrating crystal lattices	D43
		4 Experiments: Investigating elements and compounds	D45
		5 Experiment: Investigating the electrolysis of water	D45
		6 Case study: Investigating glass	D45
		Summative assessment	D46
Module 3: Chemical change	Unit 1: Physical and chemical change	1 Experiment: Decomposing hydrogen peroxide	D48
		2 Experiment: Investigating the synthesis of water	D48
		3 Experiments: Proving the Law of Conservation of Matter	D49
		4 Experiment: Determining the ratio in which elements combine	D50
	Unit 2: Representing chemical change	1 Test yourself: Writing balanced equations	D51
		2 Experiment: Investigating the relation between amount of reactant and amount of product	D51
		Summative assessment	D51
Module 4: Electricity and magnetism	Unit 1: Magnetism	1 Experiment: Investigating the magnetic field patterns of bar magnets	D53
		2 Test yourself: Interpreting the effects of Earth's magnetic field	D54
		3 Research project: Finding out how migratory animals use Earth's magnetic field	D54
		4 Case study: Considering Earth's magnetic field	D54
	Unit 2: Electrostatics	1 Experiment: Testing the charge on different materials	D55
		2 Test yourself: Applying electrostatic attraction	D56

Module	Unit	Activity	Page
Module 4: Electricity and magnetism	Unit 3: Electric circuits	1 Practical demonstration: The difference between emf and potential difference	D56
		2 Test yourself: Interpreting current distribution in a circuit	D57
		3 Experiment: Investigating the current in electric circuits	D57
		4 Prescribed experiment: Investigating the effect of resistors in series and parallel	D58
		5 Test yourself: Answering questions on circuits	D59
		Summative assessment	D60
		Control test Term 2	B15
Term 3			
Module 3: Chemical change (continued)	Unit 3: Reactions in aqueous solution	1 Practical investigation: Investigating different types of solutions	D62
		2 Research project: Investigating hard water or acid rain	D62
		3 Experiment: Investigating the electrical conductivity of liquids	D64
		4 Practical investigation: Investigating dissolution processes	D65
		5 Research project: Researching chemical and physical change	D65
		6 Experiment: Investigating the solubility of salts	D65
		7 Experiment: Preparing $CuCO_3$	D67
		8 Experiments: Investigating acids and bases	D67
		9 Experiments: Identifying chemical reaction types	D68
		10 Case study: Studying limestone and its products	D68
	Unit 4: Quantitative aspects of chemical change	1 Experiment: Determining the mass of water of crystallisation	D70
		2 Test yourself: Working with stoichiometric calculations	D71
		3 Test yourself: Determining percentage composition	D72
		4 Experiments: Determining the composition of compounds	D72
		5 Test yourself: Calculating concentration and volume	D73
		6 Test yourself: Working with stoichiometric calculations in balanced equations	D73
		Summative assessment	D74
Module 5: Mechanics	Unit 1: Vectors and scalars	1 Test yourself: Applying vector diagrams	D78
	Unit 2: Motion in one dimension	1 Experiment: Measuring velocity	D80
		2 Test yourself: Calculating distance, displacement, speed, velocity and acceleration	D80
	Unit 3: Description of motion in graphs and equations	1 Test yourself: Interpreting position–time graphs	D81
		2 Test yourself: Interpreting a velocity–time graph	D81
		3 Experiment: Determining the position–time graph of a trolley	D82
		4 Prescribed project: Investigating acceleration	D83
		5 Test yourself: Calculations using equations of motion	D85
		6 Case study: Comparing indigenous and modern tracking devices	D86
		7 Practical investigation: Investigating motion graphically	D86
		Summative assessment	D87
		Control test Term 3	B19

Module	Unit	Activity	Page
Term 4			
Module 5: Mechanics (continued)	Unit 4: Energy	1 Test yourself: Investigating energy transformation in a roller-coaster	D90
		2 Test yourself: Calculating energy	D90
		Summative assessment	D91
Module 6: Chemical systems	Unit 1: The hydrosphere	1 Research project: Studying the ecology of a dam	D93
		2 Case study: Considering indigenous knowledge about collecting water	D94
		3 Practical investigation: Investigating water quality	D94
		4 Case study: Studying water-based activities	D95
		5 Experiment: Testing the composition of water samples	D95
		6 Prescribed project: Researching the purification and quality of water	D96
		Summative assessment	D97

LB p. 4

Activity 1 Test yourself

Converting units in scientific notation

1 a) $8,64 \times 10^4$ s
b) $6,38 \times 10^6$ m
c) 3×10^{-7} m
d) 3×10^{14} Hz
e) 1×10^{-6} m
f) $6,67 \times 10^{-11}$ N·m²·kg⁻²
g) $1,496 \times 10^8$ km
h) 1×10^{-15}
i) $8,848 \times 10^3$ m or $2,9029 \times 10^4$ ft
j) $1,292 \times 10^3$

2 a) $8,00 \times 10^{-5}$ N
b) $9,79$ m·s^{-2}
c) $6,00 \times 10^{-5}$ N
d) $2,68 \times 10^{20}$ molecules
e) $6,00 \times 10^{-7}$ N
f) $6,33 \times 10^6$ m
g) $1,10 \times 10^4$ m·s^{-1}

LB p. 9

Activity 2 Test yourself

Using conversion factors

1 a) 0,7 kg × 1 000 = 700 g
b) 250 mm ÷ 1 000 = 0,25 m
c) 10 cm ÷ 100 = 0,1 m
d) 25 °C + 273 = 298 K
e) 350 K – 273 = 75 °C
f) 5 atm × 101,3 = 506,5 kPa
g) 810,4 kPa ÷ 101,3 = 8 atm

2 a) 15 500 000 g ÷ 1 000 = 15 500 kg
b) $1,55 \times 10^4$ kg

3 a) $1,392 \times 10^6$ km
b) 1,392 Mm (megametres) (1 Mm = 10^6 m)
c) 2×10^{30} kg/1×10^{15} kg = 2×10^{15} kg
d) $t = T - 273 = 5\ 778 - 273 = 5\ 505$ °C
e) 500 million tonnes × 1 000 = 500 000 million kg
f) 500 000 000 000 kg = 5×10^{11} kg

LB p. 12

Activity 3 Test yourself

Changing the subject of a formula

1 a) $\Delta x = v\Delta t$
b) $\Delta t = \dfrac{v}{a}$
c) $h = \dfrac{E_p}{mg}$

d) $v = \sqrt{\dfrac{2E_k}{m}}$

e) $G = \dfrac{Fr^2}{m_1 m_2}$

f) $r = \sqrt{\dfrac{Gm_1 m_2}{F}}$

g) $I = \dfrac{V}{R}$

2 $2\ dm^3 = 2 \times 10^3\ cm^3$

$D = \dfrac{m}{V} \quad \therefore\ m = DV = 11{,}35\ g{\cdot}\cancel{cm^{-3}} \times 2 \times 10^3\ \cancel{cm^3}$

$= 22\ 700\ g$

$= 22{,}7\ kg$

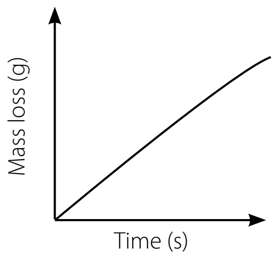
LB p. 14

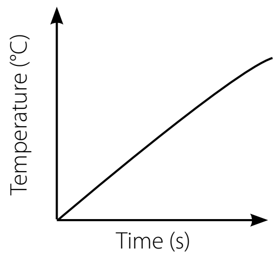
Activity 4 Experiment

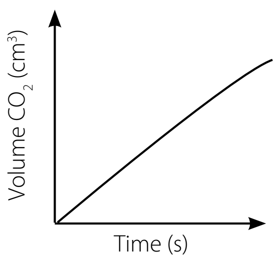
Investigating the rate of a chemical reaction

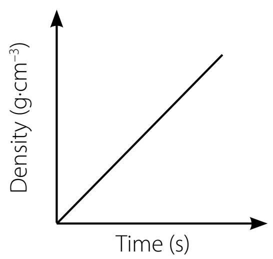
Safety
Learners and teachers must always wear protective safety goggles during all chemical experiments.
The chemicals used in this experiment are in most household kitchens and are low hazard.
Be careful when handling glassware.

Time (s)	0	5	10	15	20	25	30
Temperature (°C)							
Mass (g)							
Volume (cm^3)							









a) The shapes of the graphs are all initially straight lines through the origin.
b) Volume, mass loss, temperature and density are all initially directly proportional to the time.

c) The gradient is the rate of change of volume, mass, temperature or density. From the graph we can work out the gradient as the change in y-value (the dependent variable) divided by the change in x-value (time): $m = \frac{\Delta y}{\Delta x}$
d) The constant will be equal to the gradient when there is a direct proportionality – that is, where the graph line is straight.
e) The fixed variables must remain constant during the course of the experiment. They are the initial volume and mass of the reactants and temperature of the surrounding air.

MODULE 1 MATTER AND MATERIALS

Background information for Module 1

In this module learners come into contact with the basics of chemistry. It is very important that learners link the chemistry of their Physical Sciences books and the Periodic Table to their everyday life and experiences. We have made a special effort to include general information and activities that will assist learners in making that link. An important aspect to instil in learners is that nobody knows it all, and we discover new information every day. All great scientists were inherently inquisitive about their surroundings. In fact, a scientific investigation starts with a question.

In this module we assume that the learners already know the symbols of the different elements. It is a good idea to give them a test on the symbols as a baseline assessment. You cannot speak the language of chemistry if you do not know the alphabet!

Many questions in the activities (e.g. Activities 1, 2, 3 and others) do not have simple correct or incorrect answers. Encourage learners to think about the questions. The answers provided are not the only correct ones. Give the learners credit for original thought. There is also extension information to assist with some of the activity answers.

Matter and materials makes up 17,5% of the Physical Sciences curriculum for Grade 10, so you should spend 24 teaching hours on this module to cover the content. The content has been divided into six units. In Term 1 you will revise the classification of matter in Unit 1. Most of the concepts in this unit were explained in the Senior Phase. Unit 2 covers the states of matter and the Kinetic Molecular Theory, which also formed part of the Senior Phase. Learners should have a basic understanding of these concepts. Unit 3 deals with the structure of the atom and Unit 4 with the Periodic Table. Unit 5 covers covalent, ionic and metallic bonding. Unit 6 deals with the particles that substances are made of and is done at the beginning of Term 2. There is a logical progression of building chemistry knowledge through the units. A good understanding of this module will ensure that learners find Module 3 on chemical change easy to follow.

This unit revises knowledge about the classification of matter that was done in the Senior Phase. Only two hours are allocated to this unit, but it covers a lot of information. You should first determine the level of prior knowledge that the learners have before they 'waste' time repeating sections that learners already know. We recommend a baseline assessment task. The Learner's Book provides enough information to assist learners who do not have a sound base of prior knowledge. There are also many short activities that you can give as revision exercises.

Learners must know how to write accurate formulae for compounds before they can balance equations. This will enable learners to deduce the products of reactions. Encourage learners to discover that formulae are not arbitrarily created and 'given by the teacher'. They should know that they can also work out the formulae for themselves.

LB p. 28

Activity 1 Test yourself

Cognitive level 3 P

Classifying materials

1 Everyday materials classified according to their properties:

	Strong	Conduct heat and electricity	Brittle	Malleable and ductile	Magnetic	Dense	Light in weight	High melting point
Drinking glass			✓				✓ not as light as plastic	✓
Plastic cup							✓	
Iron nail	✓	✓		✓	✓	✓		✓
Copper wire	✓	✓		✓		✓		✓
Aluminium foil		✓		✓		✓	✓ light metal	✓
Newspaper							✓	
Ceramic plate			✓					✓

2 Properties that make the objects listed in the table suitable for their functions:
Drinking glass: clear, hygienic, easy to clean, relatively cheap
Plastic cup: hygienic, easy to clean, cheap, does not break
Iron nail: strong, malleable
Copper wire: conducts electricity, ductile
Aluminium foil: malleable, conducts heat, relatively light
Newspaper: light, can be printed on, cheap, can be folded
Ceramic plate: hygienic, easy to clean, relatively cheap, not a good conductor of heat

LB p. 31

Activity 2 Test yourself

Cognitive levels 1–3 P

Investigating mixtures

1 and 2

Homogeneous mixtures	Solvent	Solute
Can of fizzy cooldrink	Liquid cooldrink	Carbon dioxide gas
Cornflakes	Corn	Additives such as colourants and flavourants
Stainless steel bowl	Iron	Carbon, chromium and nickel
Petrol	Octane	Nonane and other hydrocarbons
Brass	Copper	Zinc
Clouds	Gas (air)	Liquid (water)
Two-stroke motor oil	Petrol	Oil
Cup of coffee	Water	Solid coffee

Heterogeneous mixture	Main phase	Particle type mixed into phase
Sponge cake	Solid	Gas (air)
Muesli	Solid (oats)	Solid (raisins, etc.)
Scrambled egg (gel)	Solid	Liquid (milk, etc.)
Pizza	Solid (base)	Solid (topping – cheese, tomato, etc.)
Hair mousse (foam)	Liquid	Gas
Wood	Cellulose (carbon)	Minerals, plant sap, etc.

LB p. 31

Activity 3 Research project

Cognitive levels 3–4 I

Investigating additives in food and medicine

1 The aim of this part of the activity is to make learners aware of the different forms of matter all around us. Encourage learners to identify different types of homogeneous mixtures (e.g. gas in liquid, solid in gas) and heterogeneous mixtures (e.g. aerosol, gel, foam) in their homes. They might find the number of additives and flavourants in some products interesting, especially in foodstuffs. Encourage learners to think about the effects of these products on the environment and our bodies. They can find information from a nearby pharmacy, the library or the internet. Use the rubric for tables on page E6 to assess the learners' tables.

2 Meat and fish are the main sources of protein that humans eat. Both have a short shelf-life before bacteria and other micro-organisms multiply in meat and fish and cause food poisoning. The symptoms of food poisoning are nausea, stomach cramps, vomiting and diarrhoea. Food poisoning can cause death. Fish spoils within 12 hours, but we can extend this time period by keeping fish in ice after it has been caught. Hygienic slaughtering and clean handling of fresh meat extends the shelf-life of meat.

The main form of preservation of fresh meat and fish that we buy in fisheries, butcheries and supermarkets is the *cold chain*. After animals are slaughtered and fish are caught, it is important to lower the product's temperature and to keep it low (less than 5 °C) until the customer buys the food. All handling, packing and transport of the product must be in refrigerated rooms and trucks. Micro-organisms that are responsible for food poisoning cannot grow and multiply in low temperatures. Nitrates are used to preserve the red colour of meat. Nitrates are either mixed with fresh meat before packing or a nitrate-containing gas is injected into the cavity between the meat and the plastic film that covers the container.

Through the ages humans have developed methods to preserve their fresh fish and meat. The curing process uses a combination of salt, sugar, nitrates and nitrites. Humans also smoke meat and fish to preserve them. Sodium nitrate and potassium nitrate kill bacteria and retain the red colour of the meat. Nitrates are used for making sausages, hams, bacon and tinned meat. An example of traditional meat preservation is *biltong*. Fresh meat cuts are soaked in a mixture of salt, sugar, spices and vinegar. Fish can be salted and dried to make *bokkoms*. Oily fish such as snoek can be cured by salting or smoking.

Traditional curing methods preserve meat and fish for long periods of time, but the curing changes the appearance, taste and nutritional value of the food. Before refrigeration was available it was the only way to preserve some of the meat after slaughtering animals. Nowadays technology allows us to eat fresh meat every day.

LB p. 33

Activity 4 Test yourself

Cognitive level 1 *I*

Classifying pure substances and mixtures

Pure substances	Mixtures
Water	Tea
Copper	Salt water
Zinc	Brass
Oxygen	Air
Carbon dioxide	Household cooking gas
Ethanol	Petrol
Caustic soda flakes	Soap

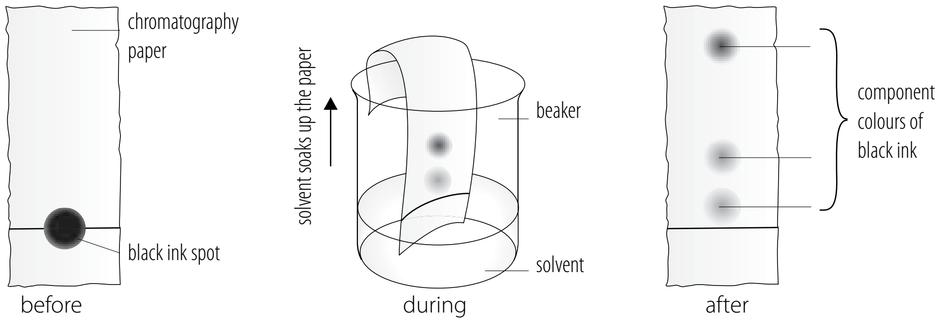
LB p. 34

Activity 5 Practical investigation

Cognitive levels 3–4 *P*

Determining the purity of ink

The diagrams on page 34 of the Learners' Book show the learners how to conduct this experiment.



- Cut a strip of filter paper or ink blotting paper.
- Make a dot near the bottom of the strip with the black felt-tipped pen. A non-permanent water soluble transparency marker works well.
- Place the edge of the paper strip with the dot on it in water and hang the other end over the side of the beaker so that it does not fall into the water.
- Allow the apparatus to stand until the black dot has separated into its constituent colours.
- Wet the bottom end of another strip of paper and place a smartie type of chocolate on it. Allow the colour of the sweet to stain the paper. Remove the sweet and leave the paper to dry.
- Follow the same method as with the felt-tipped pen to separate the colours in the smartie dye.

LB p. 36

Activity 6 Test yourself — Cognitive level 1 I

Investigating symbolic representation of elements and compounds

Name of compound	Formula	Atoms in the compound
Carbon dioxide *	CO_2*	1 carbon atom, 2 oxygen atoms *
Water	H_2O	1 oxygen atom, 2 hydrogen atoms *
Ammonia *	NH_3	1 nitrogen atom, 3 hydrogen atoms
Copper sulfate	$CuSO_4$ *	1 copper atom, 1 sulfur atom, 4 oxygen atoms
Calcium oxide	CaO	1 calcium atom, 1 oxygen atom *
Calcium hydroxide *	$Ca(OH)_2$	1 calcium atom, 2 oxygen atoms, 2 hydrogen atoms
Ammonium nitrate	NH_4NO_3 *	2 nitrogen atoms, 4 hydrogen atoms, 3 oxygen atoms

* means given already in the table in the question

LB p. 42

Activity 7 Test yourself — Cognitive level 2 I

Writing chemical formulae

Learners write down the correct formulae for the compounds that are formed when you combine:

1 potassium and sulfate: K_2SO_4
2 calcium and carbonate: $CaCO_3$
3 aluminium and hydroxide: $Al(OH)_3$
4 zinc and nitrate: $Zn(NO_3)_2$
5 copper(II) and chlorine: $CuCl_2$
6 silver and bromine: AgBr
7 potassium and oxygen: K_2O
8 hydrogen and nitrogen: NH_3
9 magnesium and fluorine: MgF_2
10 hydrogen and sulfur: H_2S

LB p. 42

Activity 8 Test yourself — Cognitive levels 1–2 I

Identifying ingredients in medicine

1 Sodium bicarbonate; scientific name sodium hydrogen carbonate
2 Sodium chloride is table salt; sucrose is sugar
3 Sodium chloride: NaCl
Potassium chloride: KCl
Sodium bicarbonate: $NaHCO_3$
Glucose: $C_6H_{12}O_6$
Sucrose: $C_{12}H_{22}O_{11}$
4 Total active ingredients: 13,44 g
Total mass that is not part of medication: 14,00 g − 13,44 g = 0,56 g
5 It has no medicinal value or effect on the body.

LB p. 44

Activity 9 Practical investigation — Cognitive levels 3–4 P

Classifying metals, non-metals and metalloids

1 Learners use the properties of metals to determine which substances are metals:
- shiny and usually grey in colour
- conduct electricity and heat
- malleable and ductile.

Metals	Metalloids	Non-metals
Copper	Silicon	Sulfur
Lead		Carbon
Aluminium		Iodine
Zinc		Graphite
Iron		

2 Some uses of substances:
This is not a complete list. Divide the class into groups and ask each group to research a substance and report back to the class.
Copper: coins; wiring and electric circuits; pots and pans, particularly the bottoms/bases; water pipes; doorknobs and other house fixtures; jewellery; to make brass
Lead: car lead-acid batteries; ballast keel of sailboats and scuba diving weight belts; glazing bars for stained glass; fishing sinkers; fire arms; construction industry as roofing and cladding; sound insulation; radiation shielding; soldering; statues and sculptures
Aluminium: packaging (cans and foil); transport (bicycles, cars and aircraft); construction (windows, sliding doors) cooking utensils; street lighting poles, ships' masts, walking poles; electrical transmission lines; electronics; in paint; pyrotechnics; coins
Zinc: galvanising; precision components (die casting); construction material; to make brass
Iron: to make steel; wrought iron in fencing and furniture; magnets
Silicon: electronic equipment
Sulfur: manufacture of sulfuric acid, fertilisers, rubber, matches, adhesives, explosives; antibiotics, skin creams and lotions; fungicides; dyes; preservation
Carbon: printing; odour absorbent; jewellery (diamond)
Graphite: lead in pencils; steel making; brake linings; lubricants; foundry facings
Iodine: medication (for thyroid and other ailments); water purification

Note
Graphite is a form of carbon, but it has specific uses.

LB p. 45

Activity 10 Practical investigation

Cognitive level 1 G

Determining the conductivity of various solids

Conductors (bulb lights up): copper pipe, pencil 'lead' (this is graphite), silver or gold ring, aluminium foil, lead sinker
Insulators (bulb does not light up): plastic ruler, rubber pipe, glass, piece of wood, ceramic plate

LB p. 45

Activity 11 Research project

Cognitive levels 3–4 I

Learning more about semiconductors

You might not have time to allow learners to conduct a research project. The information on this topic also often contains difficult terms and words that confuse the learners. You can use this information during the lesson to broaden the learners' science general knowledge. Emphasise that the application of semiconductors and their use in electronics is important. Learners need to understand the huge impact that silicon, the semiconductor used in computer chips, has had on the world. Functioning of personal computers depends on the miniaturisation of computer components that is possible using silicon and germanium. This has transformed our world.

Metalloids tend to be semiconductors; they conduct electricity, but not nearly as well as metals. The conductivity of semiconductors increases with temperature and when they are 'doped' with small amounts of certain impurities. The conductivity of metals decreases with temperature. The property of conductivity, particularly in silicon and germanium, is responsible for the progress made in recent decades in the field of solid-state electronics. Almost every hi-fi stereo system, television set and FM radio relies on transistors made from semiconductors. Perhaps the most amazing advantage of all has been the incredible reduction in size of electronic components that semiconductors have allowed. We owe the development of small and versatile television cameras, CD players, hand-held calculators and microcomputers to semiconductors. The heart of these devices is a microcircuit printed on a tiny silicon chip.

LB p. 46

Activity 12 Practical investigation Cognitive levels 3–4 P

Investigating thermal conduction

1 A tiled floor feels colder than a carpeted floor because ceramic tiles are better conductors of heat than carpets. Ceramic substances conduct heat away from your feet, leaving them feeling colder than before. However, carpets trap air, which is a good insulator. When you stand on a carpet, no heat is conducted away from your feet and it feels warm.

3 You can use the information on microwave ovens as part of the lesson content to broaden the learners' science general knowledge.

Microwaves are especially interesting from the point of view of cooking food. Conventional ovens cook food by heating the outside of the food and then relying on conduction for the heat to penetrate the food. Microwaves radiate the food with microwaves (of frequency 2 450 MHz), which cause the food particles to rotate. The food is cooked more evenly as all the food particles rotate and get hot, thus cooking the food.

Microwaves pass through glass, plastics and ceramics (microwave-proof containers). This means that the container the food is cooked in does not get as hot as it would in a conventional oven. This is one of the conveniences of microwave ovens. It may be worthwhile going through the advantages and disadvantages with the class.

Allow the learners to research the health risks associated with microwaves. This is a lively topic and may generate a debate since many people have microwave ovens and would strongly argue that they do not cause cancer!

Microwaves are a form of electromagnetic radiation. They are generated by magnetrons, which were invented during World War II when radar technology was being developed. The magnetron is a hollow cylinder inside a horseshoe-shaped magnet. In the centre of the cylinder is a cathode rod. The walls of the cylinder form the anode. When heated, the cathode emits electrons that travel towards the anode. The magnetic field forces the electrons to move in circles. The motion of the charged particles generates microwaves. A waveguide directs the microwaves into the cooking compartment. Rotating fan blades deflect the microwaves to all parts of the oven.

The cooking action in the oven results from the interaction between the radiation and polar molecules. Most foods contain polar water molecules. Microwaves cause the water molecules to rotate faster. Friction from the rotating water molecules heats up the surrounding food molecules. Radiation cannot be absorbed by non-polar molecules.

- Plastic and Pyrex glassware do not contain polar molecules and therefore are not affected by microwave radiation.

- We cannot use styrofoam and certain plastics in microwaves because they have low melting points.
- Metals reflect microwaves. Reflected microwaves can overload the microwave emitter. Microwaves can also induce a current in a metal and sparks can jump between the container and sides of the oven.

LB p. 47

Activity 13 Practical investigation — Cognitive levels 1–2 G

Investigating the magnetic properties of various solids

Magnetic materials:

- due to the magnetism of iron: iron nails, steel pins, paper clips, stainless steel cutlery, iron/steel cooldrink cans
- due to the magnetism of nickel and cobalt: coins and certain types of cutlery.

Silver, gold, platinum and aluminium cooldrink cans are not magnetic. (But they may be slightly magnetic due to the presence of ferromagnetic materials alloyed with the other metal.)

Unit 2 States of matter and the Kinetic Molecular Theory

TERM 1, MODULE 1

The basic concepts of the Kinetic Molecular Theory were covered in the Senior Phase. Learners should have prior knowledge of states of matter and the significance of boiling and melting points. This unit contains a prescribed experiment.

LB p. 51

Activity 1 Test yourself — Cognitive levels 2–3 I

Classifying solids, liquids and gases

Solids (Melting point higher than 25 °C; Boiling point higher than 25 °C)	Liquids (Melting point lower than 25 °C; Boiling point higher than 25 °C)	Gases (Melting point lower than 25 °C; Boiling point lower than 25 °C)
Iodine	Bromine	Helium
Carbon	Water	Chlorine
Phosphorus	Ethanol	Oxygen
Sulfur		Nitrogen
Sugar		Carbon dioxide
Copper		Methane
Sodium		Ammonia
Magnesium		
Lead		
Iron		
Silicon		
Germanium		
Table salt		
Rust		

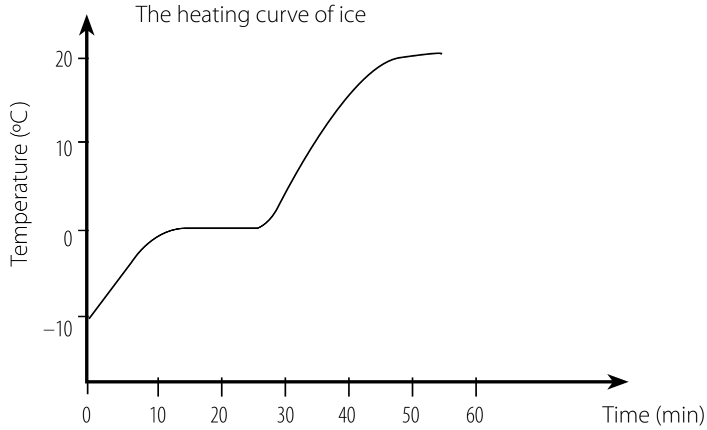
LB p. 53

Activity 2 Test yourself

Cognitive levels 2–3 *I*

Investigating heating curves

1 a)



b) When the beaker was taken out of the freezer the temperature was −10 °C. That must have been the temperature inside the freezer.
c) The ice was melting.
d) The heat absorbed was used to break the intermolecular bonds between the water molecules in the ice crystals.
e) No. If the temperature of the surrounding atmosphere is 20 °C, the water molecules cannot gain more heat for the temperature to rise any higher.

2 a) A – solid
B – solid and liquid (substance is melting)
C – liquid
D – liquid and gas (substance is boiling)
b) Melting point: 17 °C
c) Boiling point: 115 °C
d) The temperature remains constant while the substance is changing state.

LB p. 54

Activity 3 Prescribed experiment

Cognitive levels 3–4 *G* *PPA*

Determining the heating and cooling curves of water

Rubric for formal assessment of prescribed experiment

Total: 20 marks

Assessment criteria	Rating			
	4	3	2	1
Organisation – works through method in orderly manner	Method followed; efficient and organised; neat	Method partly followed, not well organised; neat	Method not well followed; disorganised; untidy	No idea how to follow method; disorganised; messy
Efficient use of allocated time			Experiment completed efficiently and in time	Experiment not completed; inefficient
Ability to use apparatus			Used apparatus correctly and with care	Sometimes used apparatus correctly

Assessment criteria	Rating			
	4	3	2	1
Data tables	1. Suitable heading 2. Correct format 3. Units correct 4. Data entered correctly	Three of the four criteria correct	Two of the four criteria correct	One of the four criteria correct
Graphs	1. Suitable heading 2. Size and scale correct 3. Axes labelled and with units 4. Graph correct	Three of the four criteria correct	Two of the four criteria correct	One of the four criteria correct
Questions	Answered and explained all questions correctly	Answered questions correctly; explanations not clear	Answered questions; no explanations	Answered some questions

a) At 0 °C and 100 °C (at sea level). If measurements are taken inland, the boiling point of water will be lower than 100 °C.

Background information for teachers

The pressure on the substance affects its boiling point. Boiling points are usually listed at atmospheric pressure, which is called **standard pressure**. When the pressure increases or decreases the boiling points change. When the pressure decreases, for example in a vacuum, the boiling points are lower. When the pressure increases the boiling points are higher, for example, the boiling point of water varies according to the altitude. At sea level we have atmospheric pressure and the boiling point of water is 100 °C. At inland areas where the altitude is above sea level, the boiling point of water decreases.

Place	Altitude	Boiling point of water
Cape Town, Port Elizabeth, Durban	Sea level	100 °C
Bloemfontein	1 389 m	95,6 °C
Johannesburg	1 755 m	94,4 °C
Mount Kilimanjaro	5 895 m	80,5 °C
Mount Everest	8 850 m	70,4 °C

It is ‘easier’ to boil water at lower pressures. An interesting example is that it will take a long time – perhaps 30 minutes or more – to hard-boil an egg on Mount Everest, which is 8 850 m above sea level. It is not the boiling action of the water that cooks the egg, but the amount of heat transferred. It will take a long time to transfer enough heat to cook the egg.

b) At 0 °C the ice melts and changes phase from solid ice to liquid water. At 100 °C the water vaporises and changes phase from liquid water to gaseous steam.

c) The heat from the Bunsen burner is used to break some of the intermolecular forces between the water molecules in the ice crystal.

When enough of these forces are broken, the ice crystal collapses and the water molecules can flow freely around one another.

As the temperature rises, the speed of the individual water molecules increases steadily. At boiling point the temperature is sufficiently high to overcome all the intermolecular forces and free the molecules from these forces. Without the intermolecular forces holding them down, they are free to move up into the air in the form of a gas called steam.

Unit 3 The atom

TERM 1, MODULE 1

The atom is the basic unit of all matter. Emphasise that the atomic model is a dynamic model that has changed many times in the past. This model will also change in the future as new information becomes available. The electron configuration of atoms determines their chemical reactivity and is the first step in understanding chemical change.

LB p. 58

Activity 1 Research project

Cognitive levels 3–4 G

Learning about the history of the atomic model

Make sure that the learners present the different scientists in the correct time line order on their posters.

Comment during and after their presentations to show that the atomic model was the result of combined work of many scientists working in different countries over many centuries. These scientists all played a part in adding to earlier scientists' work to gain a better understanding of the atom. What we know today was not a brilliant idea from one brilliant man.

At the end of the presentations it may be beneficial to place the different posters next to each other to compare how scientists' understanding of the atom developed as time progressed.

Use the rubric on page E10 to assess the posters.

Key discoveries about atomic structure

- Empedocles (450 BC) claimed that all things are made of four primal elements – fire, air, earth and water. Two active and opposing forces – love and hate or affinity and antipathy – act on these elements to combine and separate them into infinitely varied forms.
- Leucippus and Democritus (440 BC) proposed the idea of the atom as an indivisible particle making up all matter. Natural philosophers have mostly rejected this idea in favour of Aristotle's view.
- Epicurus (300 BC) believed that events in the world are ultimately based on the motions and interactions of atoms moving in empty space.
- Lucretius (50 BC) published *De Rerum Natura*, a poetic description of the ideas of atomism.
- Maria the Jewess (100–200) invented several pieces of chemical apparatus. She was first non-fictional alchemist in the Western world.
- Zosimos (300) wrote some of the oldest books on alchemy. He defined alchemy as the study of the composition of waters, movement, growth, embodying and disembodying, drawing the spirits from bodies and bonding the spirits within bodies.

- Geber (815) was an Arab/Persian, and probably the most famous alchemist in medieval Islam. He made important advances in alchemy.
- Rhazes (1000) was a Persian chemist who refuted the practice of alchemy and the theory of the transmutation of metals.
- Robert Boyle (1661/1662) published *The Sceptical Chymist* on the distinction between chemistry and alchemy. The treatise contains some of the earliest modern ideas of atoms, molecules, and chemical reactions and was the start of the history of modern chemistry. Boyle proposed Boyle's Law which he based on experimentation. His law describes the behaviour of gases, specifically the relationship between pressure and volume.
- Henry Cavendish (1766) discovered hydrogen as a colourless, odourless gas that burns and can explode when mixed with air.
- Antoine Lavoisier is considered the father of modern chemistry. He recognised and named oxygen and saw its importance and role in combustion (1778). He published *Methode de Nomenclature Chimique*, the first modern system of chemical nomenclature (1787). He also published *Traite Elementaire de Chimie*, the first modern chemistry textbook, which is a complete survey of modern chemistry. This textbook includes the first concise definition of the Law of Conservation of Mass and represents the founding of stoichiometry or quantative chemical analysis (1789).
- John Dalton described the relationship between the components in a mixture of gases and the relative pressure that each contributes to the overall mixture (1803). This first modern scientific description of the atomic theory is a clear description of the Law of Multiple Proportions (1805).
- James Maxwell (1831) formulated the classical electromagnetic theory.
- Henri Becquerel (1852) discovered radioactivity by spontaneous emission of nuclear radiation.
- Max Planck (1858) was the founder of the quantum theory.
- Marie Curie (1867) pioneered the field of radioactivity. She isolated radioactive isotopes and discovered polonium and radium.
- CJ Davisson (1881) discovered electron diffraction through grating.
- Max Born (1882) was instrumental in developing quantum mechanics.
- LH Germer (1896) proved the wave-particle duality of matter in the Davisson-Germer experiment. He supported De Broglie's theoretical work.
- JJ Thomson (1897) discovered the electron using the cathode ray tube.
- Ernest Rutherford discovered the source of radioactivity as decaying atoms and introduced the terms for various types of radiation (1900). Rutherford's gold foil experiment proves the nuclear model of the atom, with a small dense positive nucleus surrounded by a diffuse electron cloud (1911).
- Albert Einstein (1905) explained Brownian motion in a way that definitively proves atomic theory.
- Niels Bohr (1913) introduced concepts of quantum mechanics to atomic structure by proposing the Bohr model of the atom, where electrons exist only in strictly defined orbitals.
- Louis De Broglie (1924) introduced the wave model of atomic structure, based on the ideas of wave-particle duality.
- Erwin Schrödinger (1926) proposed the Schrödinger equation, which provides a mathematical basis for the wave model of atomic structure.
- Werner Heisenberg (1927) developed the uncertainty principle that explains the mechanics of electron motion around the nucleus.
- James Chadwick (1932) discovered the neutron.

Adapted from Wikipedia

LB p. 61

Activity 2 Test yourself

Cognitive level 1

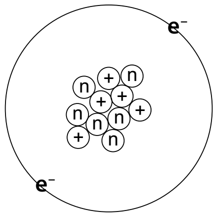
Applying atomic structure

1 a) electron: −1 b) neon atom: neutral c) helium nucleus: +2
d) oxygen nucleus: +8 e) neutron: neutral f) proton: +1

2 a)

	protons	neutrons	electrons
B	5	6 (mostly)	5
B^{3+}	5	6 (mostly)	2

b)



LB p. 62

Activity 3 Test yourself

Cognitive level 3

Applying knowledge of isotopes

1 a) Relative atomic mass of zinc

$$= \frac{(48{,}63 \times 64) + (27{,}90 \times 66) + (4{,}10 \times 67) + (18{,}75 \times 68) + (0{,}52 \times 70)}{100} = 65{,}40$$

b) Most abundant isotope of zinc: ^{64}Zn

Number of protons	Number of neutrons	Number of electrons in neutral atom
30	34	30

2 Number of neutrons

A	B	C	D
C: 12 – 6 = 6	F: 19 – 9 = 10	Na: 23 – 11 = 12	Co: 59 – 27 = 32
Mg: 24 – 12 = 12	Ne: 20 – 10 = 10	K: 39 – 19 = 20	Ni: 59 – 28 = 31

The answer is B.

3

Isotope	Symbol	Number of protons	Number of neutrons	Number of electrons
Uranium-235	$^{235}_{92}U$	92	143	92
Uranium-238	$^{238}_{92}U$	92	146	92

LB p. 67

Activity 4 Test yourself

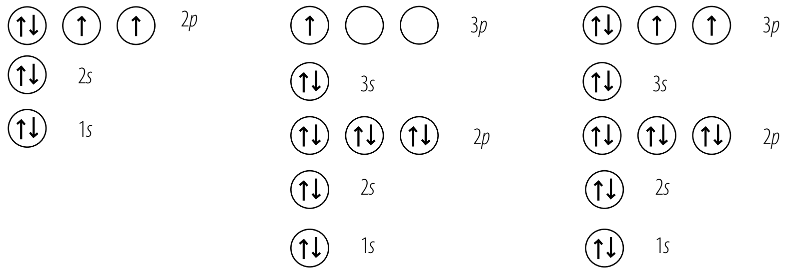
Cognitive levels 1–3

Applying the concepts of the atomic model

1 a) Nucleons – particles that make up the nucleus (protons and neutrons)
b) Mass number – the total number of protons and neutrons added together
c) Atomic number – the number of protons
d) Isotopes – different types of the same element, i.e. having the same number of protons but different numbers of neutrons
e) Relative atomic mass – the mass of an atom of an element relative to the mass of a carbon-12 atom, which has a mass of 12 atomic mass units
f) Ground state – the lowest energy level of an electron
g) Excited state – state of an electron when it gains energy and moves into a higher energy level
h) Atomic orbital – area around the nucleus where there is a certain probability of finding an electron

i) Electron configuration – the way in which electrons are arranged around the nucleus of an atom

2 Orbital box diagrams for oxygen, aluminium and sulfur.



oxygen (Z = 8) aluminium (Z = 13) sulfur (Z = 16)

3 a) Boron: $1s^2\ 2s^2\ 2p^1$

b) Relative atomic mass is not a whole number because it represents the average mass of a sample of that element and takes into account all the isotopes of the element and their percentage occurrence in nature.

c) $\frac{(10 \times 19{,}9) + (11 \times 80{,}1)}{100} = 10{,}8$

4 Magnesium has an *atomic number* of 12 and three *isotopes*: ^{24}Mg, ^{25}Mg and ^{26}Mg.

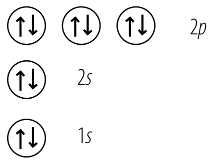
a) Atomic number – the number of protons in the nucleus of an atom
Isotopes – different types of the same element, i.e. having the same number of protons but different numbers of neutrons

b)

Isotope	Protons	Neutrons	Electrons
Magnesium-24	12	12	12
Magnesium-25	12	13	12
Magnesium-26	12	14	12

c) Magnesium-24 is the most common isotope because the average is closer to 24 than 25 or 26.

d) The orbital box diagram for the magnesium ion (Mg^{2+}):



Mg^{2+}

LB p. 68

Activity 5 Experiment

Cognitive level 1–3 G RPA

Using flame tests to identify elements

Safety

- Learners and the teacher must wear safety goggles during experiments.
- Methanol is flammable and the methanol container should not be near the open flame.
- Handle the bamboo sticks with a pair of tongs.
- Don't allow the bamboo sticks to catch alight. The methanol should burn with the colour of the salt to be tested.

Checklist of teacher's assessment of individual in a group during demonstration

Task skills	Yes	No	Comments
Stays focused on demonstration			
Understands experimental method			
Answers simple questions during demonstration			
Helpful/ assists teacher			
Records results correctly			

Salt or metal	Colour of flame
NaCl	bright yellow-orange
$CuCl_2$	bright green
$CaCl_2$	yellowish-red
KCl	light purple-violet
Cu	bluish-green
Mg	bright white
Zn	bluish-green
Fe	gold

Unit 4 The Periodic Table

TERM 1, MODULE 1

It is vitally important for learners to understand the basics of the Periodic Table and its periodicity. This is the chemist's most valuable tool for understanding matter, the elements and the changes it undergoes. Each learner should have their own copy of the Periodic Table. Colour-coding the important aspects, for example the *s*-blocks, *p*-blocks and *d*-blocks, names of different groups and valencies will make it easier to remember.

LB p. 73

Activity 1 Test yourself

Cognitive level 3 I

Using the Periodic Table to determine the arrangement of elements

1 Complete the table:

Element	Notation	Protons	Neutrons	Electrons	Electron configuration
Sodium *	$^{23}_{11}Na$	11	12	11	[Ne] $3s^1$ or $1s^2\ 2s^2\ 2p^6\ 3s^1$
Magnesium ion*	$^{23}_{12}Mg^{2+}$	12	12	10	[Ne] or $1s^2\ 2s^2\ 2p^6$
Fluoride ion*	$^{19}_{9}F^-$	9	10	10	[Ne] or $1s^2\ 2s^2\ 2p^6$
Calcium ion	$^{40}_{20}Ca^{2+}$	20	21	18	[Ar] or $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
Aluminium ion	$^{23}_{13}Al^{3+}$	13	14	10	[Ne] or $1s^2\ 2s^2\ 2p^6$
Oxygen	$^{16}_{8}O$	8	8	8	[He] $2s^2\ 2p^4$
Helium	$^{4}_{2}He$	2	2	2	$1s^2$
Sulfur	$^{33}_{16}S$	16	17	16	[Ne] $3s^2\ 3p^4$
Chloride ion	$^{35}_{17}Cl^-$	17	18	18	[Ar]

* = given already in the table in the question

2 All the elements of Group 17 have 7 valence electrons. Therefore these elements can gain an electron in a chemical reaction relatively easily, and they do this readily. The elements in Group 18 are already stable since they have full energy levels. They do not lose or gain electrons easily in chemical reactions.

LB p. 81

Activity 2 Test yourself

Cognitive level 1 I

Filling in a period of the Periodic Table

Period 3 of the Periodic Table

1	2	13	14	15	16	17	18
G	B	C	D	H	E	A	F

LB p. 83

Activity 3 Practical investigation

Cognitive levels 2–3 G

Investigating the properties of Group 1 elements

Safety

- The Group 1 metals lithium, sodium and potassium are extremely flammable and corrosive. Teachers should handle them with great caution.
- The teacher and learners must wear safety goggles.
- The teacher should wear protective gloves.
- The troughs should have safety screens around them.
- Learners should be at least 2 m away from the apparatus.
- Teachers should try the experiments in advance if they have not done them before. Prepare the apparatus and chemicals in advance: cut small pieces of the metals and store in oil; fill water troughs; collect other apparatus needed.

The teacher must do this activity as a demonstration – learners must never be allowed to perform the experiments. It is designed to give learners a practical insight into the concept of periodicity.

You will need

tweezers
filter paper
ceramic tile
scalpel or sharp knife to cut the metals
large water trough(s)
universal indicator
detergent
small cubes (3 mm max) of lithium, sodium and potassium.

Method

Remove a piece of the alkali metal from the oil with the tweezers. Place the metal on a tile and, using a scalpel or sharp knife, cut a small piece of lithium about the size of a 3 mm cube. Return the large piece to its bottle immediately. Perform the experiments with each metal in turn. Make sure that the pieces of metal do not lie around on the tile for too long as they might catch alight spontaneously. Repeat experiments with similar small pieces of sodium and potassium. The pieces should be 3mm cubes or smaller.

1. **Physical properties**
   Do the following with a small piece of each metal:
   - Remove the metal from the oil with tweezers.
   - Cut the metal with a scalpel. Note the colour. Place any unused pieces back into the oil.

- Wearing protective gloves, squeeze the remaining metal in your gloved hand to show its softness. Do not let learners touch any of them!
- The metals are softer as they go down the group in the Periodic Table. Lithium is the hardest metal to mould.

2 **Chemical properties: reaction with water**
- Fill the trough(s) about half-full of water. Add a drop of detergent to stop the metals sticking to the side. Place enough universal indicator solution into each until the colour is clearly visible.
- Place safety screens around the troughs.
- Remove a small piece of lithium from the bottle with the tweezers. Place it on a filter paper and close the bottle. Use the filter paper to wipe off the oil.
- Drop the piece of metal onto the water surface in a trough with the tweezers.
- The lithium should float and fizz as it gives off hydrogen. The water in the trough should turn alkaline.
- Use a fresh trough (or fresh water) for the next metal.
- Repeat with the other metals.
- Potassium is the most reactive. Do not dry potassium with the filter paper – it might set the paper alight!

Reactivity increases as elements go down the group. Lithium should bubble on the surface of the water, while potassium should give a more violent reaction – the heat of the reaction is enough to ignite the hydrogen that is released.

3 Group 1 elements become a) softer and b) more reactive. With this in mind the learners should be able to deduce that caesium, which sits right near the bottom of the group should be a) the softest (melting point 28 °C) and b) the most reactive of the four elements.

4 Li: $1s^2\ 2s^1$
Na: $1s^2\ 2s^2\ 2p^6\ 3s^1$
K: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$
a) Lithium has one filled energy level, Na has two filled energy levels and K has three filled energy levels.
b) All three elements have one valence electron in an *s*-orbital – they all have valencies of 1.
c) The outer electrons (valence electrons) are the first to come into contact with other atoms around them. They are responsible for the way the atoms of elements will react. If elements have the same valence structure, they will show similarities in the way they react with other substances.

LB p. 88

Activity 4 Test yourself

Cognitive levels 1–2 P

Building a Periodic Table

1

P								D
E	O		G	B	K	H	M	R
A	F		N	I	Q	C	L	J

2

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Na	C	S	He	Li	Mg	B	O	Si	Ar	N	Cl	F	Al	Be	H	P	Ne

Chemical reactions involve changes to the structure of molecules. This usually involves making or breaking chemical bonds. This unit provides the groundwork for understanding chemical change. Once learners understand the principles of bonding, they should be well-equipped to understand why elements join together in specific proportions to form compounds.

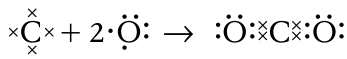
LB p. 92

Activity 1 Test yourself

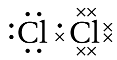
Cognitive levels 2–3

Investigating covalent molecules

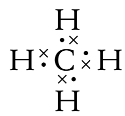
1 a) CO_2 – carbon dioxide
b) Electron diagrams:



2 Lewis dot diagrams:

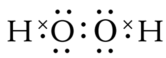


Chlorine gas

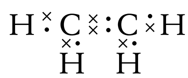


Methane

3 a)



Hydrogen peroxide



Ethyne

b) H_2O_2 and C_2H_4
c) Eight electrons
d) Between the C atoms in ethyne: C=C

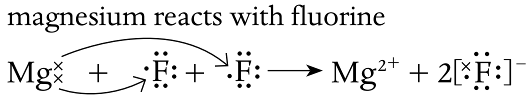
LB p. 95

Activity 2 Test yourself

Cognitive levels 2–3

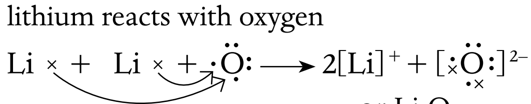
Investigating ionic compounds

1 Lewis dot diagrams to show the formation of ions and the ionic bond when these reactions occur:
a) magnesium reacts with fluorine



or MgF_2

b) lithium reacts with oxygen



or Li_2O

2 a) lithium bromide – LiBr
b) calcium chloride – $CaCl_2$
c) sodium oxide – Na_2O

LB p. 96

Activity 3 Test yourself

Cognitive levels 2–3 I

Investigating metal bonding in aluminium

1 The learners should draw a number of positive atomic kernels. Their labels must show that each ion has 13 protons, 14 neutrons and 10 electrons. Each aluminium atom has 3 valence electrons (those in the last energy level). These electrons overlap and form the sea of delocalised electrons. The other 10 electrons remain locally bound to the positive atomic kernel.

Element	Protons	Neutrons	Inner electrons	Valence electrons
Al	13	14	10	3

2 Aluminium conducts heat and electricity. The delocalised electrons are the agents that transfer the electricity when they move from the negative terminal to the positive terminal of a cell. Delocalised electrons are also responsible for transferring the kinetic energy when the metal conducts heat. Aluminium is malleable, i.e. we can bend it without breaking it because the sea of electrons binds the positive atomic kernels together in all directions like an electrostatic 'glue'.

LB p. 97

Activity 4 Test yourself

Cognitive level 3 I

Calculating relative formula and molecular mass

Relative formulae or molecular masses of these compounds:
$NaCl$; H_2SO_4; $CaCO_3$; NH_4NO_3; Al_2O_3; $(NH_4)_2SO_4$; $CuSO_4{\cdot}5H_2O$
$NaCl$: $23{,}0 + 35{,}5 = 58{,}5$
H_2SO_4: $(2 \times 1{,}0)+ 32{,}1 + (4 \times 16{,}0) = 98{,}1$
$CaCO_3$: $40{,}1 + 12{,}0 + (3 \times 16{,}0) = 100{,}1$
NH_4NO_3: $(2 \times 14{,}0) + (4 \times 1{,}0) + (3 \times 16{,}0) = 80{,}0$
Al_2O_3: $(2 \times 27{,}0) + (3 \times 16{,}0) = 102{,}0$
$(NH_4)_2SO_4$: $(2 \times 14{,}0) + (8 \times 1{,}0) + 32{,}1 + (4 \times 16{,}0) = 132{,}1$
$CuSO_4{\cdot}5H_2O$: $63{,}5 + 32{,}1 + (4 \times 16{,}0) + 5(2 \times 1{,}0 + 16{,}0) = 249{,}6$

Learner's Book page 98

Unit 1–5 Summative assessment answers

TERM 1, MODULE 1

1 a) Thermal conductor: iron (any other metal or diamond)
b) Electrical conductor: copper (any other metal or graphite)
c) Thermal insulator: air, wool, etc.
d) Electrical insulator: plastic, ceramics, etc.
e) Magnetic substance: iron, nickel or cobalt

2 Mixtures: sea water, curry powder, vinegar (Vinegar consists of acetic acid dissolved in water, plus various flavourants and colourants that can be natural or artificial.)
Compounds: table salt, sugar, carbon dioxide

3 Solids, liquids and gases

a)

Solid (Melting point higher than 25 °C; Boiling point higher than 25 °C)	Liquid (Melting point lower than 25 °C; Boiling point higher than 25 °C)	Gas (Melting point lower than 25 °C; Boiling point lower than 25 °C)
Iodine	Ethanol	Butane
Sulfur	Octane	Fluorine
	Benzene	Krypton
	Acetic acid	

b) Liquid over the smallest temperature range: benzene (a difference of 75 °C)

c) Gaseous below 0 °C: fluorine and krypton

d) Lowest freezing point: fluorine

e) Liquid at 400 °C: sulfur

4 a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

b) The element is chlorine.

c)

Protons	Neutrons	Electrons
17	35–17 = 18	17

d) $\mathrm{H}\,{}^{\times}_{\bullet}\,\overset{\times\times}{\underset{\times\times}{\mathrm{Cl}}}\,{}^{\times}_{\times}$

5 a) 2 protons

b) J

c) D

d) 10 neutrons

e) A

f) The alkali metals

g) F

h) H

i) Group 18 – the noble gases

j) K and L are atoms that have full energy levels and are very stable. They show us how many electrons an atom must gain or lose to become stable.

6 a) Carbon, hydrogen and oxygen

b) 11 atoms

c) $C_3H_6O_2$

d) Between the third C and single O

e) Carbon makes four covalent bonds.

7 a) and b)

Aluminium hydroxide; $M(\mathrm{Al(OH)_3}) = 26{,}98 + (3 \times 16{,}00) + (3 \times 1{,}01) = 78{,}01$

Nitric acid; $M(\mathrm{HNO_3}) = 1{,}01 + 14{,}01 + (3 \times 16{,}00) = 63{,}02$

Phosphorus trichloride; $M(\mathrm{PCl_3}) = 30{,}97 + (3 \times 35{,}45) = 137{,}32$

Copper carbonate; $M(\mathrm{CuCO_3}) = 63{,}55 + 12{,}01 + (3 \times 16{,}00) = 123{,}56$

Iron(II) sulfate; $M(\mathrm{FeSO_4}) = 55{,}85 + 32{,}07 + (4 \times 16{,}00) = 151{,}92$

8 a) Ba: +2
b) I: −1
c) P: −3
d) Al: +3
e) H: +1
f) O: −2

9 a) $CaCl_2$
b) $Mg(NO_3)_2$
c) $CuSO_4$
d) Na_2CO_3
e) H_2S

MODULE 2 WAVES, SOUND AND LIGHT

Background information for Module 2

Some schools may have apparatus such as a ripple tank with the accompanying vibrator and obstructions, springs and strings, and a variety of sound equipment. If this apparatus is available, we strongly advise teachers to include demonstrations and experiments in the lessons. Learners will remember the properties of waves so much better if they can see them firsthand.

We suggest that you introduce the concept of vibration by demonstrating the simple harmonic motion of a swinging pendulum. It is easy to point out rest position, amplitude, vibration cycle, period and frequency from the to-and-fro motion of the pendulum.

The concept of electromagnetic radiation might be new to many learners. We cannot see these waves, but the applications and uses of electromagnetic waves are numerous and well-known. Use as many examples as possible to explain the importance of each of these types of waves. Emphasise that the waves are the same in composition; it is only the wavelength and frequency that vary. This section lends itself to learner projects and investigations.

This module looks at all the different types of waves. You will start off with transverse pulses in Unit 1 and then move on to transverse waves in Unit 2. Unit 3 deals with longitudinal waves and Unit 4 covers the main application of longitudinal waves – sound. Unit 5 looks at the global picture of electromagnetic radiation that covers all waves produced on Earth and in the universe. You should spend 16 hours during the latter part of Term 1 on this module. Waves, sound and light make up 10% of the Physical Sciences content of Grade 10.

We have included a number of extension activities for enrichment of the learners. These are:

- Unit 2, Activity 3: Investigating the effect of water depth on wave speed
- Unit 2, Activity 4: Investigating the pendulum
- Unit 3, Activity 3: Measuring the speed of sound in air
- Unit 4, Activity 2: Investigating noise pollution

Sometimes learners are taught about waves without ever learning about pulses. A pulse is a single disturbance. It has an amplitude and pulse length, but no frequency, since it only happens once.

Superposition is one of the fundamental principles in physics. Make sure learners understand it well so that they can grasp all its applications in later modules also.

We have included information on Schrödinger's famous thought experiment about the difference between the quantum world (subatomic world) and the macroscopic world that we live in. This experiment illustrates the principle of superposition. Please explain to learners that this was a bizarre thought experiment and that they must never use the ideas in an attempt to kill cats or any other animals. The sequence of events that would eventually kill the cat relies on the decay of a radioactive source. Without this essential part the thought experiment has no meaning and would never work.

LB p. 104

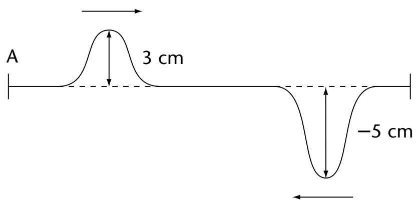
Activity 1 Test yourself

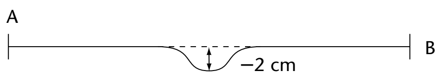
Cognitive levels 1–3 *I*

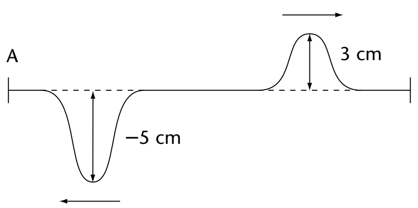
Demonstrating superposition in pulses

1 Both learners jerked the rope once. Learner B jerked the rope harder and in the opposite direction to Learner A jerking the rope.

2

a) 

b) 

c) 

3 Resultant amplitude $= -5 + 3 = -2$ cm

4 Destructive interference: the pulses move on opposite sides of the rope

LB p. 105

Activity 2 Demonstration

Cognitive levels 1–2 *G* *RPA*

Observing superposition

The teacher uses a ripple tank to demonstrate the formation and properties of pulses and waves. You should become familiar with the type of ripple tank and its attachments before attempting the demonstration in front of the class.

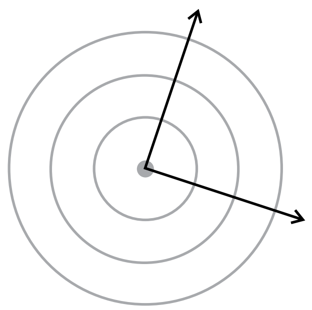
- Pour water into the ripple tank so that the water is 10–20 mm deep. Make sure that the shadows cast by the ripples are clearly visible.
- Generate a single pulse by allowing a drop of water to fall into the ripple tank or by dipping your finger into the water. Repeat until the learners can observe a clear ripple pattern.

- Generate a straight pulse by dipping a ruler into the water.
- Generate two pulses from two points. The learners must observe how the resultant ripples interfere with one another.
- Explain the concepts of destructive and constructive interference.

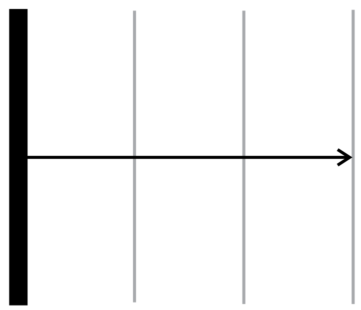
Checklist of teacher's assessment of individual in a group during demonstration

Task skills	Yes	No	Comments
Stays focused on demonstration			
Understands experimental method			
Answers simple questions during demonstration			
Helpful/ assists teacher			
Records results correctly			
Diagrams accurate with labels			
Can explain interference			

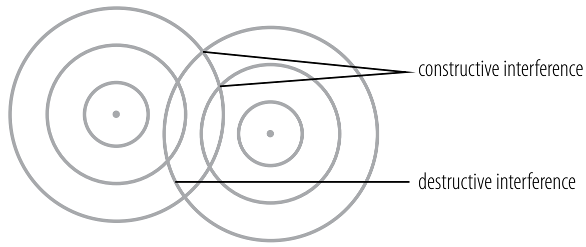
1 Ripples from a single point



Ripples from a straight, long object



2 Ripples from two points



3 Constructive interference: When two waves in phase meet, the crests reinforce one another to produce a wave crest that is the combined height of the two crests added together.
Destructive interference: When two waves meet that are out of phase, the crest of one wave coincides with the trough of another wave. They cancel each other and the result is a smaller wave crest or trough.

Unit 2 Transverse waves

TERM 1, MODULE 2

Any vibrating system shows simple harmonic motion. We can use a pendulum to illustrate this motion.

Using a pendulum to explain terminology

Attach a string of at least one metre in length to a mass piece and suspend it from a suitable stand. Swing the mass piece to-and-fro and explain the terminology of simple harmonic motion: equilibrium position; amplitude; vibration cycle. Measure the time it takes for ten complete vibrations.

Calculate the period. Also count the number of vibrations in ten seconds and calculate the approximate frequency.

There is a practical investigation on the pendulum in the Learner's Book as an extension activity. Another extension activity is the practical determination of the relationship between wave speed and water depth. This relationship has practical application in understanding ocean wave motion. We can also illustrate transverse waves using a ripple tank.

Worked example: Wave speed

The distance between 14 consecutive wave crests in a ripple tank is 650 mm and a wave crest covers a distance of 300 mm in three seconds. Calculate the speed of the wave, the wavelength and the frequency of the wave.

Convert distance values to metres: 650 mm = 0,650 m and 300 mm = 0,300 m

speed of the wave = $\frac{\text{distance travelled}}{\text{time}}$

The wave travels 0,3 m in 3 s.

$\therefore v = \frac{\Delta x}{\Delta t} = \frac{0{,}3\text{ m}}{3\text{ s}} = 1\text{ m·s}^{-1}$

The wavelength is the distance between two consecutive crests. 14 consecutive crests will include 13 full waves. The distance between 13 waves is 0,65 m.

wavelength = $\frac{\text{total distance}}{\text{number of full waves}} = \frac{0{,}65\text{ m}}{13} = 0{,}05\text{ m}$

speed of the wave = wavelength × frequency

$$v = f \times \lambda \quad \therefore f = \frac{v}{\lambda}$$

$$f = \frac{0{,}1\ \cancel{\text{m}}\text{·s}^{-1}}{0{,}5\ \cancel{\text{m}}} = 2\text{ Hz}$$

LB p. 110

Activity 1 Test yourself — Cognitive levels 3–4

Calculating wave speed

1 $v = \frac{\Delta x}{\Delta t} = \frac{10\text{ m}}{2\text{ s}} = 5\text{ m·s}^{-1}$

2 $v = f\lambda = 2\text{ Hz} \times 0{,}4\text{ m} = 0{,}8\text{ m·s}^{-1}$

3 Convert mm to m: 25 mm × 1 000 = 0,025 m

a) $f = \frac{v}{\lambda} = \frac{0{,}5\ \cancel{\text{m}}\text{·s}^{-1}}{0{,}025\ \cancel{\text{m}}} = 20\text{ Hz}$

b) $T = \frac{1}{f} = \frac{1}{20\text{ Hz}} = 0{,}05\text{ s}$

4 a) $f = \frac{1}{T} = \frac{1}{5\text{ s}} = 0{,}2\text{ Hz}$

b) wavelength = 10 m (Note that there are four full waves between five wave crests.)

c) $v = f\lambda = 0{,}2\text{ Hz} \times 10\text{ m} = 2\text{ m·s}^{-1}$

LB p. 110

Activity 2 Test yourself — Cognitive levels 1–4

Testing yourself on waves

1 a) The wavelength is the distance between two consecutive points that are in phase. It is the distance between two crests or two troughs.

b) The frequency is the number of waves that pass a point in one second.

c) The period is the time taken to complete one full wave.

d) The amplitude is the maximum distance the wave particles reach from their rest position.

2 a) Points in phase: A, E, H or B, F or D, G

b) One wavelength between A and E; B and F; D and G; E and H

c) Rest position: line AH

d) Amplitude= $\frac{20\text{ cm}}{2} = 10\text{ cm}$

e) 0,5 s for 2 waves; $T = 0{,}25$ s
f) 5 waves × 0,25 s = 1,25 s
g) $\lambda = 1$ m
h) $f = \frac{1}{T} = \frac{1}{0{,}25\text{ s}} = 4$ Hz
i) $v = f\lambda = 4\text{ Hz} \times 1\text{ m} = 4\text{ m·s}^{-1}$

3

	a) Amplitude (mm)	a) Wavelength (mm)	b) Frequency (Hz)	c) Speed ($m·s^{-1}$)
A	~7,5	~20	3	~0,06
B	~3,5	~10	6	~0,06
C	~10	~10	6	~0,06
D	~11,5	~50	2	~0,1

LB p. 112

Activity 3 Practical investigation **Cognitive levels 3–4** G

Investigating the effect of water depth on wave speed

1 How does the depth of water affect the wave speed?
2 Pour water into the tray to a depth of a few millimetres. Measure the length of the inside of the tray. Measure the depth of the water.
- Raise one end of the tray by 1 cm, and then gently drop it. A ripple moves across the water. Measure the time the ripple takes to travel from one end to the other, and then back again. Repeat the reading five times and work out an average reading.
- Pour more water into the tray and again measure the depth. Repeat the measurements.
- Continue adding more water and measuring the time for at least five different depths of water.

3

Depth of water (mm)	Distance travelled (twice length of tray in cm)	Time taken (s)					Average time (s)	Velocity ($cm·s^{-1}$)

4 Independent variable: Water depth
Dependent variable: Time taken for ripple to travel a certain distance
5 Raise the tray to the same height each time.
Use the same tray for each trial.
Use water of the same temperature for each trial.
6 speed $(\text{cm·s}^{-1}) = \frac{\text{distance travelled (twice the length of the tray in cm)}}{\text{average time taken (s)}}$
7 Water waves travel more slowly in shallow water than in deep water.
8 An ocean wave will slow down as it approaches the shore since the water becomes shallower the closer the wave is to the shore.
9 The results of the experiments should be reasonably accurate because they demonstrate the main idea. Timing the wave ripple is the biggest source of error as a result of human reflexes when using a hand-held stopwatch. Learners should realise that for a more accurate answer they have to take at least five readings to work out the average.
10 Temperature
11 Use the same water depth for all trials, but change the temperature of the water.

Activity 4 Practical investigation Cognitive levels 3–4 G

Investigating the pendulum

1 The period and frequency of a pendulum are inversely proportional, i.e. if the period is large then the frequency is small and vice-versa. Learners used the formula $f = \frac{1}{T}$ to calculate the frequency. Learners can check their answers by counting the number of swings in 10 seconds and then dividing the number of swings by 10. This gives the number of swings per second (frequency).
   h) The period is inversely proportional / directly proportional to the frequency.
   i) Dependent variable: Time taken for 10 vibrations
      Independent variable: Number of vibrations (10)
   j) i) Period
      ii) Frequency
   k) The time taken for one swing is difficult to measure accurately. The results will be more accurate if the time is taken for ten vibrations and then divided by 10 to calculate the average time of one vibration.

2 The length and frequency are not exactly inversely proportional, but we can say that as the length of the cord increases, the frequency decreases. A piece of cord more than a metre long is ideal for the learners. The learners can adjust the cord to make five different lengths and therefore five corresponding frequencies. The relationship between length and frequency of a pendulum is given in the equation $f = \frac{1}{2}\pi\sqrt{\frac{g}{L}}$ so the frequency is inversely proportional to the root of the length. It would be interesting to check whether the learners' answers were correct by using the simplified formula of $f = 0{,}5\sqrt{L}$.

3 There is no effect on frequency when the amplitude is changed. Unless the amplitude is increased so that the pendulum does not swing properly, the frequency remains virtually unchanged no matter how high the pendulum is pulled.

4 It is important that learners understand how inverse proportionality works. To explain this you can use simple examples, e.g. show that the inverse of 2 is ½, the inverse of 4 is even smaller (¼) and the inverse of 8 is smaller again (⅛). The learners must realise that as the amount of time for one vibration increases, so the number of vibrations per second will decrease. Similarly, as the amount of time for one vibration decreases, the number of vibrations per second will increase. Make sure that learners understand this.

5 Because the frequency and period are inversely proportional, as the length of the cord increases, the period also increases, i.e. it takes longer for the pendulum to complete a cycle.

6 Just as the amplitude does not affect the frequency, so it does not affect the period.

7 a) If the pendulum completes 12 vibrations in 3 s, it completes 4 vibrations in 1 s and so its frequency is 4 Hz.
   b) Since $T = \frac{1}{f}$, the period = 0,25 s.

Sound waves are longitudinal waves. Sound is one of our important senses when it comes to acquiring new knowledge. Learners learn new things mainly through sight and hearing. The determination of the speed of sound in air is an extension practical investigation. It shows learners how speed is dependent on factors such as the type of medium it moves through and the temperature.

Worked example: Speed of sound

Calculate your distance in kilometres from a lightning bolt if you heard the thunder six seconds after you saw the lightning. Assume that the speed of sound in air is 343 m·s^{-1}.

Write down what you know and what you must calculate:
time taken, $\Delta t = 6$ s
speed of sound, $v = 343$ m·s^{-1}
distance, $\Delta x = ?$
Write down the correct equation:
$v = \frac{\Delta x}{\Delta t}$
Change the subject of the equation to distance:
$\Delta x = v\,\Delta t$
Substitute the values and calculate the answer:
$\Delta x = 343 \text{ m}\cdot\cancel{\text{s}^{-1}} \times 6\ \cancel{\text{s}} = 2\,058 \text{ m} = 2{,}058 \text{ km}$

LB p. 117

Activity 1 Test yourself

Cognitive levels 1–4

Applying the properties of longitudinal waves

1 $f = \frac{v}{\lambda} = \frac{5\,060\ \cancel{\text{m}}\cdot\text{s}^{-1}}{0{,}5\ \cancel{\text{m}}} = 10\,120$ Hz

2 $v = f\lambda = 64 \text{ Hz} \times 1{,}80 \text{ m} = 115{,}2 \text{ m}\cdot\text{s}^{-1}$

3 Sound waves transmit energy. The particles of the medium that sound passes through vibrate and in the process energy is transmitted. If there is a vacuum and therefore no material medium (gas, liquid or solid) to transmit energy, sound waves cannot travel.

4 $\lambda = \frac{v}{f} = \frac{343 \text{ m}\cdot\text{s}^{-1}}{264 \text{ Hz}} = 1{,}30$ m

5 The sound takes 1 s to travel to the first building and 1,5 s to travel to the second building. The total time taken between the two buildings is 2,5 s.
$v = \frac{\Delta x}{\Delta t}\ \therefore \Delta x = v\Delta t = 343 \text{ m}\cdot\cancel{\text{s}^{-1}} \times 2{,}5\ \cancel{\text{s}} = 857{,}5$ m

6 a) $\lambda = \frac{v}{f}$

For 20 Hz: $= \frac{343 \text{ m}\cdot\cancel{\text{s}^{-1}}}{20\ \cancel{\text{Hz}}} = 17{,}15$ m

For 20 kHz: $= \frac{343 \text{ m}\cdot\cancel{\text{s}^{-1}}}{20\,000\ \cancel{\text{Hz}}} = 0{,}01715$ m

b) $\frac{4}{17{,}15} = 0{,}23$ of a wave of 20 Hz will fit into the room

$\frac{4}{0{,}01715} = 233$ waves of 20 kHz will fit into the room

LB p. 118

Activity 2 Project **Cognitive level 3** P

Making a string telephone

Learners can achieve the clearest sound in a string telephone when they use a metal tin with a taut copper wire to conduct the sound. Speaking into an open tin causes a pressure wave inside the tin that is propagated through the metal to the listener's ear. Because the sound is propagated through the wire or string, the learners can use the telephone around a corner.

LB p. 119

Activity 3 Experiment **Cognitive levels 3–4** G

Measuring the speed of sound in air

1 Apparatus needed
- stopwatches
- measuring tape
- wooden blocks or person to clap hands
- pen and paper to record readings.

2 Method

Step 1: Measure and mark a distance (50 m or 100 m) from a large flat wall.
Step 2: Clap your hands or the wooden blocks together.
Step 3: Continue to clap at a steady rate, clapping every time the echo reaches your ear.
Step 4: Take the time between 11 or 21 claps, which will be 10 or 20 time intervals.

3

Distance *s* in m	Average time *t* in s	Speed of sound $v = \frac{\Delta x}{\Delta t}$

4

Distance *s* in m	Time *t* in s	Speed of sound $v = \frac{\Delta x}{\Delta t}$
50 m × 2 = 100 m for echo to return once × 20 returns = 2 000 m	$t_1 = 5{,}84$ $t_2 = 5{,}77$ $t_3 = 5{,}90$ $t_4 = 5{,}87$ $t_5 = 5{,}73$ Average $t = 5{,}822$	$v = \frac{2\,000 \text{ m}}{5{,}822 \text{ s}}$ $= 343{,}5 \text{ m·s}^{-1}$

a) $v = \frac{\Delta x}{\Delta t} \therefore \Delta x = v\Delta t = 343{,}5 \text{ m·}\cancel{\text{s}^{-1}} \times 15\ \cancel{\text{s}} = 5\,152{,}5 \text{ m} = 5{,}1525 \text{ km}$

b) Sound travels more slowly in cold air. The distance travelled in 15 s will be shorter.

Unit 4 Sound

TERM 1, MODULE 2

The human ear can hear a wide range of sound intensities, but many animals have better hearing than we have. We can lose our hearing through loud noises, and therefore we have included extension information on loudness of sounds in the Learners' Book.

LB p. 124

Activity 1 Case study

Cognitive level 2 P

Investigating the *vuvuzela*

1

Vuvuzela	Pennywhistle
Flared wind instrument	Cylindrical wind instrument
Only produces one note (B♭)	Can produce all the notes in the key that it was made for (often D major key)
Sounds louder than the pennywhistle for the same intensity of sound – resonant frequencies in sensitive hearing range of humans	Sounds softer than the *vuvuzela* for the same intensity of sound – resonant frequencies not in the sensitive hearing range of humans
No skill required to blow	Musician needs musical skill to play the instrument
Player must create a note in the instrument for it to make a sound	Musician must blow into the mouth opening and the air column inside the instrument provides the notes

2 A *vuvuzela* has a loudness of 127 dB at 1 m distance from its opening. This is higher than the pain threshold of sound. Scientists believe that noise-induced deafness can result from this instrument if you are exposed to the noise for more than 15 minutes per day. During soccer matches the spectators sit close to each other and many people blow on *vuvuzelas*. All spectators are therefore exposed to a deafening noise from all directions, and not only those who blow *vuvuzelas*. Soccer enthusiasts who care about their hearing should wear ear plugs to local soccer matches.

LB p. 125

Activity 2 Case study

Cognitive levels 3–4 I

Investigating noise pollution

1 a) Accept any of these sources from the learners: noise from neighbours – music and home movie systems, late-night parties, children making a noise, dogs barking; road and railway traffic; aircraft arrivals and departures; industrial and commercial centres; construction activities; leisure activities
b) Suggestions unique to each learner's circumstances
c) At an airport aircraft are constantly departing and arriving. The noise caused by a jet engine is extremely high and even at a distance can affect one's hearing.
d) Excessive noise has a negative effect on people. It causes stress and aggressive behaviour and can also cause permanent damage to ears, as well as deafness.

LB p. 128

Activity 3 Test yourself

Cognitive levels 1–2 I

Testing yourself on sound

1 The pitch of a sound is dependent on its frequency. A higher frequency will produce a sound with a higher pitch.
2 The loudness of a sound is determined by its amplitude. A sound with a smaller amplitude will result in a decrease in loudness (softer sound).
3 Sound waves are longitudinal waves in which the direction of the motion of the particles in the medium is the same as the direction of the propagation of the wave. This makes it difficult to determine frequency, wavelength and amplitude accurately. We use an oscilloscope to indicate sound waves because sine curves, like those produced by an oscilloscope, are clearer and much easier to interpret.

4 Bats make use of ultrasound waves to 'see' their surroundings. They send out high frequency sound waves that are reflected off objects. Their parabolically shaped ears collect the original wave and the reflected wave. The bats' brains interpret the time delays between the original wave and the reflected wave to form a mental picture of objects around them.

5 a) i) The same volume: B, C and E
   ii) The same pitch: A and C; B and D
   iii) The softest note: A
  b) i) The highest note: E
   ii) The lowest note: B or D

Unit 5 Electromagnetic radiation

TERM 1, MODULE 2

We are bombarded by electromagnetic radiation all the time but can only see a very small part of it – the visible spectrum. Humans have learned to exploit the whole spectrum of electromagnetic radiation to the benefit of humankind. We use some type of electromagnetic rays in most of the devices in our homes and industries.

LB p. 138

Activity 1 Investigation — Cognitive levels 2–4 P

Investigating cell phone radiation

Learners will answer the questions according to their circumstances. The activity aims to develop awareness of the dangers that excessive cell phone use can have on our health.

Advantages of cell phones: You can keep in contact with friends and family wherever you are. You can call for help when you need it, for example, when the car is broken down or when you are in danger. The sms service is an inexpensive way of contacting people. You can connect to the internet if you have a cell phone with this facility. You can take photographs with some cell phones so do not need a separate camera.

Disadvantages of cell phones: Cell phones can be a nuisance to other people in public places, such as concerts and the cinema. Cell phones can be antisocial and limit personal contact and direct conversation between people. It is rude to use your cell phone whilst having a conversation with another person. Many people overuse their cell phones and waste money on unnecessary calls. Many young people play loud music on their cell phones whilst walking in streets and this disturbs other people.

Worked example: Calculations on electromagnetic waves

A microwave has a frequency of 150 GHz. Calculate its wavelength and the energy of its photons.

Write down what you know and what you must calculate:

frequency, $f = 150$ GHz

change unit of frequency to Hz: 150 GHz $= 1{,}5 \times 10^{11}$ Hz (1 GHz $= 10^{9}$ Hz)

wavelength, $\lambda = ?$

energy, E = ?

Write down the constant values of the speed of electromagnetic radiation and the Planck's constant:

speed of electromagnetic radiation, $c = 3 \times 10^{8}\ \text{m·s}^{-1}$

Planck's constant, $h = 6{,}63 \times 10^{-34}$ J·s

Write down the wave equation:

$c = f\lambda$

Change the subject of the formula to wavelength:

$\lambda = \frac{c}{f}$

Fill in the values and calculate the wavelength:

$\lambda = \frac{3 \times 10^8 \text{ m·s}^{-1}}{1,5 \times 10^{11} \text{ Hz}} = 0,002 \text{ m or } 2 \text{ mm}$

To calculate the energy, write down the equation that link energy, Plank's constant and frequency:

$E = hf$

Substitute the values and calculate the wavelength:

$E = 6,63 \times 10^{-34} \text{ J·s} \times 1,5 \times 10^{11} \text{ Hz} = 9,95 \times 10^{-23} \text{ J}$

LB p. 140

Activity 2 Test yourself

Cognitive level 3 I

Interpreting the electromagnetic spectrum

1 a) Increasing frequencies: radio waves; microwaves; infrared waves; visible light; ultraviolet rays; X-rays; gamma rays

b) Increasing wavelengths: gamma rays, X-rays; ultraviolet light; visible light; infrared light; microwaves; radio waves

c) Increasing energy: radio waves; microwaves; infrared waves; visible light; ultraviolet rays; X-rays; gamma rays

2 $c = f\lambda \therefore f = \frac{c}{\lambda}$

a) $f = \frac{3 \times 10^8 \cancel{\text{m}}\text{·s}^{-1}}{2 \cancel{\text{m}}} = 1,5 \times 10^8 \text{ Hz}$

b) $f = \frac{3 \times 10^8 \cancel{\text{m}}\text{·s}^{-1}}{600 \times 10^{-9} \cancel{\text{m}}} = 5 \times 10^{14} \text{ Hz}$

c) $f = \frac{3 \times 10^8 \cancel{\text{m}}\text{·s}^{-1}}{10^{-12} \cancel{\text{m}}} = 3 \times 10^{20} \text{ Hz}$

3 $c = f\lambda \therefore \lambda = \frac{c}{f}$

a) $\lambda = \frac{3 \times 10^8 \text{ m·}\cancel{\text{s}^{-1}}}{2,5 \times 10^9 \cancel{\text{Hz}}} = 0,12 \text{ m}$

b) $\lambda = \frac{3 \times 10^8 \text{ m·}\cancel{\text{s}^{-1}}}{10^{16} \cancel{\text{Hz}}} = 3 \times 10^{-8} \text{ m}$

c) $\lambda = \frac{3 \times 10^8 \text{ m·}\cancel{\text{s}^{-1}}}{5 \times 10^{19} \cancel{\text{Hz}}} = 6 \times 10^{-12} \text{ m}$

LB p. 140

Activity 3 Practical investigation

Cognitive levels 3–4 G I

Discussing the uses and effects of certain light rays

Gamma rays

Pros: Gamma rays can be useful in medicine to sterilise instruments or kill cancer cells inside patients' bodies.

Cons: Over-exposure to gamma rays can kill living cells or cause cancer.

Precautions: Medical people giving gamma ray treatment must ensure that the gamma rays kill cancer cells and not healthy cells. Trained people use a special machine to ensure that the gamma rays enter the body at the correct place and travel in the correct direction to kill the cancer cells.

X-rays

Pros: X-rays are used in medicine to take photographs of bones or diseased tissues inside human bodies. X-rays are vital for the diagnosis of broken bones and cancer. Dentists use X-rays to see if patients have holes in their teeth.

Cons: Over-exposure to X-rays can damage cells and lead to cancer or other illnesses. There is a limit to how many X-rays a patient can have.

Precautions: Radiographers cover the areas of patients' bodies that do not need to be X-rayed with a piece of material containing lead. X-rays cannot pass through lead so this protects the patients' bodies and skin from over-exposure. Radiographers, doctors and dentists who take the X-rays should leave the X-ray room to take X-rays so that they are not over-exposed.

Ultraviolet rays
Pros: Ultraviolet rays are essential for the formation of vitamin D in our bodies. UV rays can also make the skin darker.

Cons: Overexposure to UV rays can lead to sunburn and skin cancer.

Precautions: There are many ways of protecting ourselves against the harmful effects of UV rays. We can use sun creams that block harmful UV rays and stop them from damaging the skin. We can wear suitable clothes and hats when we are in the sun, and stay out of the sun during the hottest part of the day.

Infrared rays
Pros: The remote control of a television set or video player uses infrared rays to operate it. Infrared cameras that pick up heat can take photographs under very low light conditions. Infrared rays carry heat and are essential for keeping us warm and heating up food.

Cons: Skin cells are damaged by too much heat and can be badly burned from radiation of hot objects.

Precautions: Be careful when handling hot objects and protect your bodies and hands against the heat. People who work in hot conditions, for example firefighters, wear protective clothing that reflects heat against overexposure to infrared radiation.

LB p. 141

Activity 4 Test yourself — Cognitive level 3

Calculating energy, frequency and wavelength

1 $E = hf = \frac{hc}{\lambda} = \frac{(6{,}63 \times 10^{-34}\ \text{J}\cdot\cancel{\text{s}})\ (3 \times 10^{8}\ \cancel{\text{m}}\cdot\cancel{\text{s}^{-1}})}{0{,}02 \times 10^{-9}\ \cancel{\text{m}}} = 9{,}95 \times 10^{-15}\ \text{J}$

2 a) $E = hf \therefore f = \frac{E}{h} = \frac{(5 \times 10^{-18}\ \cancel{\text{J}})}{6{,}63 \times 10^{-34}\ \cancel{\text{J}}\cdot\text{s}} = 7{,}54 \times 10^{15}\ \text{Hz}$

b) $c = f \times \lambda \therefore \lambda = \frac{c}{f} = \frac{(3 \times 10^{8}\ \text{m}\cdot\cancel{\text{s}^{-1}})}{7{,}54 \times 10^{15}\ \cancel{\text{Hz}}} = 3{,}98 \times 10^{-8}\ \text{m}$

c) This wavelength falls within the range of ultraviolet rays.

3 a) $c = f \times \lambda \therefore \lambda = \frac{c}{f} = \frac{(3 \times 10^{8}\ \text{m}\cdot\cancel{\text{s}^{-1}})}{30 \times 10^{6}\ \cancel{\text{Hz}}} = 10\ \text{m}$

b) Radio waves

c) $E = hf = (6{,}63 \times 10^{-34}\ \text{J}\cdot\cancel{\text{s}})(\ 30 \times 10^{6}\ \cancel{\text{Hz}}\ ) = 2 \times 10^{-26}\ \text{J}$

Learner's Book page 142

Units 1 to 5 — Summative assessment answers

TERM 1, MODULE 2

1 a) The period of the wave is the time taken for one full cycle of vibration. In the case of the water wave, a full wave is from the crest and through the trough to the next crest. So a full vibration is the full wave from crest to crest. The period is therefore 8 seconds.

b) The frequency of the wave is the inverse of the period. This means that while the period is the time taken for one full wave to pass a point, the frequency is the number of waves that pass one point in one second (it is measured in Hz). In this case it takes 8 seconds for one wave to pass a point, and so the number of waves passing a point in one second will be less than one. We calculate this using the formula $f = \frac{1}{T}$. The frequency therefore equals $\frac{1}{8}$ or 0,125 Hz.

c) The wavelength is the length of a full vibration, or crest to crest which equals 3 m.

d) We can calculate the speed of the wave in two ways:
- using the formula speed = $\frac{\text{distance}}{\text{time}}$
- using the formula speed = frequency × wavelength

In both cases we can calculate the speed of the wave to be 0,375 m·s^{-1}.

e) In a transverse wave the particles of the medium move up and down while the wave passes through it (they are perpendicular to each other). The seagulls illustrate this point. They are moving up and down on the water but are not moving towards the beach in the direction of the waves.

f) Waves show us that energy is transferred between particles. The water particles move because they are transferring energy from one particle to the next.

2 a) The frequency of a wave is the number of waves that pass a point in one second.

b) Transverse waves

c) Longitudinal waves: the motion of the particles of the wave is in the same direction as that of the wave motion. (In transverse waves the motion of the particles is perpendicular to the motion of the wave.)

d) wavelength = $\frac{0{,}08\text{ m}}{20} = 0{,}004\text{ m}$

e) $v = f\lambda = 10\text{ Hz} \times 0{,}004\text{ m} = 0{,}04\text{ m·s}^{-1}$

3 a) period $(T) = \frac{1}{f} = \frac{1}{30\text{ Hz}} = 0{,}03\text{ s} \times 3\text{ waves} = 0{,}1\text{ s}$

b) $\lambda = \frac{12\text{ m}}{3} = 4\text{ m}$

c) amplitude = $\frac{4{,}5\text{ m}}{2} = 2{,}25\text{ m}$

d) downwards

e) $v = f\lambda = 30\text{ Hz} \times 4\text{ m} = 120\text{ m·s}^{-1}$

or: $v = \frac{\Delta x}{\Delta t} = \frac{12\text{ m}}{0{,}1\text{ s}} = 120\text{ m·s}^{-1}$

4 $v = 1\,500\text{ m·s}^{-1}$; $t = 20\text{ s}$

$\Delta x = vt = 1\,500\text{ m·}\cancel{\text{s}}^{-1} \times 20\,\cancel{\text{s}} = 30\,000\text{ m}$

$\therefore$ depth = $\frac{30\,000\text{ m}}{2} = 15\,000\text{ m}$

5 a) period $(T) = 0{,}5\text{ s}$ $\therefore$ time for 4 waves $= 4 \times 0{,}5\text{ s} = 2\text{ s}$

b) amplitude = $\frac{20\text{ cm}}{2} = 10\text{ cm}$

c) $T = 0{,}5\text{ s}$

d) i) $\lambda = \frac{50\text{ cm}}{2} = 25\text{ cm} = 0{,}25\text{ m}$

ii) $f = \frac{1}{T} = \frac{1}{0{,}5\text{ s}} = 2\text{ Hz}$

iii) $v = f\lambda = 2\text{ Hz} \times 0{,}25\text{ m} = 0{,}5\text{ m·s}^{-1}$

6 a) C and E; A, B and D

b) A and E; C and D

c) B

d) C and D

Formal Assessment Task

For the formal assessment task give the learners the Control Test for Term 1 which you will find in the Assessment section on pages B11–B12. You will find the answers to this formal assessment task on pages B13–B14.

All the chemistry covered in Term 1 now comes together to explain how matter is composed. In this unit we look at the different types of compounds that result from chemical bonding. We have included a number of extension activities to link the learners' acquired knowledge to materials in the real world. You will find case studies on table salt, glass and crystal lattices.

LB p. 147

Activity 1 Research project

Cognitive levels 3–4

Investigating the allotropes of carbon

Allotrope	Chemical bonding between atoms	Physical properties
Diamond	Each carbon atom is covalently bonded to three other carbon atoms in a tetrahedron. The tetrahedrons form a 3D network which is very stable. All four outer electrons are localised between atoms in covalent bonds.	Hardest known mineral; excellent abrasive – no known material can cut or scratch diamond. Does not conduct electricity.
Graphite	Layered planar structure to form a hexagonal lattice. Each carbon atom uses three valence electrons for covalent bonds to form a ring. Each carbon contributes one electron to a delocalised sea of electrons that are free to move to conduct electricity.	Most stable form of carbon. Electrical conductor.
Carbon fibre	Carbon atoms are bonded together in microscopic crystals that align parallel to the long axis of the fibre. The fibre is very strong for its size.	Forms extremely thin fibres that twist together to form a yarn that can be woven into fabric. Has high flexibility, high tensile strength, low weight, high temperature tolerance, low thermal expansion. Used in aerospace, civil engineering, military, sports
Buckyballs	Part of the fullerene family that is composed of carbon atoms bonded to form a hollow sphere, ellipsoid or tube. 60 carbon atoms most common.	Uses still being investigated. Potential use as molecular ball bearings to allow surfaces to glide over each other.

LB p. 151

Activity 2 Case study

Cognitive levels 2–3

Investigating sodium chloride

1 a) Salarium = paying salt wages; money paid for salt
 b) Meat and fish do not spoil when heavily coated with salt.
 c) Both *biltong* and *bokkoms* are foods that have been treated by salting and then hung to dry. *Biltong* is treated meat while *bokkoms* are treated fish.
 d) Sea water contains on average 2,64% sodium chloride.
 e) Brine is a salt-water solution.
 f) The chief sources of sodium chloride are sea water and halite (rock salt).
 g) Yes, sea salt is probably clean because the organisms that cause disease cannot exist in such concentrated brine solutions that exist before the water evaporates from the sea water.
 h) Chlorine, hydrochloric acid and sodium hydroxide

2 a) Group 1 – the alkali metals
b) Number of protons in Na = 11
c) Number of electrons in Cl = 17
d) i) Sodium loses one electron.
ii) There is no change in the nucleus.
e) Cl^-
f) The single electron lost by a sodium atom is gained by a chlorine atom. There is therefore only one sodium atom and one chlorine atom present in the unit NaCl. The formula $NaCl_2$ represents one sodium atom and two chlorine atoms, which is incorrect.
g) Chlorine (Cl_2) has a very low melting point which means that it has weak intermolecular forces. Not much energy is required to separate the molecules from each other and it occurs as a gas at room temperature. Sodium chloride has a very high melting point, and so much energy is required to break the strong bonds between the ions. Sodium chloride has a much more rigid structure than chlorine.

LB p. 154

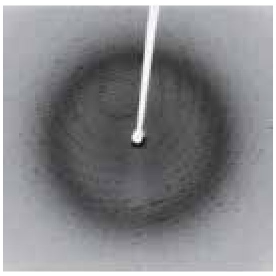
Activity 3 Research project

Cognitive levels 3–4 P G

Researching and demonstrating crystal lattices

1 Making models of metal lattices: In this activity learners work in three dimensions, which is very different from drawing molecules on paper. Clay or play-dough balls with toothpicks that hold the balls in place might work best.

2 X-ray diffraction
Almost all we know about crystal structure has been learned from X-ray diffraction studies. When X-rays hit a crystalline solid, the rays are scattered by the units of the crystal. The scattering, or diffraction, produces a pattern that is used to determine the arrangement of the particles in the lattice. X-rays have wave properties and the diffraction pattern is a result of interference of these waves. When an X-ray hits an atom, the atom absorbs the energy and re-emits it in a different direction. It is called scattering of the X-rays. Scattered X-rays that meet and interfere constructively form dark spots on the X-ray film.



X-ray diffraction pattern

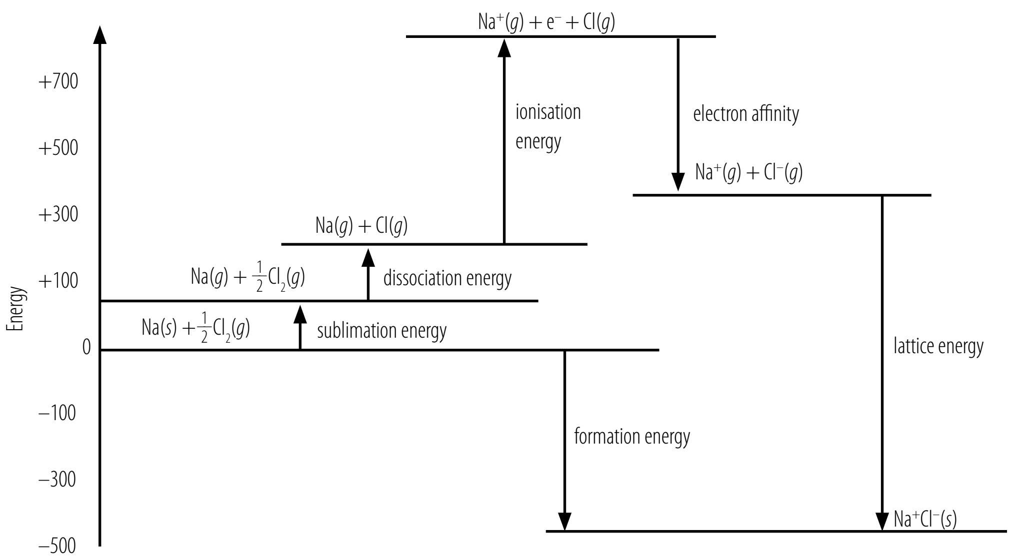
3 Structure of ice
The water molecules in ice are strongly attracted to one another. The positive parts of one molecule are attracted to the negative parts of other water molecules. These attractions between water molecules hold them in position. The forces between water molecules are called hydrogen bonds. At temperatures below 0 °C at atmospheric pressure, water is in a solid phase and the water molecules are arranged in a regular pattern or lattice. Air pockets are trapped within the lattice. This means that ice is less dense than water and it floats. In the cold arctic regions of the planet ice floats on top of the ocean and forms an insulating layer that allows sea life to continue underneath the ice. If ice were denser than water, it would sink to the bottom of the ocean. Eventually the whole water mass would freeze upwards and extinguish sea life.

4 Born-Haber cycle

The lattice energy of a compound is a quantative measure of the stability of an ionic solid. It is defined as the energy required to separate one mole of a solid ionic compound into gaseous ions. The lattice energy consists of different types of energy that play a role in each step of the reaction.

1. Sublimation energy is used to convert solid sodium into sodium vapour. (The direct conversion of a solid to a gas is called sublimation.)
2. Dissociation energy is used to separate the diatomic chlorine molecules into gaseous Cl atoms.
3. First ionisation energy is required to remove an electron from the sodium atom to form a Na^+ ion.
4. Electron affinity releases an amount of energy when the Cl^- ions form from the chlorine atoms by addition of an electron.
5. Lattice energy is released when solid NaCl condenses from isolated Na^+ and Cl^- ions. It is not possible to measure the lattice energy experimentally, but we can determine the other individual energies. We can then use the Born-Haber cycle to determine the lattice energy.

We can calculate the formation energy for NaCl using the equation:
formation energy = (lattice energy + electron affinity) –
(sublimation energy + dissociation energy + ionisation energy)



The Born-Haber cycle

General safety rules for Activities 4 and 5

- Learners should always wear safety goggles during all chemical experiments.
- Avoid skin contact with chemicals.
- Wash hands after handling chemicals.
- Dilute solutions of acids, bases and salts are regarded as low-hazard chemicals.
- Handle glass apparatus with care. Learners must report breakages immediately. The teacher must treat and monitor skin cuts.
- Take care when using a Bunsen burner. Always handle hot apparatus with a pair of tongs.
- Hydrogen gas is explosive and flammable. When hydrogen is produced during a reaction, extinguish all open flames and ventilate the room well.

LB p. 155

Activity 4 Experiments

Cognitive level 3 P G

Investigating elements and compounds

Experiment 1

The detailed method is in the Learner's Book.

The ingredients in Cal-C-Vita are: $CaCO_3$; vitamins B6, C and D3. Calcium carbonate ($CaCO_3$) is responsible for the reaction.

Carbon dioxide is released and this gas cannot support combustion.

Experiment 2

The detailed method is in the Learner's Book.

The Zn metal reacts with the HCl. Hydrogen gas is produced which makes an explosive popping noise when a burning wooden splint is held at the mount of the test tube.

Experiment 3

The detailed method is in the Learner's Book.

Water is produced that condenses in small droplets on the upper cooler parts of the test tube. The blue crystals turn white.

	Elements	Compounds
Experiment 1		$CaCO_3$; H_2O; CO_2
Experiment 2	Zn; H_2	HCl
Experiment 3		$CuSO_4$; H_2O

LB p. 157

Activity 5 Experiment

Cognitive level 3 G

The detailed method is in the Learner's Book.

Investigating the electrolysis of water

a) The gases formed in a ratio of 2 : 1.
b) Positive electrode: Oxygen O_2
c) Negative electrode: Hydrogen H_2
d) More hydrogen formed.
e) Compound: Water H_2O
Elements: Oxygen O_2 and hydrogen H_2

LB p. 159

Activity 6 Case study

Cognitive level 2 P

Investigating glass

1 Pure quartz has a very high melting point (above 1 700 °C) and becomes rigid very quickly on cooling, which makes it hard to work with.
2 Lime is added to the glass to make it less soluble in water.
3 Adding soda ash lowers the melting point to 700–850 °C.
4 Borosilicate glass does not have stress points that make it break or shatter easily and it is thermally stable (it can withstand high temperatures). This type of glass is ideal for the laboratory work where test tubes are heated directly with Bunsen burners. If test tubes are made of borosilicate glass, they do not break easily. If they did, it would be a safety hazard because sometimes people use corrosive or toxic chemicals in laboratories.
5 Car windows and large sliding doors are vulnerable to hard blows. If these windows are made of safety glass, they will shatter into small chunks that are safer than large sharp pieces of glass that fly around.

6

Soda-lime glass	Borosilicate glass	Lead crystal glass	Safety glass
Windowpane	Laboratory beaker	Wine glass	Car windscreen
Drinking glass	Kitchen jug	Crystal ball	Sliding door
Light bulb	Microwave plate	Crystal bell	Revolving doors

Learner's Book page 160

Unit 6 Summative assessment answers

TERM 2, MODULE 1

1 a) Substances grouped in categories

Atoms	Covalent molecular structures	Covalent network structures	Ionic compounds	Metallic compounds
Argon	Water	Graphite	Limestone	Bronze
Neon	Sugar	Sand	Caustic soda	Mercury
	Ozone	Diamond	Table salt	Copper
	Sulfur dioxide		Silver nitrate	Steel

b) Argon: Ar
Neon: Ne
Water: H_2O
Sugar: $C_{12}H_{22}O_{11}$
Ozone: O_3
Sulfur dioxide: SO_2
Graphite: C
Sand: SiO_2
Diamond: C
Limestone: $CaCO_3$
Caustic soda: NaOH
Table salt: NaCl
Silver nitrate: $AgNO_3$
Bronze: Cu/Zn alloy
Mercury: Hg
Copper: Cu
Steel: Fe/C alloy

2
- Covalent substances have low melting and boiling points while ionic substances have high melting and boiling points.
- Ionic substances are hard and brittle and are solids at room temperature. Covalent substances may be solids, liquids or gases at room temperature.
- Covalent substances form molecules when they bond. Ionic substances pack into a crystal lattice when bonding takes place.
- Covalent substances never conduct an electric current (except carbon in the form of graphite). Ionic substances can conduct a current when molten or dissolved in water.

3 a) Butane: C_4H_{10}
b) Benzoic acid: $C_7H_6O_2$
c) Sulfuric acid: H_2SO_4
d) Methyl acetate: $C_3H_6O_2$
e) Glucose: $C_6H_{12}O_6$
f) Amphetamine: $C_9H_{13}N$
g) Urea: CH_4N_2O

MODULE 3 CHEMICAL CHANGE

Background information for Module 3

The learners should now have a sound background of elements and atoms and how atoms combine to form the particles that make up all matter. We will continue our studies of chemistry by investigating the changes that compounds undergo when they are exposed to different conditions.

Module 3 describes chemical change and explains the chemical reactions that compounds can undergo. Unit 1 on physical and chemical change and Unit 2 on representing chemical change are covered in Term 2. Learners should already have background knowledge on chemical change as the concept forms part of the Senior Phase curriculum. Unit 3 on reactions in aqueous solution and Unit 4 on quantitative aspects of chemical change (stoichiometry) are done in Term 3. You should spend 8 hours on Units 1 and 2 in Term 2 and another 16 hours on Units 3 and 4 in Term 3. The allocation for this module is 15% of the Physical Sciences curriculum.

Chemical change is the practical part of chemistry and teachers are encouraged to incorporate as many practical activities in their classrooms as possible. The prescribed experiments were chosen for their simplicity. The apparatus required is minimal, the chemicals are safe when they are used as prescribed, and the results of the experiments are usually easily observable, for example, the formation of a precipitate or liberation of a gas. A diagram or photograph in a book can never replace the impact of an experiment done in a laboratory.

The experiments described in the Learner's Book are mostly from the suggestions in the CAPS document. There are many other simple experiments that teachers can use to demonstrate the various concepts prescribed in the curriculum. You should use your initiative, knowledge, experience and available chemicals in the chemistry storerooms to do experiments to demonstrate the chemistry concepts.

Writing balanced chemical equations is the basis of all chemistry. The chemistry done in Grades 11 and 12 relies on the learners' ability to write balanced chemical equations. You should allow enough time for learners to practice this skill and ensure that they all grasp the technique of balancing equations. Unit 4 on stoichiometry can be challenging and many learners might find the abstract concept of the mole difficult to grasp. Learners also need a lot of practice with calculations in this unit. Make sure you don't reduce the allocated 8 hours for this unit.

By now learners should have an idea about the difference between physical change and chemical change as the concepts have appeared in Module 1: Matter and materials. There are many demonstrations to illustrate these differences.

General safety rules for the experiments in Activities 1 to 4

- Learners should always wear safety goggles during all chemical experiments.
- Avoid skin contact with chemicals.
- Wash hands after handling chemicals.
- Dilute solutions of acids, bases and salts are regarded as low hazard chemicals.
- Handle glass apparatus with care. Learners must report breakages immediately. The teacher must treat and monitor skin cuts.
- Take care when using a Bunsen burner. Always handle hot apparatus with a pair of tongs.
- Hydrogen gas is explosive and flammable. When hydrogen is produced during a reaction, extinguish all open flames and ventilate the room well.
- Concentrated H_2SO_4 is extremely corrosive and toxic. Only the teacher must handle it and with great care.
- High concentrations of hydrogen peroxide (H_2O_2) are an oxidiser and can burn the skin. Low concentration of H_2O_2 is a low-hazard chemical.
- All lead salts and their solutions are toxic: avoid skin contact; wash hands after the experiment. Do not dispose of these salts and their solutions down the drain. Contact the local authority for rules regarding safe disposal of chemical waste.

LB p. 166 »

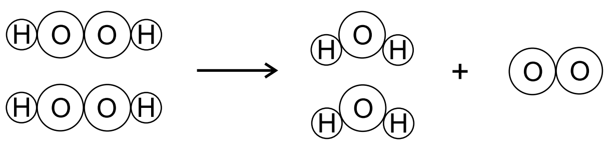
Activity 1 Experiment

Cognitive level 3 G

Decomposing hydrogen peroxide

Use a 3% H_2O_2 solution for this activity. Assemble the apparatus beforehand. Place the test tube with reactants in a test tube stand. Clamp the delivery tube and test tube that collects the gas to retort stands. You can use a beehive to effectively channel the gas from the delivery tube to the test tube. The detailed method is in the Learner's Book.

a) The glowing splint starts to burn with a flame when it is held at the mouth of the test tube.
b) The gas that is liberated must be oxygen.
c) This is a chemical change because new products were formed.
d)



4H + 4O   4H + 2O   + 2O

LB p. 167 »

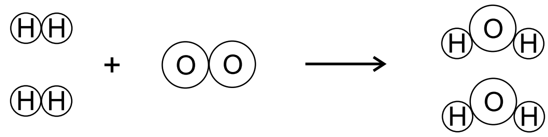
Activity 2 Experiment

Cognitive levels 3–4 G

Investigating the synthesis of water

Hydrogen is the lightest gas. Use a stopper to prevent the gas from leaving the test tube when it is inverted. The detailed method is in the Learner's Book.

a) A small explosion can be heard when the burning splint is held at the mouth of the test tube.
b) The gas that was liberated must be hydrogen.
c) This is a chemical change, because a new product, hydrogen, was formed.
d)



4H + 2O → 4H + 2O

e) Liquid hydrogen (boiling point –253 °C) is the most powerful rocket fuel. It forms an explosive mixture with oxygen that releases a lot of energy. This mixture was first used as fuel in the Lockheed CL-400 Sultan reconnaissance aircraft in the mid-1950s. Today a liquid hydrogen/oxygen mix is used to power the Space Shuttle that orbits Earth. The product of the combustion reaction is liquid water, which can be purified and used for drinking and cleaning on board the Space Shuttle.

LB p. 169

Activity 3 Experiments

Cognitive level 3 G RPA

Proving the Law of Conservation of Matter

Checklist for teacher's assessment of individual in a group during teacher demonstration

Task skills	Yes	No	Comments
Stays focused on demonstration			
Understands experimental method			
Answers simple questions during demonstration			
Helpful/ assists teacher			
Records results correctly			
Explains results correctly			

Checklist for teacher's assessment of individual in a group during learner experiment

Task skills	Yes	No	Comments
Follows method in an orderly manner			
Uses time efficiently			
Uses apparatus and equipment correctly			
Works well in a group			
Answers simple questions during experiment			
Records results correctly			
Explains results correctly			

Detailed methods for these experiments are in the Learner's Book.

Experiment 1: Reaction between lead(II) nitrate and sodium iodide

7 A chemical change happens because a yellow precipitate forms when the solutions mix.
8 The weight before and after the reaction is the same.

Experiment 2: Reaction between sodium hydroxide and hydrochloric acid

4 a) The bromothymol indicator changes colour from blue (in an alkali) to green, which indicates a neutral pH. The HCl neutralised the NaOH to form new neutral products (NaCl and H_2O).
b) The weight of the flask before the reaction equals the weight of the flask after the reaction. The results prove the Law of Conservation of Mass.

Experiment 3: Reaction of Cal-C-Vita tablet with water

4 a) The Cal-C-Vita fizzes and releases large bubbles of gas. The plastic bag puffs up.
b) The weight of the flask and plastic bag before the reaction equals the weight of the apparatus after the reaction. The result proves the Law of Conservation of Mass.

LB p. 172

Activity 4 Experiment

Cognitive level 3 I P G

Determining the ratio in which elements combine

The detailed method is in the Learner's Book.
To make up 1 $mol{\cdot}dm^{-3}$ aqueous solutions of the salts, dissolve the following masses of the salts in 250 ml of water. Use a volumetric flask.

$AgNO_3$	42,5 g
NaCl	14,6 g
$Pb(NO_3)_2$	82,8 g
NaI	37,5 g
NaOH	10,0 g
$FeCl_3$	40,6 g

7 NaCl + $AgNO_3$: The amount of precipitate is the same in each test tube.
$Pb(NO_3)_2$ + NaI: The amount of precipitate is the same in Test tubes 2 and 3, and double as much as in Test tube 1.
NaOH + $FeCl_3$: The amount of precipitate is different in each test tube – the smallest amount is in Test tube 1 and the most in Test tube 3.

8 NaCl + $AgNO_3$: The compounds reacted in equal amounts and the ratio of NaCl : $AgNO_3$ is 1 : 1. Adding more NaCl did not increase the amount of precipitate.
$Pb(NO_3)_2$ + NaI: The compounds reacted in a ratio of 1 $Pb(NO_3)_2$: 2 NaI. In Test tube 1 only half of the NaI reacted; in Test tube 2 all the reactants reacted; in Test tube 3 all the NaI reacted, but the $Pb(NO_3)_2$ was in excess and some was left unreacted.
NaOH + $FeCl_3$: The compounds reacted in a ratio of 3 NaOH : 1 $FeCl_3$. Only in Test tube 3 did all the reactants react and that is why you saw an increase in precipitate in each consecutive test tube. Test tubes 1 and 2 both had an excess of $FeCl_3$.

Unit 2 Representing chemical change

TERM 2, MODULE 3

Balanced chemical equations are fundamental to understanding quantitative chemistry. Teachers must explain this very important basic skill well. The learners must then practise balancing equations until they master the skill.

LB p. 174

Activity 1 Test yourself

Cognitive level 3 I

Writing balanced equations

1 a) Law of Constant Composition
b) Law of Conservation of Mass

2 Balanced equations:
a) $2H_2O_2 \rightarrow 2H_2O + O_2$
b) $2SO_2 + O_2 \rightarrow 2SO_3$
c) $4Al + 3O_2 \rightarrow 2Al_2O_3$
d) $2KClO_3 \rightarrow 2KCl + 3O_2$
e) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$
f) $Cl_2 + SO_2 + 2H_2O \rightarrow 2HCl + H_2SO_4$
g) $2AgNO_3 + MgCl_2 \rightarrow 2AgCl + Mg(NO_3)_2$
h) $Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$

LB p. 175

Activity 2 Experiment

Cognitive level 3 G

Investigating the relation between amount of reactant and amount of product

The detailed method is in the Learner's Book.

7

	Experiment 1	Experiment 2
Volume reactant (H_2SO_4)		
Volume product (CO_2)		

8 When the amount of acid is doubled, the amount of gas also doubles.

9 $2NaHCO_3(s) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell) + 2CO_2(g)$

10 Yes, the ratio of reactant (H_2SO_4) to product (CO_2) is constant and remains the same when more reactant is used.

Learner's Book page 179

Units 1 to 2 Summative assessment answers

TERM 2, MODULE 3

1 a) Nitrogen is separated from air by fractional distillation: physical change
b) Lightning causes nitrogen in the air to combine with oxygen to form nitrogen oxides: chemical change
c) Iron is melted in a furnace and made into useful products: physical change
d) Iron is left outside and begins to rust: chemical change
e) Hydrogen burns in air to form water: chemical change
f) Water from a dam is purified with chlorine: physical change
g) Sand is mixed with water: physical change
h) Salt is stirred into water: physical change
i) Cooking oil and vinegar are mixed to make salad dressing: physical change
j) Carbon dioxide gas is bubbled through lime water: chemical change

2 a) $2H_2S + 3O_2 \rightarrow 2H_2O + 2SO_2$
b) $2Al + 3CuSO_4 \rightarrow Al_2(SO_4)_3 + 3Cu$
c) $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$
d) $2AgNO_3 + BaCl_2 \rightarrow 2AgCl + Ba(NO_3)_2$
e) $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

MODULE 4 ELECTRICITY AND MAGNETISM

Background information for Module 4

This module deals with the basic concepts of magnetism, electrostatics and electricity. Teachers must explain these basic concepts well. It is important that the learners understand these concepts as a solid foundation for the more advanced fields of electromagnetism, electronics and electric circuits that follow in Grades 11 and 12. Please do not be tempted to go beyond the scope of the curriculum. Learners need to spend time to understand and master basic concepts of the interrelationships between voltage, current and resistance. They will then feel confident and ready to master calculations successfully with Ohm's Law in Grade 11.

Circuits and circuit diagrams are integral parts of the basics of electricity. Make every effort to give learners the opportunity to experience the flow of an electric current in a simple series circuit. Many schools have circuit boards. If you do not have circuit boards, you can construct simple circuits using parts of a torch. Electrical shops also carry components that you can use to construct a series circuit. Ask your local electrical shop or hardware store for help. If you need help in setting up experiments, ask a local electrician to assist.

Electricity and magnetism make up 8,75% of the Physical Sciences curriculum for Grade 10. You should spend 2 hours on magnetism, 4 hours on electrostatics and 8 hours on electric circuits. The content on electricity and magnetism is straightforward and should not present any problems.

The properties of magnets lay the foundation for understanding electromagnetism in later grades. Learners should have the opportunity to investigate how magnets behave by themselves. Earth is one huge magnet and this phenomenon is responsible for animal behaviour and modern technologies such as the global positioning system.

LB p. 183

Activity 1 Experiment

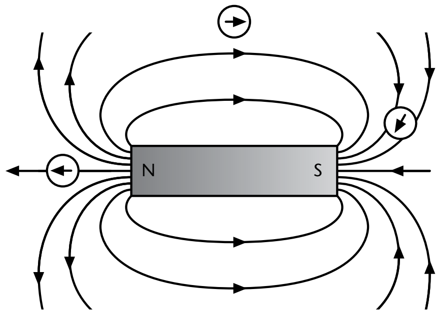
Cognitive level 3 P RPA

Investigating the magnetic field patterns of bar magnets

Checklist for teacher's assessment of individual in a group during demonstration

Task skills	Yes	No	Comments
Stays focused on demonstration			
Understands experimental method			
Answers simple questions during demonstration			
Helpful/ assists teacher			
Presents magnetic field lines correctly			
Answers questions correctly			

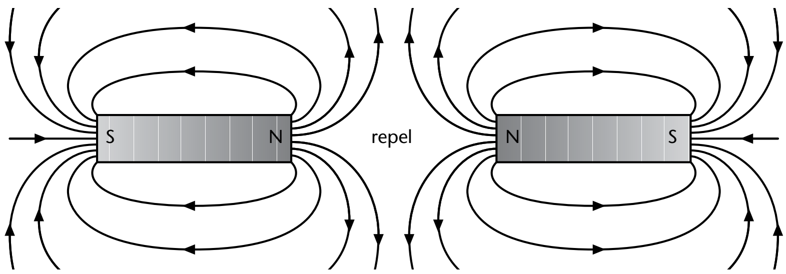
7



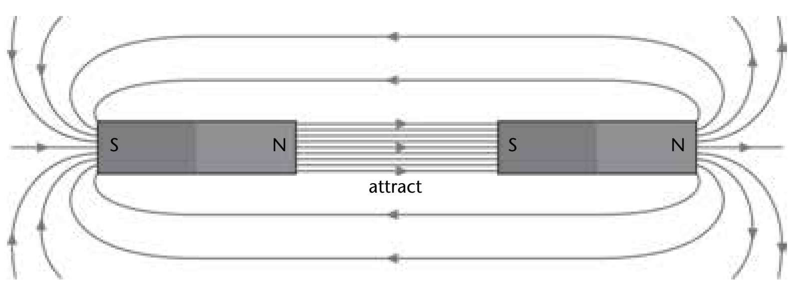
The detailed method for the experiment is in the Learner's Book.

8 Follow these methods to identify the poles of an unmarked magnet:
   a) Use another marked magnet and bring it near the unmarked magnet. Since like poles repel each other and unlike poles attract each other, you can tell which pole is which on the unmarked magnet if it is attracted or repelled. For example, if one of the poles is repelled by the south pole of the marked magnet, it must also be south.
   b) Suspend the magnet from a thread so that it hangs freely. The north pole of the magnet will point towards the north pole of Earth.
   c) Place a plotting compass near the pole. The compass will point in the direction of the field lines – away from north towards south.

9



10

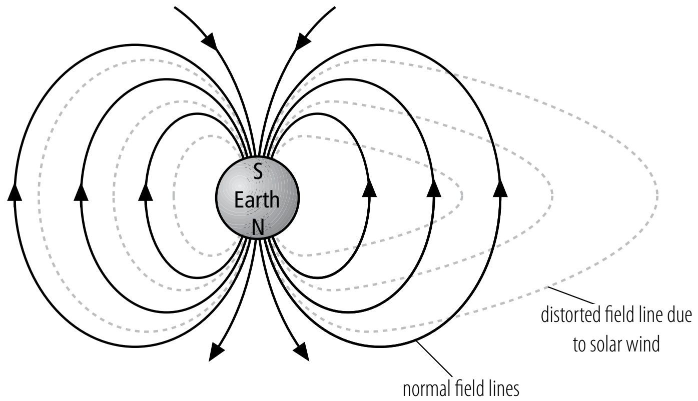


LB p. 187

Activity 2 Test yourself Cognitive levels 1–3 P

Interpreting the effects of Earth's magnetic field

1 High energy charged particles – negative electrons and positive ions
2 Solar wind
3 Earth's magnetosphere is the area around Earth where its magnetic field has an effect.
4



5 At the poles
6 Lithosphere (the ground); atmosphere (the air); biosphere (the living organisms)
7 The charged particles in the solar wind spiral down the field lines towards the poles and collide with the gas particles in the ionosphere. The gas particles become energised and emit light of different colours.
8 Humans use satellites for radio communication, navigation, television broadcasts and GPS. The satellites are affected by magnetic storms from the Sun. Auroras can also induce currents in long electric conductors that cause an overload that can disrupt electric power.

LB p. 188

Activity 3 Research project Cognitive levels 2–4 I

Finding out how migratory animals use Earth's magnetic field

Bird migration is an especially fascinating topic. Consult bird books, such as Newman's bird book, to find out about a number of birds in your area that migrate. If the status of the bird is 'summer resident', this means that it does migrate but nests in South Africa. If the bird is a 'summer visitor', this means that it nests elsewhere but visits South Africa in our summer.

Use the rubrics on pages E4 and E9 to assess this project.

LB p. 189

Activity 4 Case study Cognitive levels 1–4 I

Considering Earth's magnetic field

1 'Magnetically clean' means that there is an absence of substantial amounts of magnetic materials. Cities and towns with many large structures, such as bridges, large buildings and railway tracks, contain lots of magnetic material.

2 Iron
3 'Geo' refers to Earth, so geomagnetism is the magnetism of Earth.
4 Magnetic materials will not align if there is no magnetic field – they will be arranged randomly.
5 Magnetic north pole: Arctic region
Magnetic south pole: Antarctic region
6 2 000 years
7 No, compasses align themselves according to Earth's magnetic field. If the field is too weak or does not exist, the compasses will not work.
8 The GPS method uses accurate coordinates received from three satellites above Earth's surface. These satellites are not affected by Earth's magnetic field.

Unit 2 Electrostatics

TERM 2, MODULE 4

The outer electrons on objects can be moved during friction, which allows objects to become charged. We are all aware of some of the effects of static charge, for example, the crackling noise and sparks when you put on a jersey made from synthetic wool in dry weather. The first activity tests the charges on objects that were rubbed to obtain a charge.

LB p. 192

Activity 1 Experiment — Cognitive levels 1–2 G

Testing the charge on different materials

The Learner's Book lists a range of materials. Use a selection of rods from the list, but make sure to include at least one rod that will become positive and one that will become negative after rubbing. This activity is a difficult one to carry out properly. The weather must be hot and dry to make it work correctly. Learners must rub the rods vigorously for some time for enough charge to be transferred. If you have success with this activity, it is well worth the hard rubbing, and learners will remember the concepts so much better.

1 Glass and Perspex rods with nylon, wool, silk and polyester cloth.
Results: Perspex and glass repel each other; all the cloths attract both glass and Perspex.
2 Glass/Perspex and PVC/plastic rods with nylon, wool, silk and polyester cloth.
Results: glass/Perspex and PVC/plastic attract each other.
3 Plastic and PVC rods with nylon, wool, silk and polyester cloth.
Results: plastic and PVC repel each other; all the cloths attract both plastic and PVC.
Glass and Perspex have a positive charge and plastic and PVC have a negative charge according to convention.

Worked example: Charge conservation

Two identical conducting spheres are suspended from the ceiling by isolating strings. Sphere 1 has a charge of +7 nC and the charge on Sphere 2 is −5 nC. Calculate the charge on each sphere if they are allowed to touch. How many electrons were transferred in the process?

Write down what you know and what you must calculate:

charge on Sphere 1 = +7 nC

charge on Sphere 2 = −5 nC

charge after contact?

number of electrons transferred?
Change the magnitude of the values to scientific notation in coulombs:
Sphere 1: $+7\text{ nC} = +7 \times 10^{-9}\text{ C}$
Sphere 2: $-5\text{ nC} = -5 \times 10^{-9}\text{ C}$
Write down the correct equation:
$Q = \frac{Q_1 + Q_2}{2}$
Fill in the values and calculate the answer:
$Q = \frac{Q_1 + Q_2}{2} = \frac{+7 \times 10^{-9}\text{ C} + (-5 \times 10^{-9}\text{ C})}{2} = +1 \times 10^{-9}\text{ C}$
Sphere 1 carried a charge of $+7 \times 10^{-9}$ C originally; its final charge is $+1 \times 10^{-9}$ C. The sphere is now less positive, so it gained electrons.
The change in charge is $(+7 \times 10^{-9}\text{ C}) - (+1 \times 10^{-9}\text{ C}) = +6 \times 10^{-9}\text{ C}$
Charge on one electron $= -1{,}6 \times 10^{-19}$ C
The number of electrons that were transferred to sphere 1:
$\frac{\text{total charge transferred}}{\text{charge on one electron}} = \frac{+6 \times 10^{-9}\text{ C}}{1{,}6 \times 10^{-19}\text{ C}} = 3{,}75 \times 10^{10}$ electrons

LB p. 197

Activity 2 Test yourself

Cognitive levels 1–4 I

Applying electrostatic attraction

1 $n = \frac{Q}{q_e} = \frac{-2 \times 10^{-9}\text{ C}}{-1{,}6 \times 10^{-19}\text{ C}} = 1{,}25 \times 10^{10}$ electrons
2 A and B have opposite charges and attract one another – opposite charges attract. When they touch, electrons will transfer from B to A until both have the same charge. They will then repel one another and move away.
3 $Q = \frac{Q_A + Q_B}{2} = \frac{(+3 \times 10^{-9}\text{ C}) + (-2 \times 10^{-9}\text{ C})}{2} = \frac{+1 \times 10^{-9}\text{ C}}{2} = +5 \times 10^{-10}\text{ C}$
Both A and B will have a charge of $+5 \times 10^{-10}$ C or 0,5 nC
4 B has a deficit of $n = \frac{Q}{q_e} = \frac{5 \times 10^{-10}\text{ C}}{1{,}6 \times 10^{-19}\text{ C}} = 3{,}13 \times 10^{9}$ electrons.
5 Principle of Charge Quantisation
6 The Perspex rod will repel Sphere B and it will swing away.
7 False; the smallest charge possible is the charge on an electron, which is $1{,}6 \times 10^{-19}$ C. No smaller charge is possible.

Unit 3 Electric circuits

TERM 2, MODULE 4

A stationary charge on an object is called an electrostatic charge, but when the charge is allowed to flow from one place to another, an electric current arises. A charge can flow in a series circuit provided that the circuit is complete (closed) and there is a source of power that provides the energy to the electrons. The quantities of resistance, current and potential difference are all interlinked when a series circuit is in operation. The quantitative calculations involving these quantities (Ohm's Law) is covered in Grade 11. In this unit it is important that learners experience the relationships qualitatively.

LB p. 199

Activity 1 Practical demonstration

T

The difference between emf and potential difference

This is a teacher demonstration. Set up any circuit to illustrate that the reading on the voltmeter is lower when the switch is closed and a current is flowing than the voltmeter reading across the battery when it is not delivering current. This circuit demonstration makes it easy to explain the concept of internal resistance, although learners will only formally learn about internal resistance in Grades 11 and 12.

Worked example: Charge and current

Calculate the current in a conducting wire if it takes two seconds for a charge of 0,3 C to pass a point in the wire.

Write down what you know and what you must calculate:

charge = 0,3 C
time = 2 s
current = ?

Write down the correct equation:

$Q = I\Delta t$

Change the subject of the formula to current and substitute the values. Calculate the answer:

$I = \frac{Q}{\Delta t} = \frac{0,3\ \text{C}}{2\ \text{s}} = 0,15\ \text{A}$

LB p. 200

Activity 2 Test yourself

Cognitive levels 2–3 *I*

Interpreting current distribution in a circuit

1 a) $A_1 = 1,0$ A and $A_3 = 0,5$ A
b) $Q = I\Delta t = 1,0\ \text{A} \times 1\ \text{s} = 1\ \text{C}$
c) $\Delta t = \frac{Q}{I} = \frac{1\ \text{C}}{0,5\ \text{A}} = 2\ \text{s}$

LB p. 201

Activity 3 Experiment

Cognitive levels 1–4 *P*

Investigating the current in electric circuits

a) The light bulbs are dimmest in the circuit that has the light bulbs connected in series (Circuit 2).
b) The light bulbs in the parallel circuit (Circuit 3) are the same brightness as the light bulb in Circuit 1.
c) The parallel circuit (Circuit 3) gives out most light.
e) The learners should be able to reason that the current going through the light bulbs in Circuit 3 is the same as the current going through the light bulb in Circuit 1 because they glow with the same brightness. Therefore the amount of current leaving the power pack in Circuit 3 is twice the current leaving the power pack in Circuit 1.
f) This activity should confirm the answer given in e).
g) This is perhaps more difficult to predict. The amount of current going through each light bulb in series (Circuit 2) is half the current going through the light bulb in Circuit 1. The current is constant around the circuit so the amount of current leaving the power pack is also half the current going through each light bulb in series.
h) The current in a series circuit decreases with every additional resistor that is added. The current in a parallel circuit increases with every additional resistor in the parallel part.

Worked example: Series and parallel circuits

Here are two circuits with a set of values for resistance, current and potential difference added to each circuit. Explain to learners how these values are interlinked. Assume that each battery has an emf of 1,5 V and that internal resistance is ignored.

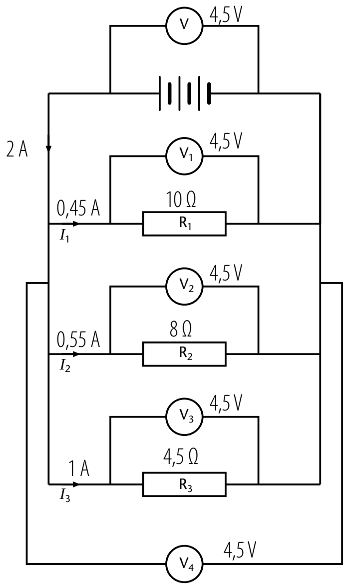
Resistors in series

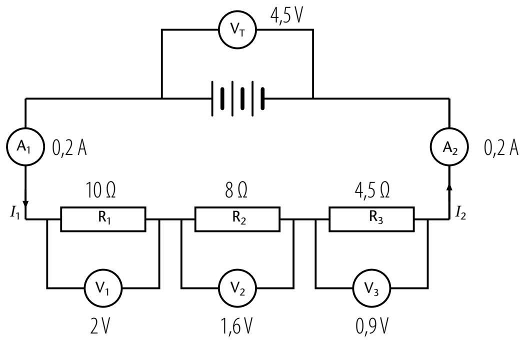
Current (constant) = 0,2 A

Total resistance = 10 Ω + 8 Ω + 4,5 Ω = 22,5 Ω

Total emf = 4,5 V

Voltage is divided between resistors: 2 V + 1,6 V + 0,9 V = 4,5 V





Resistors in parallel

Voltage (constant and equal to emf) = 4,5 V

Total resistance = 2,24 Ω

Current is divided between resistors: 0,45 A + 0,55 A + 1 A = 2 A

LB p. 207

Activity 4 Prescribed experiment — Cognitive levels 3–4 G PPA

Investigating the effect of resistors in series and in parallel

Resistors can be connected in series and in parallel. The type of connection and the subsequent equivalent resistance affects the current and voltage distribution in the circuit.

Hand out a selection of three different resistors and light bulbs to each group. Each group will therefore have a different set of results. Collect the results from all the groups and show them to the class. Explain to learners that more than one set of results is needed to draw general conclusions. Compare the results from all the groups and allow the learners to each formulate their own conclusion regarding resistors in parallel and in series.

Rubric for formal assessment of prescribed experiment

Total: 20 marks

Assessment criteria	Rating			
	4	3	2	1
Organisation – works through method in orderly manner	Method followed; efficient and organised; tidy	Method partly followed, not well organised; tidy	Method not well followed; disorganised; untidy	No idea how to follow method; disorganised; messy
Teamwork			Effective teamwork and good spirit	Does not participate sufficiently
Efficient use of allocated time			Experiment completed efficiently and in time	Experiment not completed; inefficient
Ability to use apparatus and equipment	All apparatus used correctly and with care	Apparatus used correctly	Apparatus sometimes used incorrectly	Apparatus used incorrectly
Data tables	1. Suitable heading 2. Correct format 3. Units correct 4. Data entered correctly	Three of the four criteria correct	Two of the four criteria correct	One of the four criteria correct
Conclusion	Conclusion well phrased with all facts	Conclusion correct	Conclusion lack certain facts	Conclusion not correct

Part 1: Resistors in series

3

Results	
Ammeter reading: A_1	
Ammeter reading: A_2	
Voltmeter reading: V_1	
Voltmeter reading: V_2	
Voltmeter reading: V_3	
Voltmeter reading: V_T	

Resistors connected in series	
Voltage dividers: $V_T = V_1 + V_2 + V_3$	
The current throughout the circuit is constant: $I_1 = I_2 = I_3$	

Part 2: Resistors in parallel

3

Results	
Ammeter reading: A_1	
Ammeter reading: A_2	
Ammeter reading: A_3	
Voltmeter reading: V_1	
Voltmeter reading: V_2	
Voltmeter reading: V_3	

Resistors connected in parallel	
The potential difference across resistors is constant: $V_1 = V_2 = V_3$	
Current dividers: $I_T = I_1 + I_2 + I_3$	

LB p. 209

Activity 5 Test yourself

Cognitive levels 1–4 I

Answering questions on circuits

1 a) None will light up.
b) Bulbs X and Z will glow equally bright; Bulb Y will not glow.
c) Bulbs X and Y will have the same potential difference that will be half of the potential difference across Z.
d) $I_X = 0{,}25$ A; $I_Z = 0{,}5$ A
e) The ammeter reading will increase. Another resistor in parallel will decrease the total resistance and therefore the current will increase.

2 a) A_2: 2 A; A_3: 1 A
b) $R_p = \frac{R_1R_2}{R_1 + R_2} = \frac{1 \times 1}{1 + 1} = 0{,}5\ \Omega$
$R_T = R_p + R_s = 0{,}5\ \Omega + 1\ \Omega = 1{,}5\ \Omega$
c) $V_2 = 1$ V

3 a) $Q = I\Delta t = 0{,}5\text{ A} \times 3\ 600\text{ s}$ (1 h = 60 × 60 s)
$= 1\ 800$ C
b) The resistance increases as the temperature increases.

4 a) $R_s = R_1 + R_2 + R_3 = 6\ \Omega + 3\ \Omega + 12\ \Omega = 21\ \Omega$
b) $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{6} + \frac{1}{3} + \frac{1}{12} = \frac{2+4+1}{12} = \frac{7}{12}$
$R_p = \frac{12\ \Omega}{7\ \Omega} = 1{,}71\ \Omega$

c) $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{12} + \frac{1}{3} = \frac{1+4}{12} = \frac{5}{12}$

$R_p = \frac{12\ \Omega}{5\ \Omega} = 2{,}4\ \Omega$

or $R_p = \frac{R_1 R_2}{R_1 + R_2} = \frac{3 \times 12}{3 + 12} = 2{,}4\ \Omega$

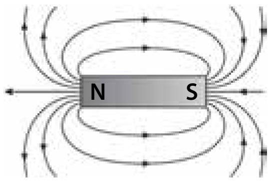
$R_T = R_s + R_p = 6\ \Omega + 2{,}4\ \Omega = 8{,}4\ \Omega$

Learner's Book page 211

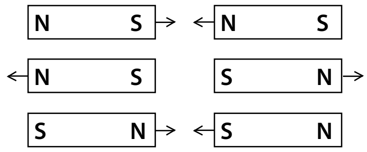
Units 1–3 Summative assessment answers

TERM 2, MODULE 4

1 Magnetic field pattern:



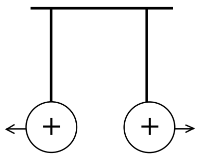
2



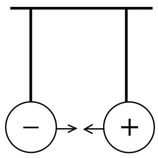
Like poles repel each other.
Unlike poles attract each other.

3 a) End A of the magnet is a <u>north</u> pole because it repels the <u>north</u> pole of the compass needle.
b) End B of the magnet is a <u>south</u> pole because it attracts the <u>north</u> pole of the compass needle.

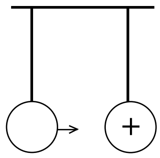
4 a)



b)

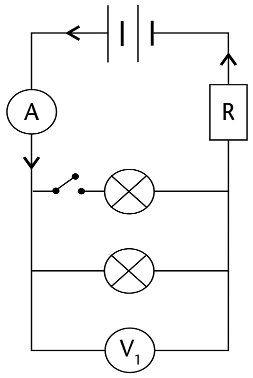


c)

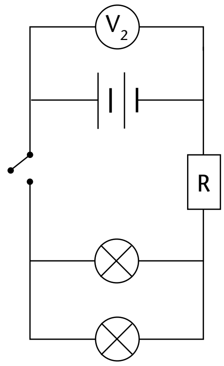


5 a) Vigorously rub the glass rod with a cloth.
b) Frictional force
c) The friction between the rod and the cloth removes electrons from the glass rod. The glass rod is left with fewer electrons than protons. The cloth is left with more electrons than protons. The glass rod has a positive charge and the cloth has an equal but negative charge.
d) When we bring the charged rod close to an uncharged piece of paper, the uncharged paper is polarised. Electrons nearest the positive glass rod are attracted to it. A temporary negative side is formed in the paper which sticks to the glass rod.
e) $n = \frac{Q}{q_e} = \frac{3 \times 10^{-9}\ \cancel{C}}{1{,}6 \times 10^{-19}\ \cancel{C}} = 1{,}88 \times 10^{10}\ e^-$

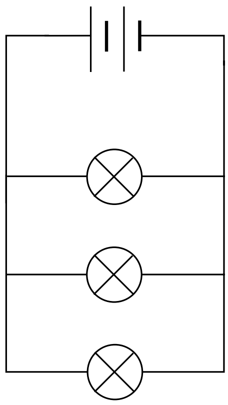
6 a)



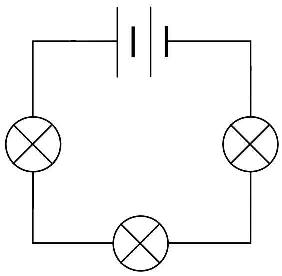
b)



7 a)



b)



Formal Assessment Task

You can use the Control test for Term 2 as part of the Mid-year exams. You will find in the Assessment section on pages B15–B16. You will find the answers to this formal assessment task on pages B17–B18.

Many reactions in chemistry and the reactions in living systems take place in aqueous solution. Learners should be aware that different types of reactions occur in water and that the combination of reactants determine the products. Some products are easily noticed, for example, gas being liberated, colour changes or formation of precipitates.

LB p. 216

Activity 1 Practical investigation   Cognitive level 3 G

Investigating different types of solutions

Safety
- Learners should always wear safety goggles during all chemical experiments.
- Solid $KMnO_4$ is an oxidiser and solid NaOH is highly corrosive. Handle with great care and avoid skin contact.
- Wash hands after handling chemicals.

2 Sodium chloride dissolves in water to form a clear solution. The temperature remains constant during the dissolution process.
Potassium permanganate dissolves in water to form a clear purple solution. There is a slight increase in temperature.
Sodium hydroxide dissolves in water to form a clear solution. The temperature increases during the dissolution process.
Potassium nitrate dissolves in water to form a clear solution. The temperature drops during the dissolution process and the solution becomes cold.

3 $NaCl(s) + H_2O(\ell) \rightarrow Na^+(aq) + Cl^-(aq)$
$KMnO_4(s) + H_2O(\ell) \rightarrow K^+(aq) + MnO_4^-(aq)$
$NaOH(s) + H_2O(\ell) \rightarrow Na^+(aq) + OH^-(aq)$
$KNO_3(s) + H_2O(\ell) \rightarrow K^+(aq) + NO_3^-(aq)$

4 Properties of a solution:
- A solution is a homogeneous mixture of two or more substances.
- The greatest amount in a solution is called the solvent. The physical state of the solution is the same as that of the solvent.
- The smallest amount in a solution is the solute.
- The solute is distributed evenly throughout the solvent and the composition of the solution is uniform.

LB p. 216

Activity 2 Research project   Cognitive levels 3–4 I

Investigating hard water or acid rain

Background information on hard water and acid rain

1 Hard water
All water that does not originate in sandstone is hard. Permanent hardness is caused by CaO and MgO that are dissolved in water. Temporary hardness is caused by $CaHCO_3$ and $MgHCO_3$ that are dissolved in the water. A high concentration of these ions in solution can cause problems. The dry western part of our country in particular is plagued by hard water.
The carbon dioxide in the atmosphere dissolves in rainwater to form carbonic acid. The normal pH of rainwater (weak carbonic acid) is 5,6. When

rainwater moves through the soil, it dissolves limestone, chalk and dolomite to release calcium ions (Ca^{2+}) and magnesium ions (Mg^{2+}). For example:

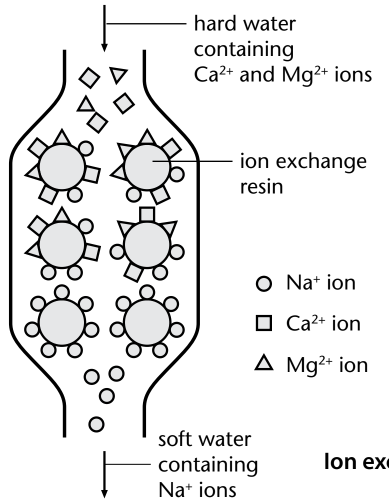
$H_2CO_3(aq) + CaCO_3(s) \rightarrow Ca^{2+}(aq) + CO_3^{2-}(aq) + CO_2(g) + H_2O(\ell)$

These ions can dissolve in the groundwater to make the water hard. Hard water contains a high percentage of dissolved Ca^{2+} and Mg^{2+} ions. The calcium ions can react again with hydrogen carbonate ions to form calcium carbonate (limestone). In this way the ions are removed from the water. For example:

$Ca^{2+}(aq) + 2HCO_3^-(aq) \rightarrow CaCO_3(s) + CO_2(g) + H_2O(\ell)$

Hardness gives water a different taste that many people find unpalatable. Hardness causes calcium carbonate, commonly known as lime scale, to build up in pipes, geysers and kettles. When soap is used with hard water it forms scum that makes it difficult to wash dishes and clothes.

We can soften hard water in an ion exchange column. The column contains sodium ions in porous resin beads. When the hard water runs through the resin, Ca^{2+} and Mg^{2+} ions are exchanged for Na^+ ions.



Ion exchange column

We can also soften hard water using a reverse osmosis filtering system. The filters remove the salts and pure water is produced. This system is relatively expensive.

2 Acid rain

Normal rain is slightly acidic with a pH of about 5,6. This is because carbon dioxide in the air dissolves in raindrops to form carbonic acid, which is a weak acid. Sulfur dioxide, and to a lesser extent nitrogen oxides, can dissolve in rainwater to form acid rain. Acid rain can have a pH of 4 or lower and can cause widespread damage.

Most power stations burn coal or oil to generate electricity. Both these fuels are contaminated with sulfur and form sulfur dioxide during combustion.

$S(s) + O_2(g) \rightarrow SO_2(g)$

Some of the sulfur dioxide dissolves in rainwater to form sulfurous acid.

$SO_2(g) + H_2O(\ell) \rightarrow H_2SO_3(aq)$

Some of the sulfur dioxide in the atmosphere is slowly converted to sulfur trioxide when it reacts with the oxygen in the air.

$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

Sulfur trioxide dissolves in rainwater to form sulfuric acid.

$SO_3(g) + H_2O(\ell) \rightarrow H_2SO_4(aq)$

Nitrogen oxides are produced in power stations as well as in petrol engines of motor vehicles. These gases can form nitrous acid and nitric acid when dissolved in water.

$2NO_2(g) + H_2O(\ell) \rightarrow HNO_2(aq) + HNO_3(aq)$

Acid rain dissolves limestone and marble buildings and statues are slowly worn away. Limestone and marble are forms of calcium carbonate that react with an acid to produce carbon dioxide.

$$CaCO_3(s) + H_2SO_4(aq) \rightarrow CaSO_4(aq) + H_2O(\ell) + CO_2(g)$$

Acid rain also corrodes metals and damages car surfaces. Corrosion is the oxidation of metals to form rust. One of the reactants needed for this reaction is hydrogen ions that are normally present in rainwater. In acid rain the concentration of hydrogen ions is much higher than in normal rainwater and corrosion happens more quickly.

Acid rain that falls in lakes acidifies them. Some fish species have been wiped out in lakes in north-eastern United States, Canada and Scandinavia.

Acid rain leaches (washes out) nutrients such as Ca^{2+} and Mg^{2+} ions from the soil and damages plant leaves. Acid rain has caused large-scale damage to forests throughout much of central and Eastern Europe. Trees become more susceptible to stresses such as cold temperatures, diseases, insects, drought and fungi that thrive under acidic conditions. In South Africa, research into the damage caused by acid rain to crops and forests are conducted by the CSIR, Eskom and other research organisations.

Acid rain leaches certain ions (for example Al^{3+} ions) from the soil. These ions dissolve in lakes and dams and poison fish and plants. The aluminium ions affect the gills of fish, and young fish are particularly vulnerable to aluminium poisoning.

The damage caused by acid rain is difficult and expensive to rectify. We can add lime to lakes and the surrounding land to decrease the acidity, but the best remedy is preventing the acid rain. Many countries implement laws against pollution. Petrol for cars is now almost free of sulfur. Power stations can fit flue-gas desulfurisers in their chimneys to reduce the levels of sulfur dioxide they give off. Installing a sulfuric acid plant near a metal refining site is also an effective way to cut SO_2 emission, because SO_2 is used to synthesise sulfuric acid. This is a sensible way to turn a pollutant from one process into a starting material for another process.

LB p. 218

Activity 3 Experiment — Cognitive levels 3–4 G

Investigating the electrical conductivity of liquids

Safety

- Learners should always wear safety goggles during all chemical experiments.
- Avoid skin contact with chemicals.
- Wash hands after handling chemicals.
- Dilute solutions of acids, bases and salts are regarded as low-hazard chemicals.
- Benzene, alcohol and paraffin are flammable; do not use near an open flame.
- Benzene is toxic; avoid skin contact.
- Solvents are volatile; do experiment in a well-ventilated room.
- Do not dispose of solvents by pouring them down the drain. Contact the local authority for rules regarding safe disposal of chemical waste.

a) Particles from the liquid can cling to the beaker and rods and contaminate the next reading.

b)

Conductors	Non-conductors
Acetic acid (weak conductor)	Distilled water
Sodium chloride in water	Benzene
Copper(II) sulfate in water	Alcohol
Dilute hydrochloric acid	Turpentine
Dilute sulfuric acid	Paraffin
Sodium hydroxide solution	Naphthalene in alcohol
	Sugar solution
	Candle wax in carbon tetrachloride

c) Conductors contain ionic substances.
d) Electrolytes contain positive cations and negative anions. When carbon rods are placed in an electrolyte and connected to an energy source, the cations move towards the negative electrode (opposites attract). The anions move towards the positive electrode. Chemical reactions take place at the cathode and the anode. The movement of the cations and anions in the solution (electrolyte) carry the charge in the solution. A closed circuit results and an electric current flows.

LB p. 219

Activity 4 Practical investigation — Cognitive level 3 G

Investigating dissolution processes

Safety
- The chemicals are low hazard and no special precautions need to be taken.

2 There is no temperature change when sugar and NaCl dissolve in water. In both cases a clear solution forms.
The dissolution of $CaCl_2$ in water increases the temperature of the water – it is an exothermic process.
The dissolution of NH_4Cl in water decreases the temperature – it is an endothermic process.
4 On evaporation all the original substances were obtained. This means that dissolution in water is a physical change.

LB p. 219

Activity 5 Research project — Cognitive level 2 P

Researching chemical and physical change

A chemical change occurs during a chemical reaction when the atoms in the reactants rearrange to form new products. The chemical and physical characteristics of the reactants and products are totally different.

LB p. 223

Activity 6 Experiment — Cognitive levels 3–4 G P

Investigating the solubility of salts

Safety
- Learners should always wear safety goggles during all chemical experiments.
- Avoid skin contact with chemicals.
- Wash hands after handling chemicals.

5

	Group 1				
	NaCl	NaBr	NaI	Na_2CO_3	$NaNO_3$
$AgNO_3$	AgCl	AgBr	AgI	Ag_2CO_3	
	Group 2				
	Na_2SO_4	$MgSO_4$	Na_2CO_3	NaCl	$NaNO_3$
$Ba(NO_3)_2$	$BaSO_4$	$BaSO_4$	$BaCO_3$		

6 Ag_2CO_3 and $BaCO_3$ dissolve in concentrated HNO_3.

7 Ionic equations for all the reactions in which precipitates were formed:

$Na^+(aq) + Cl^-(aq) + Ag^+(aq) + NO_3^-(aq) \rightarrow AgCl(s) + Na^+(aq) + NO_3^-(aq)$

$Na^+(aq) + Br^-(aq) + Ag^+(aq) + NO_3^-(aq) \rightarrow AgBr(s) + Na^+(aq) + NO_3^-(aq)$

$Na^+(aq) + I^-(aq) + Ag^+(aq) + NO_3^-(aq) \rightarrow AgI(s) + Na^+(aq) + NO_3^-(aq)$

$2Na^+(aq) + CO_3^{2-}(aq) + 2Ag^+(aq) + 2NO_3^-(aq) \rightarrow Ag_2CO_3(s) + 2Na^+(aq) + 2NO_3^-(aq)$

$Ag_2CO_3(s)$ dissolves in concentrated nitric acid:

$Ag_2CO_3(s) + 2HNO_3(\ell) \rightarrow 2Ag^+(aq) + 2NO_3^-(aq) + H_2O(\ell) + CO_2(g)$

$Ba^{2+}(aq) + 2NO_3^-(aq) + 2Na^+(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s) + 2Na^+(aq) + 2NO_3^-(aq)$

$Ba^{2+}(aq) + 2NO_3^-(aq) + Mg^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s) + Mg^{2+}(aq) + 2NO_3^-(aq)$

$Ba^{2+}(aq) + 2NO_3^-(aq) + 2Na^+(aq) + CO_3^{2-}(aq) \rightarrow BaCO_3(s) + 2Na^+(aq) + 2NO_3^-(aq)$

$BaCO_3(s)$ dissolves in concentrated nitric acid:

$BaCO_3(s) + 2HNO_3(\ell) \rightarrow Ba^{2+}(aq) + 2NO_3^-(aq) + H_2O(\ell) + CO_2(g)$

General safety rules for experiments in Activities 7, 8 and 9

- Take great care when diluting acids and bases. Many strong acids and bases are toxic and corrosive. Use eye protection and gloves. Always add the acid to the water. Add small amounts of acid at a time, shake and leave to cool first if necessary before adding more acid. The dissolution process of sulfuric acid and sodium hydroxide in particular is very exothermic. Prepare chemicals in advance to allow for cooling time for the solutions.
- Sodium is a very corrosive chemical. For full instructions on how to handle the chemical safely refer to the notes on alkali metals in Module 1, Unit 4, Activity 3 on page D23 of this file.
- Learners should always wear safety goggles during all chemical experiments.
- Avoid skin contact with chemicals.
- Wash hands after handling chemicals.
- Dilute solutions of acids, bases and salts are regarded as low-hazard chemicals.
- Handle glass apparatus with care. Learners must report breakages immediately. The teacher must treat and monitor skin cuts.
- Take care when using a Bunsen burner. Always handle hot apparatus with a pair of tongs.
- Hydrogen gas is explosive and flammable. When hydrogen is produced during a reaction, extinguish all open flames and ventilate the room well.
- The Learner's Book contains complete methods for the experiments.

LB p. 224

Activity 7 Experiment — Cognitive level 3 G

Preparing $CuCO_3$

6 Both $CuSO_4$ and Na_2CO_3 dissolve completely in water. $CuSO_4$ forms a blue solution and the Na_2CO_3 solution is colourless. When the two solutions are added together, a green precipitate forms. The precipitate could be filtered and dried to leave green $CuCO_3$ crystals.
$CuSO_4(aq) + Na_2CO_3(aq) \rightarrow CuCO_3(s) + Na_2SO_4(aq)$

7 The filtrate contains Na^+ ions, SO_4^{2-} ions and water.

LB p. 228

Activity 8 Experiments — Cognitive level 3 G

Investigating acids and bases

Experiment 1

5 Indicator colours

Indicator	Acid	Neutral	Alkaline
Litmus	Red	Purple	Blue
Methyl orange	Red	Orange	Yellow
Bromothymol blue	Yellow	Green	Blue
Phenolphthalein	Colourless	Colourless	Pink (Red)
Universal indicator	Red	Yellow/Green	Blue/Violet

Experiment 2

3 The metals all react with acid to liberate hydrogen gas. The temperature of the solutions will increase.

Experiment 3

4 On heating, both MgO and CuO will react with acids. The powders will slowly dissolve. $MgCl_2(aq)$ is a colourless solution, but $Cu(NO_3)_2(aq)$ contains the blue Cu^{2+}ions. No gas is liberated.

Experiment 4

6 All carbonates react with acids to liberate large bubbles of CO_2. The clear lime water turns milky.
Balanced equations:
$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
$Fe(s) + 2HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$
$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$
$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$
$Fe(s) + H_2SO_4(aq) \rightarrow FeSO_4(aq) + H_2(g)$
$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$
$MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(\ell)$
$CuO(s) + 2HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + H_2O(\ell)$
$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(\ell) + CO_2(g)$
$Na_2CO_3(s) + 2HNO_3(aq) \rightarrow 2NaNO_3(aq) + H_2O(\ell) + CO_2(g)$

LB p. 231

Activity 9 Experiments

Cognitive level 3 G RPA

Identifying chemical reaction types

Checklist for teacher's assessment of individual in a group during demonstration

Task skills	Yes	No	Comments
Stays focused on demonstration			
Understands experimental method			
Answers simple questions during demonstration			
Helpful/ assists teacher			
Records results correctly in suitable table (Question a)			
Writes balanced chemical equations correctly with phase symbols included (Question b)			
Identifies reaction types correctly (Question c)			

a)

Chemicals	Type of reaction	Observations
$AgNO_3$ + NaBr	Precipitation reaction	A cream precipitate of AgBr formed.
Na_2CO_3 + HCl	Gas-forming reaction	Large bubbles of CO_2 formed and the solid Na_2CO_3 dissolved.
NaOH + HCl	Acid–base reaction	The bromothymol blue was blue in the NaOH and after neutralisation with HCl the colour changed to green.
Na + H_2O	Redox reaction	Bromothymol blue turned the water green. The Na reacted violently with the water and H_2 gas was released. The colour of the bromothymol blue in the water turned blue after the Na reacted.
$CuSO_4$ + Zn	Redox reaction	The Zn dissolved in the $CuSO_4$ solution; the blue colour of the $CuSO_4$ solution disappeared; a reddish-brown precipitate of Cu formed.

b) $AgNO_3(aq) + NaBr(aq) \rightarrow AgBr(s) + NaNO_3(aq)$
$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(\ell) + CO_2(g)$
$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(\ell)$
$2Na(s) + 2H_2O(\ell) \rightarrow 2NaOH(aq) + H_2(g)$
$CuSO_4(aq) + Zn(s) \rightarrow Cu(s) + ZnSO_4(aq)$

c) i) Redox reaction
ii) Acid–base reaction
iii) Gas-forming reaction
iv) Precipitation reaction
v) Redox reaction (also gas-forming reaction)
vi) Precipitation reaction

LB p. 233

Activity 10 Case study

Cognitive levels 1–4 P

Studying limestone and its products

1 Chalk is softer than limestone.
2 Marble is the hardest.

3 Limestone is abundant and primitive people could find enough limestone in most areas. Limestone is relatively soft and brittle and can be cut into blocks and slabs that make it easy to build with.
4 A kiln is an oven that can withstand very high temperatures and that is used to melt metals and minerals and bake earthenware and ceramics.
5 In Reaction 1, limestone is decomposed by heating it to high temperatures. The reaction is endothermic, because heat must be applied for the reaction to take place. When quicklime reacts with water, heat is released and the temperature of the mixture increases. Reactions in which heat is released are called exothermic.
6 (*aq*) means aqua: calcium hydroxide is dissolved in water
7 $CaCO_3(s) \rightarrow CaO(s) + CO(g)$
$CaO(s) + H_2O(\ell) \rightarrow Ca(OH)_2(s)$
$CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(\ell)$
8 $CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$
9 Calcium carbonate: $CaCO_3$
10 Reinforced concrete is used in all large structures and foundations for large structures, such as multistorey buildings and bridges.
11 Steps; foundations; floors in single and multistorey buildings; decking; roads and paths, etc.
12 In clay soil the soil particles are very small and pack tightly together. They trap and retain water molecules. Slaked lime breaks up the clay soil, makes it less 'sticky' and neutralises the acids.
13 'Slag' is the name given to the molten layer of lime that reacted with the sand in iron ore. The slag does not mix with the iron and is less dense so it can be tapped off and used for road building.
14 Impurities weaken the iron. Iron is used mainly for its strength and impurities will undermine its strength.
15 A personal choice. Here are a few examples: cement and concrete are used to build houses; slaked lime improves the soil so that crops can grow better; iron is used in all structures that need to be strong and tough; glass and glass products are used in the construction of homes and other buildings, cars and kitchenware; without paper this book would not have existed.

Unit 4 Quantitative aspects of chemical change

TERM 3, MODULE 3

Learners should realise that due to the small size of the atoms, molecules and ions, we often compare their properties on a mole basis. Learners should also realise that the Avogadro constant is a number that chemists often use to compare physical and chemical properties. Stoichiometry is the study of quantitative composition of chemical substances and the qualitative changes that take place during chemical reactions.

Note:

- In the solutions to Activity 1 we did not round off the numbers during calculations. We used the number on the calculator for each consecutive step. The learners' answers may differ slightly due to this.
- 1 ml = 1 cm^3

Worked examples: Stoichiometry

1 Calculate the number of moles and molecules in 100 g of water.
Determine the molar mass of water:
$M(H_2O) = 2 \times A_r(H) + A_r(O) = 2 \times 1{,}0 + 16{,}0 = 18{,}0\ g{\cdot}mol^{-1}$
This means that 18,0 g of water contains 1 mole of water molecules.
100 g of water will contain more than 1 mole:
number of moles $= \frac{100\ g}{18\ g} = 5{,}56$ mol molecules
1 mole contains $6{,}02 \times 10^{23}$ molecules, so 5,56 moles will contain:
$5{,}56 \times 6{,}02 \times 10^{23} = 3{,}34 \times 10^{24}$ molecules

2 Calculate the concentration of a solution when 50 g of hydrated copper sulfate is dissolved in 200 ml of water.
Write down what you know and what you must calculate:
$m = 50\ g$
$V = 200\ ml = 0{,}2\ dm^3$
$c = ?$
Find an equation that links the quantities:
$c = \frac{m}{MV}$
Calculate molar mass of $CuSO_4{\cdot}5H_2O$:
$M[CuSO_4{\cdot}5H_2O] = 63{,}5 + 32{,}1 + 4 \times 16{,}0 + 5(2 \times 1{,}0 + 16{,}0) = 249{,}6\ g{\cdot}mol^{-1}$
Substitute the values into the equation and calculate the answer:
$c = \frac{m}{MV} = \frac{50\ \cancel{g}}{249{,}6\ \cancel{g}{\cdot}mol^{-1} \times 0{,}2\ dm^3} = 1\ mol{\cdot}dm^{-3}$

3 20 g of zinc reacts in an excess dilute hydrochloric acid until all the zinc has reacted. Calculate the volume of hydrogen gas that was released at standard temperature and pressure.
Start by writing a balanced equation for the reaction:
$Zn + 2HCl \rightarrow ZnCl_2 + H_2$
From the balanced equation we notice that 1 mole of Zn releases 1 mole of hydrogen gas.
$A_r(Zn) = 65{,}4\ g{\cdot}mol^{-1}$
Calculate the number of moles in 20 g of Zn (less than 1 mole):
Number of moles Zn $= \frac{20\ \cancel{g}}{65{,}4\ g{\cdot}mol^{-1}} = 0{,}31$ mol
So 20 g of Zn will release 0,31 mol H_2
But 1 mole of a gas occupies $22{,}4\ dm^3$ at STP; therefore 0,31 mol H_2 occupies:
$0{,}31\ mol \times 22{,}4\ dm^3 = 6{,}85\ dm^3$

LB p. 241

Activity 1 Experiment

Cognitive level 3 G

Determining the mass of water of crystallisation

Safety
- Learners should always wear safety goggles during all chemical experiments.
- Take care when using a Bunsen burner. Always handle hot apparatus with a pair of tongs.

Results
Mass of empty porcelain dish = …
Mass of dish + blue copper(II) sulfate = …
Mass of dish + white copper(II) sulfate = …
Mass of blue copper(II) sulfate = …
Mass of white copper(II) sulfate = …
Mass of water = …

6 $M(H_2O) = 18{,}0\ g{\cdot}mol^{-1}$; $M(CuSO_4) = (63{,}5 + 32{,}1 + 64{,}0) = 159{,}6\ g{\cdot}mol^{-1}$

$n(H_2O) = \frac{m(H_2O)}{18{,}0\ g{\cdot}mol^{-1}}$

$n(CuSO_4) = \frac{m(CuSO_4)}{159{,}6\ g{\cdot}mol^{-1}}$

7 number of water molecules in formula $= \frac{n(H_2O)}{n(CuSO_4)}$

formula: $CuSO_4{\cdot}5H_2O$

LB p. 242 »

Activity 2 Test yourself

Cognitive level 3 I

Working with stoichiometric calculations

1 a) $M(MgSO_4{\cdot}7H_2O) = 24{,}3 + 32{,}1 + 4(16{,}0) + 7(2{,}0 + 16{,}0) = 246{,}4\ g{\cdot}mol^{-1}$

b) $M(K_2Cr_2O_7) = (2 \times 39{,}1) + (2 \times 52{,}0) + (7 \times 16{,}0) = 294{,}2\ g{\cdot}mol^{-1}$

c) $M(K_4Fe(CN)_6) = (4 \times 39{,}1) + 55{,}8 + (6 \times 12{,}0) + (6 \times 14{,}0) = 368{,}2\ g{\cdot}mol^{-1}$

2 a) $3\ mol\ Cu = (3\ \cancel{mol})(63{,}5\ g{\cdot}\cancel{mol^{-1}}) = 190{,}5\ g\ Cu$

b) $0{,}25\ mol\ CO_2 = (0{,}25\ \cancel{mol})(44{,}0\ g{\cdot}\cancel{mol^{-1}}) = 11\ g\ CO_2$

c) $0{,}02\ mol\ N_2 = (0{,}02\ \cancel{mol})(28{,}0\ g{\cdot}\cancel{mol^{-1}}) = 0{,}56\ g\ N_2$

3 a) $n(H_2O) = \frac{m}{M} = \frac{30\ g}{18{,}0\ g{\cdot}mol^{-1}} = 1{,}67\ mol\ H_2O$

number of molecules $= (1{,}67\ \cancel{mol})(6{,}02 \times 10^{23}\ molecules{\cdot}\cancel{mol^{-1}})$

$= 1 \times 10^{24}\ H_2O$ molecules

b) $3\ \cancel{mol} \times 6{,}02 \times 10^{23}\ atoms{\cdot}\cancel{mol^{-1}} = 1{,}81 \times 10^{24}$ He atoms

c) $n(NaCl) = \frac{m}{M} = \frac{292{,}5\ \cancel{g}}{58{,}5\ \cancel{g}{\cdot}mol^{-1}} = 5\ mol\ NaCl$

number of formula units $= 5\ \cancel{mol} \times 6{,}02 \times 10^{23}$ formula units$\cdot\cancel{mol^{-1}}$

$= 3{,}01 \times 10^{24}$ formula units

4 $n(K_2SO_4) = \frac{m}{M} = \frac{2\ \cancel{g}}{174{,}0\ \cancel{g}{\cdot}mol^{-1}} = 0{,}011\ mol\ K_2SO_4$

number of units $= (0{,}011\ \cancel{mol})(6{,}02 \times 10^{23}\ units{\cdot}\cancel{mol^{-1}})$

$= 6{,}92 \times 10^{21}\ K_2SO_4$ units

number of ions $= 3(6{,}92 \times 10^{21}) = 2{,}08 \times 10^{22}$ ions

5 a) $n(O_2) = \frac{m}{M} = \frac{6{,}4\ \cancel{g}}{32{,}0\ \cancel{g}{\cdot}mol^{-1}} = 0{,}2\ mol\ O_2$

b) $n(NH_4NO_3) = \frac{m}{M} = \frac{480\ \cancel{g}}{80{,}0\ \cancel{g}{\cdot}mol^{-1}} = 6\ mol\ NH_4NO_3$

c) $n(Fe) = \frac{m}{M} = \frac{2\ 000\ \cancel{g}}{55{,}8\ \cancel{g}{\cdot}mol^{-1}} = 35{,}8\ mol\ Fe$

6 a)

Element	g/100 g	$n = \frac{m}{M}$	Simplest ratio
Pb	62,5	$\frac{62{,}5}{207{,}2} = 0{,}302$	$\frac{0{,}302}{0{,}302} = 1$
N	8,45	$\frac{8{,}45}{14{,}0} = 0{,}604$	$\frac{0{,}604}{0{,}302} = 2$
O	29,05	$\frac{29{,}05}{16{,}0} = 1{,}816$	$\frac{1{,}816}{0{,}302} = 6$

$Pb_1N_2O_6 = Pb(NO_3)_2$

b)

Element	g/100 g	$n = \frac{m}{M}$	Simplest ratio
Al	53,0	$\frac{53{,}0}{27{,}0} = 1{,}96$	$\frac{1{,}96}{1{,}96} = 1$
O	47,0	$\frac{47{,}0}{16{,}0} = 2{,}94$	$\frac{2{,}94}{1{,}96} = 1{,}5$

$Al_1O_{1,5} = Al_2O_3$ (multiply by 2 to get whole numbers)

7 a) $M(CoCl_2) = 129{,}9\ g{\cdot}mol^{-1}$; $M(CoCl_2{\cdot}nH_2O) = 237{,}9\ g{\cdot}mol^{-1}$;

total m of $H_2O = 108{,}0\ g{\cdot}mol^{-1}$

number of water molecules $= \frac{108{,}0}{18{,}0} = 6$

formula: $CoCl_2{\cdot}6H_2O$

b) $M(NiCl_2) = 129,7\ g{\cdot}mol^{-1}$; $M(NiCl_2{\cdot}nH_2O) = 165,7\ g{\cdot}mol^{-1}$;
total m of $H_2O = 36,0\ g{\cdot}mol^{-1}$
number of water molecules $= \frac{36,0}{18,0} = 2$
formula: $NiCl_2{\cdot}2H_2O$

LB p. 244

Activity 3 Test yourself

Cognitive level 3 I

Determining percentage composition

1 $M(Cu) = 63,5\ g{\cdot}mol^{-1}$; $M(Cu(NO_3)_2) = 187,5\ g{\cdot}mol^{-1}$
% Cu: $\frac{63,5\ g{\cdot}mol^{-1}}{187,5\ g{\cdot}mol^{-1}} \times 100 = 33,87\ \%$

2 a) $M(CH_3COOH) = 60,0\ g{\cdot}mol^{-1}$
% C: $\frac{24,0\ g{\cdot}mol^{-1}}{60,0\ g{\cdot}mol^{-1}} \times 100 = 40\%$ C
% O: $\frac{32,0\ g{\cdot}mol^{-1}}{60,0\ g{\cdot}mol^{-1}} \times 100 = 53\%$ O
% H: $\frac{4,0\ g{\cdot}mol^{-1}}{60,0\ g{\cdot}mol^{-1}} \times 100 = 7\%$ H

b) $M(H_3PO_4) = 98,0\ g{\cdot}mol^{-1}$
% H: $\frac{3,0\ g{\cdot}mol^{-1}}{98,0\ g{\cdot}mol^{-1}} \times 100 = 3\%$ H
% P: $\frac{31,0\ g{\cdot}mol^{-1}}{98,0\ g{\cdot}mol^{-1}} \times 100 = 32\%$ P
% O: $\frac{64,0\ g{\cdot}mol^{-1}}{98,0\ g{\cdot}mol^{-1}} \times 100 = 65\%$ O

c) $M(NH_4NO_3) = 80,0\ g{\cdot}mol^{-1}$
% H: $\frac{4,0\ g{\cdot}mol^{-1}}{80,0\ g{\cdot}mol^{-1}} \times 100 = 5\%$ H
% N: $\frac{28,0\ g{\cdot}mol^{-1}}{80,0\ g{\cdot}mol^{-1}} \times 100 = 35\%$ N
% O: $\frac{48,0\ g{\cdot}mol^{-1}}{80,0\ g{\cdot}mol^{-1}} \times 100 = 60\%$ O

LB p. 244

Activity 4 Experiments

Cognitive level 3 P

Determining the composition of compounds

Safety
- Learners should always wear safety goggles during all chemical experiments.
- Take care when using a Bunsen burner. Always handle hot apparatus with a pair of tongs.
- The learners must not determine the composition of copper oxide in class. The values to calculate the composition are given.
- The Learner's Book has a complete method for the experimental determination of the percentage composition of magnesium oxide.

Experiment 1
Results
a) Mass of magnesium alone = 0,50 g
Mass of magnesium oxide = 0,81 g
b) % Mg in MgO $= \frac{0,50\ \cancel{g}}{0,81\ \cancel{g}} \times 100 = 62\%$ Mg
% O in MgO $= \frac{0,31\ \cancel{g}}{0,81\ \cancel{g}} \times 100 = 38\%$ O
c) Mg metal combined with the oxygen in the air to form MgO. The increased mass is due to the mass of the O atom being added to the Mg.
d) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
e) $2(24,3\ g) + 2(16,0\ g) \rightarrow 2(24,3 + 16,0)g$
$48,6\ g + 32,0\ g \rightarrow 80,6\ g$

f) % Mg in MgO $= \frac{48,6\ \cancel{g}}{80,6\ \cancel{g}} \times 100 = 60\%$ Mg

% O in MgO $= \frac{32,0\ \cancel{g}}{80,6\ \cancel{g}} \times 100 = 40\%$ O

g) The results of the experiment are reasonably accurate. A small amount of experimental error can always creep in.

Experiment 2

a) It is best to clamp the tube away from the flame.

b) copper oxide + hydrogen → copper + water

c) The hydrogen first had to replace all the air in the test tube.

d) It is difficult to see when all the copper oxide has been reduced. When the mass of copper remains constant, we know that all the available CuO was reduced.

e) Mass of copper oxide alone = 1,6 g

Mass of copper alone = 1,28 g

Mass of oxygen in copper oxide = 0,32 g

f) $M(\text{Cu}) = 63,5\ \text{g·mol}^{-1}$

$n = \frac{m}{M} = \frac{1,28\ \cancel{g}}{63,5\ \cancel{g}\text{·mol}^{-1}} = 0,02$ mol Cu

g) $M(\text{O}) = 16,0\ \text{g·mol}^{-1}$

$n = \frac{m}{M} = \frac{0,32\ \cancel{g}}{16,0\ \cancel{g}\text{·mol}^{-1}} = 0,02$ mol O

h) 0,02 mol Cu reacted with 0,02 mol O

∴ 1 mol Cu will react with 1 mol O

i) The formula of copper oxide must be CuO

j) $CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(g)$

LB p. 250

Activity 5 Test yourself

Cognitive level 3

Calculating concentration and volume

1 $M(Na_2O) = 62,0\ \text{g·mol}^{-1}$; $V = 200\ \text{cm}^3 = 0,2\ \text{dm}^3$

$c = \frac{m}{MV} = \frac{10\ \cancel{g}}{(62,0\ \cancel{g}\text{·mol}^{-1})(0,2\ \text{dm}^3)} = 0,81\ \text{mol·dm}^{-3}$

2 $M(MgCl_2) = 95,3\ \text{g·mol}^{-1}$; $V = 100\ \text{cm}^3 = 0,1\ \text{dm}^3$; $c = 1\ \text{mol·dm}^{-3}$

$m = cVM = (1\ \cancel{\text{mol·dm}^{-3}})(0,1\ \cancel{\text{dm}^{-3}})(95,3\ \text{g·}\cancel{\text{mol}^{-1}}) = 9,53\ \text{g}$

3 $M(\text{NaCl}) = 58,5\ \text{g·mol}^{-1}$; $V = 500\ \text{cm}^3 = 0,5\ \text{dm}^3$; $c = 0,1\ \text{mol·dm}^{-3}$

$m = cVM = (0,1\ \cancel{\text{mol·dm}^{-3}})(0,5\ \cancel{\text{dm}^{-3}})(58,5\ \text{g·}\cancel{\text{mol}^{-1}}) = 2,93\ \text{g}$

4 a) $1,5\ \cancel{\text{mol}} \times 22,4\ \text{dm}^3\text{·}\cancel{\text{mol}^{-1}} = 33,6\ \text{dm}^3$

b) $0,01\ \cancel{\text{mol}} \times 22,4\ \text{dm}^3\text{·}\cancel{\text{mol}^{-1}} = 0,224\ \text{dm}^3$

c) $3\ \cancel{\text{mol}} \times 22,4\ \text{dm}^3\text{·}\cancel{\text{mol}^{-1}} = 67,2\ \text{dm}^3$

5 a) $22,4\ \text{dm}^3 = 1$ mol

$50\ \text{dm}^3 = \frac{50\ \cancel{\text{dm}^3}}{22,4\ \cancel{\text{dm}^3}\text{·mol}^{-1}} = 2,23$ mol N_2 gas

1 mol N_2 gas = 2 mol N atoms

2,23 mol N_2 gas $= 2,23 \times 2 \times (6,02 \times 10^{23}) = 2,69 \times 10^{24}$ atoms

b) nucleons in 10 cm³ fluorine gas

$10\ \text{cm}^3 = 0,01\ \text{dm}^3 = \frac{0,01\ \cancel{\text{dm}^3}}{22,4\ \cancel{\text{dm}^3}\text{·mol}^{-1}} = 4,46 \times 10^{-4}$ mol F_2 gas

1 mol F_2 gas contains 19 × 2 nucleons

$4,46 \times 10^{-4}$ mol F_2 gas contains $(4,46 \times 10^{-4}) \times 38 \times (6,02 \times 10^{23})$

$= 1,02 \times 10^{22}$ nucleons

LB p. 253

Activity 6 Test yourself

Cognitive level 3

Working with stoichiometric calculations in balanced equations

1 $2KClO_3 \rightarrow 2KCl + 3O_2$

$2(122,6\ \text{g·mol}^{-1}) \rightarrow 2(74,6\ \text{g·mol}^{-1}) + 3(32\ \text{g·mol}^{-1})$

245,2 g → 149,2 g + 96,0 g

245,2 g $KClO_3$ release 96,0 g O_2

29,4 g $KClO_3$ release $\frac{29,4}{245,2} \times 96,0 = 11,51$ g O_2
245,2 g $KClO_3$ release $3 \times 22,4$ dm^3 O_2
29,4 g $KClO_3$ release $\frac{29,4}{245,2} \times 3 \times 22,4 = 8,06$ dm^3 O_2

2 96,15 g SO_2 = 1,5 mol SO_2
From the balanced equation:
1,5 mol SO_2 will react with 0,75 mol O_2 to form 1,5 mol SO_3
a) 1,5 mol SO_3 has a mass of $1,5(80,1\ g{\cdot}mol^{-1}) = 120,15$ g
b) 1,5 mol SO_3 has a volume of $1,5(22,4\ dm^3{\cdot}mol^{-1}) = 33,6\ dm^3$
c) 0,75 mol oxygen used = $0,75(22,4\ dm^3{\cdot}mol^{-1}) = 16,8\ dm^3$
d) total volume of gas = volume of oxygen left + volume of SO_3 formed
$= (44,8 - 16,8) + 33,6$
$= 61,6\ dm^3$
e) number of SO_3 molecules = $1,5(6,02 \times 10^{23}) = 9,03 \times 10^{23}$

3 Lithium reacts with water to form lithium hydroxide and hydrogen gas.
a) $2Li(s) + 2H_2O(\ell) \rightarrow 2LiOH(aq) + H_2(g)$
b) 13,8 g Li will form 2 g H_2 gas
2 g Li will form $\frac{2}{13,8} \times 2 = 0,29$ g H_2 gas
2 g H_2 gas = $22,4\ dm^3{\cdot}mol^{-1}$
0,29 g H_2 gas = $\frac{0,29}{2} \times 22,4 = 3,25\ dm^3$ H_2 gas

4 a) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
b) 48,6 g Mg gives 80,6 g MgO
1 g Mg gives $\frac{1\ \cancel{g}}{48,6\ \cancel{g}} \times 80,6\ g = 1,66$ g MgO
20 g Mg gives $20 \times 1,66$ g = 33,2 g MgO
c) 48,6 g Mg reacts with 22,4 dm^3 (1 mol) O_2
1 g Mg reacts with $\frac{1\ \cancel{g}}{48,6\ \cancel{g}} \times 22,4\ dm^3 = 0,46\ dm^3$
20 g Mg reacts with $20 \times 0,46\ dm^3 = 9,22\ dm^3$ O_2

Learner's Book page 254

Units 3–4 Summative assessment answers

TERM 3, MODULE 3

1

a) Electrolytes	b) Non-electrolytes
Dilute hydrochloric acid	Paraffin
Copper sulfate solution	Solution of naphthalene in alcohol
A salt solution	Sugar dissolved in water
Dilute caustic soda solution	Cooking oil

2 Balanced equations for these reactions:
a) Acid–base: $2HCl + MgO \rightarrow MgCl_2 + H_2O$
b) Redox: $H_2SO_4 + Fe \rightarrow FeSO_4 + H_2$
c) Gas-forming: $2HNO_3 + Na_2CO_3 \rightarrow 2NaNO_3 + H_2O + CO_2$
d) Acid–base: $H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$
e) Gas-forming: $HCl + NaHCO_3 \rightarrow NaCl + H_2O + CO_2$
f) Precipitation: $AgNO_3 + KI \rightarrow AgI + KNO_3$
g) Redox: $2NaI + Cl_2 \rightarrow 2NaCl + I_2$
h) Redox: $2Li + 2H_2O \rightarrow 2LiOH + H_2$
i) Precipitation: $Na_2SO_4 + Ba(NO_3)_2 \rightarrow 2NaNO_3 + BaSO_4$
j) Redox: $Mg + CuSO_4 \rightarrow MgSO_4 + Cu$

3 a) Zinc chloride
b) Copper sulfate
c) Sodium nitrate

4 a) $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$
b) 1 volume of H_2 forms 2 volumes of HCl
volume HCl $= 2 \times 60\ cm^3 = 120\ cm^3$
c) $60\ cm^3 = 0,06\ dm^3$
$22,4\ dm^3 = 1\ mol$
$0,06\ dm^3 = 0,0027\ mol\ H_2$

5 a) $M(Na_2CO_3) = (2 \times 23,0) + 12,0 + (3 \times 16,0) = 106\ g{\cdot}mol^{-1}$
$V = 200\ cm^3 = 0,2\ dm^3$
$c = \frac{m}{MV} = \frac{10,6\ \cancel{g}}{106\ \cancel{g}{\cdot}mol^{-1} \times 0,2\ dm^3)}$
$= 0,5\ mol{\cdot}dm^{-3}$
b) $[Na^+] = 2 \times 0,5\ mol{\cdot}dm^{-3} = 1,0\ mol{\cdot}dm^{-3}$

6 $M(H_2SO_4) = (2 \times 1,0) + 32,1 + (4 \times 16,0) = 98,1\ g{\cdot}mol^{-1}$
$\%H = \frac{2,0}{98,1} \times 100 = 2,04\%$
$\%S = \frac{32,1}{98,1} \times 100 = 32,72\%$
$\%O = \frac{64,0}{98,1} \times 100 = 65,24\%$

7

Element	g/100 g	*n = [m/M]*	Simplest ratio
C	58,82	$\frac{58,82}{12,0} = 4,90$	$\frac{4,90}{1,96} = 2,5$
H	9,81	$\frac{9,81}{1,0} = 9,81$	$\frac{9,81}{1,96} = 5$
O	31,37	$\frac{31,37}{16,0} = 1,96$	$\frac{1,96}{1,96} = 1$

Simplest ratio is 2,5 : 5 : 1, in whole numbers we have 5 : 10 : 2
Empirical formula: $C_5H_{10}O_2$

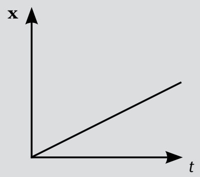
8 a) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
b) i) $M(C_6H_{12}O_6) = (6 \times 12,0) + (12 \times 1,0) + (6 \times 16,0) = 180\ g{\cdot}mol^{-1}$
1 mol glucose gives 6 moles CO_2
180 g glucose produce $6(1 \times 12,0 + 2 \times 16,0)\ CO_2$
900 g glucose produce $\frac{900\ g}{180\ g} \times 264\ g = 1\ 320\ g\ CO_2$
ii) 900 g glucose = 5 mol glucose
total gas produced $= 5 \times 6 = 30$ mol
total volume $= 30 \times 22,4\ dm^3 = 672\ dm^3$

Background information for Module 5

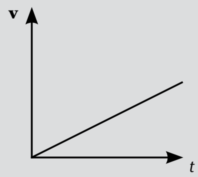
Mechanics makes up 18,75% of the Grade 10 Physical Sciences curriculum and it is the longest module. You should spend 30 hours teaching this module. The module on mechanics is divided into four units. Use four hours to explain vectors and scalars in Unit 1. Unit 2 deals with motion in one dimension where the basic concepts of position, displacement, velocity and acceleration are explained. Unit 3 covers graphs and equations of motion. Unit 4 on energy is done in Term 4.

Labels and units on the axes of graphs

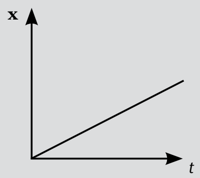
Many graphs of motion look the same so it is vital to take note and label the axes of the graphs correctly. In all graphs time is plotted on the *x*-axis, but the quantity on the *y*-axis can vary. Compare these graphs:



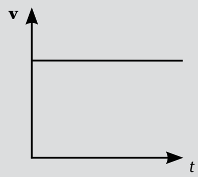
Uniform velocity



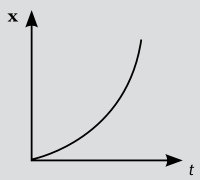
Uniform acceleration



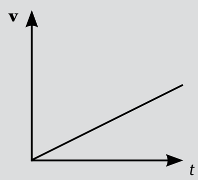
Uniform velocity



Uniform velocity



Uniform acceleration



Uniform acceleration

The slope of the graph and the area under the graph represents the following:

- **x**–*t* graph: the slope represents **v**
- **v**–*t* graph: the area represents Δ**x**
- **v**–*t* graph: the slope represents **a**
- **a**–*t* graph: the area represents **v.**

Interpreting ticker-tapes

We do trolley experiments to determine the velocity and acceleration of an object. We use the information on ticker-tapes that are tied to the trolleys to draw position–time and velocity–time graphs, and to calculate velocity and acceleration of the trolley. Explain to the learners that the distance between the dots on a ticker-tape represents the distance travelled in a certain time interval. If the ticker-timer is connected to the mains power supply, 50 dots are made per second. (In South Africa the frequency of the a.c. current is 50 Hz.) If the distance between two dots is 8 mm, this distance is travelled in 1/50 of a second, which shows that the speed is $50 \times 8 = 400\ \text{mm·s}^{-1}$.

Learners may confuse initial velocity, average velocity and final velocity. We calculate average velocities (speeds) on a tape.

$$\text{average velocity } (\mathbf{v}) = \frac{\text{initial velocity } (\mathbf{v}_i) + \text{final velocity } (\mathbf{v}_f)}{2}$$

The average velocity between points A and B equals the instantaneous velocity at a point halfway (in time) between A and B. If there are 10 dots between A and B, then the average velocity will be the instantaneous velocity at dot 5. When learners calculate acceleration, make sure that the time intervals between the two instantaneous velocities are correct.

The unit on vectors and scalars is a new addition to the Grade 10 work. Please note that there are different ways to distinguish between vectors and scalars. Printed media usually use a bold symbol to indicate a vector. When you or the learners write a vector on paper it is easier to draw an arrow above the symbol to indicate that it is a vector. When we use equations of motion in calculations, we generally do not distinguish between vector and scalar quantities.

Be careful when using examples of forces in the vertical plane. Here the weight will have to be taken into account. Equilibrium situations with three forces acting on a stationary object do not form part of the Grade 10 curriculum. Two examples of such situations were included in the activity. This is an opportunity to prepare learners qualitatively for these scenarios and allow them to deduce the magnitude of the third force, which is the equilibrant of the first two forces. Objects in equilibrium will be explained in detail in the Mechanics section at the beginning of Grade 11.

LB p. 262

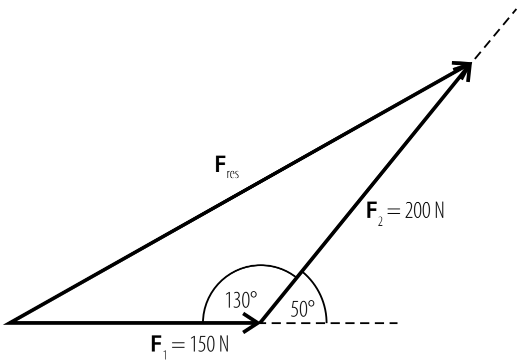
Activity 1 Test yourself

Cognitive levels 3–4 I

Applying vector diagrams

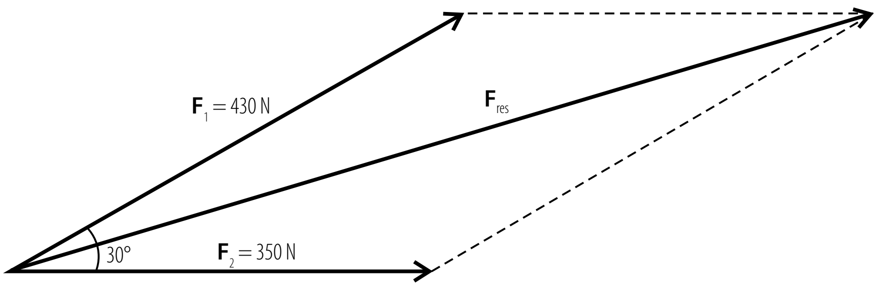
1 $\mathbf{F}_{total}$ to the left = 430 N + 350 N + 580 N = 1 360 N
$\mathbf{F}_{total}$ to the right = 600 N + 520 N + 330 N = 1 450 N
$\mathbf{F}_{res} = \mathbf{F}_{right} - \mathbf{F}_{left}$ = 90 N to the right
The blue flag will move to the right.

2



$\mathbf{F}_{res} \approx 318$ N

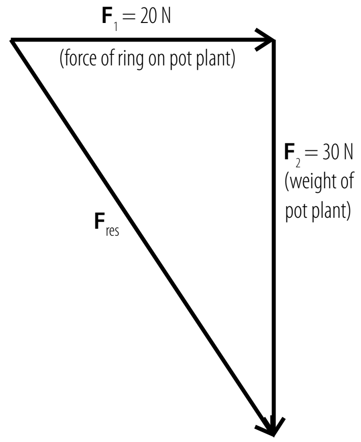
3



$\mathbf{F}_{res} \approx 754$ N

Questions 4 and 5 present an opportunity to introduce forces in equilibrium in a qualitative way. Explain to learners that the weight of the pot plant plus the pushing force of the ring on the pot plant has a resultant. The pot plant is not moving, which means that there must be another force that balances the resultant.

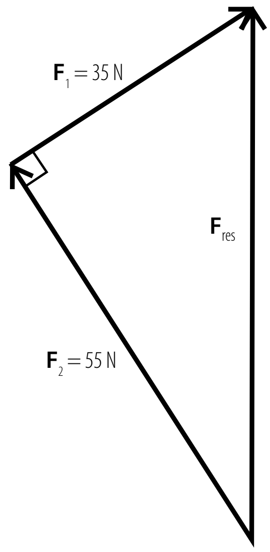
4 a)



b) $\mathbf{F}_{\mathbf{res}} = \sqrt{(30\text{ N})^2 + (20\text{ N})^2} = 36{,}06\text{ N}$

c) The tension in the chain will be the same as the resultant force, 36,06 N, but in the direction opposite to the resultant (upwards).

5 a)



b) $\mathbf{F}_{\mathbf{res}} = \sqrt{(35\text{ N})^2 + (55\text{ N})^2} = 65{,}19\text{ N}$

c) The picture's weight is 65,19 N.

Unit 2 Motion in one dimension

TERM 3, MODULE 5

This unit deals with the relationships between the vector quantities, displacement, velocity and acceleration and the scalars distance and speed. This unit lays the groundwork for Mechanics in Grades 11 and 12 and the concepts of reference frame and the quantities that define motion must be explained as clearly as possible. Learners might find the concepts of average velocity, instantaneous velocity, initial velocity and final velocity confusing. Try to use the correct terminology and symbols at all times.

LB p. 271

Activity 1 Experiment

Cognitive levels 3–4 G

Measuring velocity

Trolley experiments traditionally form part of teaching mechanics. Here is an opportunity to introduce the learners to the apparatus used in these experiments. It is important to familiarise yourself with the experiment beforehand. Ticker-timers can be temperamental. The slope of the trolley ramp is crucial to compensate for the affects of friction without causing acceleration. The trolley must move at constant velocity. The initial velocity must be fast enough for the trolley to have a reasonable final velocity after the brick is dropped on it. If the brick slows it down too much, try a mass piece with less weight. You will probably have to do several runs to obtain ticker-tapes with reasonable sets of dots.

Example of results

Displacement for 10 dots Δx (m)	Time between 10 dots Δt (s)	Velocity $\bar{v} = \frac{\Delta x}{\Delta t}$ ($m \cdot s^{-1}$)
AB =	0,2	
BC =	0,2	

a) The dots are evenly spaced which means that the motion of the trolley is constant during the measured time periods.
b) average velocity: learners' own answers

LB p. 275

Activity 2 Test yourself

Cognitive level 3 I

Calculating distance, displacement, speed, velocity and acceleration

1 a) $90\ \cancel{km} \cdot \cancel{h}^{-1} \times \frac{1\ 000\ m}{1\ \cancel{km}} \times \frac{1\ \cancel{h}}{60 \times 60\ s} = 25\ m \cdot s^{-1}$

b) $\Delta t = \frac{D}{v} = \frac{30\ \cancel{km}}{90\ \cancel{km} \cdot h^{-1}} = 0{,}33$ hours

$0{,}33$ hours $= 0{,}33 \times 60 = 20$ min

2 1 hour = 60 min × 60 = 3 600 s

$D = v\Delta t = 15\ m \cdot \cancel{s^{-1}} \times 3\ 600\ \cancel{s} = 54\ 000$ m or 54 km

3 a) total distance = 80 + 60 = 140 m

b $\Delta t = \frac{D}{v} = \frac{140\ \cancel{m}}{2\ \cancel{m} \cdot s^{-1}} = 70$ s = 1,17 min or 1 min 10 s

c) $\Delta \mathbf{x}_{AC} \sqrt{(80\ m)^2 + (60\ m)^2} = 100$ m in direction 53°

d) $\bar{\mathbf{v}}_{AC} = \frac{\Delta \mathbf{x}_{AC}}{\Delta t} = \frac{100\ m}{70\ s} = 1{,}43\ m \cdot s^{-1}$ in direction 53°

> Note: We measure the bearing from the 0° position or vertical plane/ *y*-axis. The direction will be 90° – 37° = 53°

4

Animals	Initial velocity ($m \cdot s^{-1}$)	Final velocity ($m \cdot s^{-1}$)	Change in velocity ($m \cdot s^{-1}$)	Time taken (s)	Acceleration ($m \cdot s^{-2}$)
Ostrich	0	20	20	4	5
Cheetah	10	30	20	2	10
Horse	15	23	8	4	2
Cape hare	7	0	–7	3	–2,3
Elephant	7	11	4	8	0,5

In science we mostly describe motion graphically or symbolically. Graphs of motion often present problems and learners find the different graphs confusing. Make sure they grasp a concept fully before moving on to the next new idea. We have included a few easy activities (Activities 1 and 2) to assist learners in recognising the traits in the graphs.

LB p. 279

Activity 1 Test yourself

Cognitive levels 2–4 P

Interpreting position–time graphs

This is an easy activity which allows the learners to recognise the slopes in a graph and to link them to the type of motion. It also teaches learners how to interpret the values on the axes and how to do basic calculations.

1 Copy and complete the table.

Part of graph	Speed
A	Quite fast
B	Quite slow
C	Stopped
D	Very slow
E	Very fast

2 a) 2 km = 2 000 m
 b) 5 min = 5 × 60 = 300 s
 c) $v = \frac{D}{\Delta t} = \frac{2\ 000\ \text{m}}{300\ \text{s}} = 6{,}67\ \text{m·s}^{-1}$

3 a) 8 – 5 = 3 km = 3 000 m
 b) 35 – 30 = 5 min = 300 s
 c) $v = \frac{D}{\Delta t} = \frac{3\ 000\ \text{m}}{300\ \text{s}} = 10\ \text{m·s}^{-1}$

4 $v = \frac{D}{\Delta t} = \frac{8\ \text{km}}{35\ \text{min}} = \frac{8\ 000\ \text{m}}{35 \times 60\ \text{s}} = 3{,}81\text{m·s}^{-1}$

LB p. 284

Activity 2 Test yourself

Cognitive level 3 P

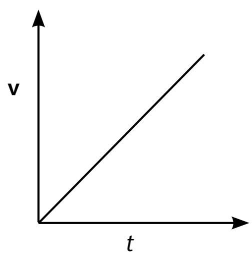
Interpreting a velocity–time graph

This activity uses a velocity–time graph to teach learners how to link the slopes of the lines to motion. The activity also helps the learners interpret the values on the axes to determine acceleration and displacement.

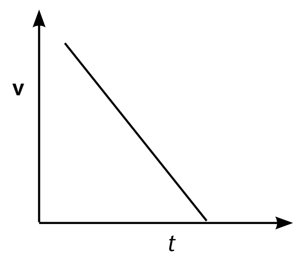
1 A horizontal line in sections A and C indicates a constant speed.

2 a) $5\ \text{m·s}^{-1}$
 b) $10\ \text{m·s}^{-1}$

3 Speeding up:



Slowing down:



A positive slope shows a steady increase in speed and is called acceleration. A negative slope shows a decrease in speed and is called deceleration.

4 No, he slows down more quickly than he accelerates. The gradient of Section D is steeper than the gradient of Section B.

5 Stage A: Velocity constant at 5 $m{\cdot}s^{-1}$
Acceleration = 0
Stage B: Velocity increases from 5 $m{\cdot}s^{-1}$ to 10 $m{\cdot}s^{-1}$
Acceleration is a constant positive value
Stage C: Velocity constant at 10 $m{\cdot}s^{-1}$
Acceleration = 0
Stage D: Velocity decreases from 10 $m{\cdot}s^{-1}$ to 0
Acceleration is constant negative

6 Stage B: $\mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t} = \frac{(10 - 5)\ m{\cdot}s^{-1}}{(350 - 200)\ s} = 0{,}03\ m{\cdot}s^{-2}$

Stage D: $\mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t} = \frac{(0 - 10)\ m{\cdot}s^{-1}}{(600 - 550)\ s} = -0{,}2\ m{\cdot}s^{-2}$

7 We can calculate distance from a velocity–time graph by calculating the area under the graph. In this graph we calculate the areas of the stages separately and then add them all together at the end.
Stage A: area = $l \times b = 5\ m{\cdot}\cancel{s^{-1}} \times 200\ \cancel{s} = 1\ 000\ m$
Stage B: area of △ + area of □
$= (\frac{1}{2}b \times h) + (l \times b)$
$= \frac{1}{2} \times 150\ \cancel{s} \times 5\ m{\cdot}\cancel{s^{-1}}) + (5\ m{\cdot}\cancel{s^{-1}} \times 150\ \cancel{s})$
$= 375 + 750 = 1\ 125\ m$
OR area of trapezium
= distance between // sides × $\frac{1}{2}$(sum of // sides)
$= 150\ \cancel{s} \times \frac{1}{2} \times 15\ m{\cdot}\cancel{s^{-1}}$
$= 1\ 125\ m$
Stage C: area of □
$= 10\ m{\cdot}\cancel{s^{-1}} \times 200\ \cancel{s} = 2\ 000\ m$
Stage D: area of △
$= \frac{1}{2}b \times h = \frac{1}{2} \times 50\ \cancel{s} \times 10\ m{\cdot}\cancel{s^{-1}} = 250\ m$
Total distance = 1 000 + 1 125 + 2 000 + 250 = 4 375 m

LB p. 285

Activity 3 Experiment

Cognitive levels 3–4 G RPA

Determining the position–time graph of a trolley

This experiment is similar to Activity 1 in Unit 2. Refer to the notes on page D80. You will need two runs – one at constant velocity and one at accelerated motion. For the second run the trolley ramp must be raised at the one end to provide the acceleration. Discard the first and last part of the ticker-tape and look for a piece of tape where the dots show even motion, either equal distances between dots or a regular increase in distance between the dots. The tape of accelerated motion must be kept for learners who will do the prescribed project on acceleration.

Checklist for teacher's assessment of individual in a group during experiment

Task skills	Yes	No	Comments
Stays focused on experiment			
Understands experimental method			
Answers simple questions during experiment			
Helpful/ assists teacher/ valuable member of group			
Records results correctly in suitable table			
Answer questions correctly			
Draws graphs correctly			

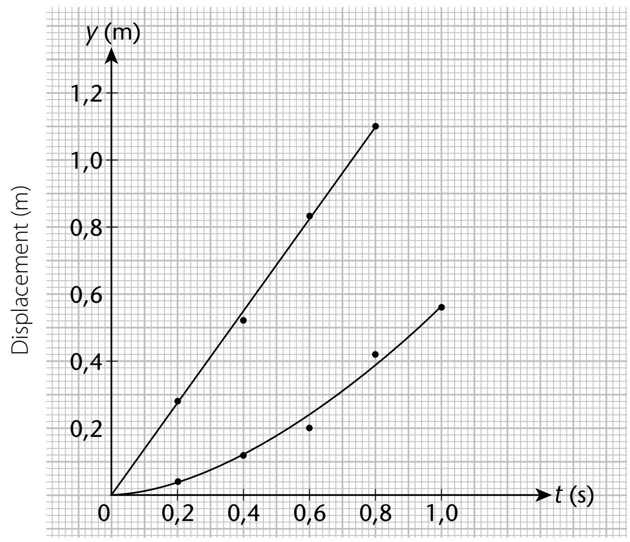
3 Record the information in tables similar to the one below.

Run 1	**Run 2**	
Displacement for 10 dots $\Delta\mathbf{x}$ (m)	Displacement for 10 dots $\Delta\mathbf{x}$ (m)	Time between 10 dots Δt (s)
AB =	AB =	0,2
BC =	BC =	0,2

a) Run 1 should show constant velocity and the dots should be spaced evenly. Run 2 should show accelerated motion and the distance between the dots should become larger.

b) Learners should obtain graphs similar to the graphs below.

Graph of displacement against time



LB p. 286 »

Activity 4 Prescribed project

Cognitive levels 3–4 I P PPA

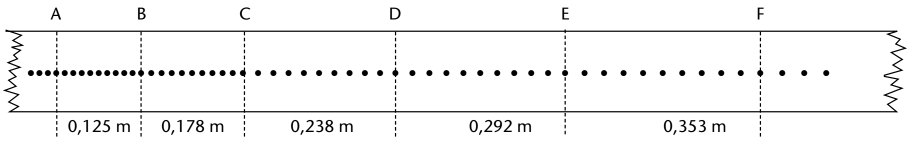
Investigating acceleration

Rubric for formal assessment of prescribed project

Total: 20 marks

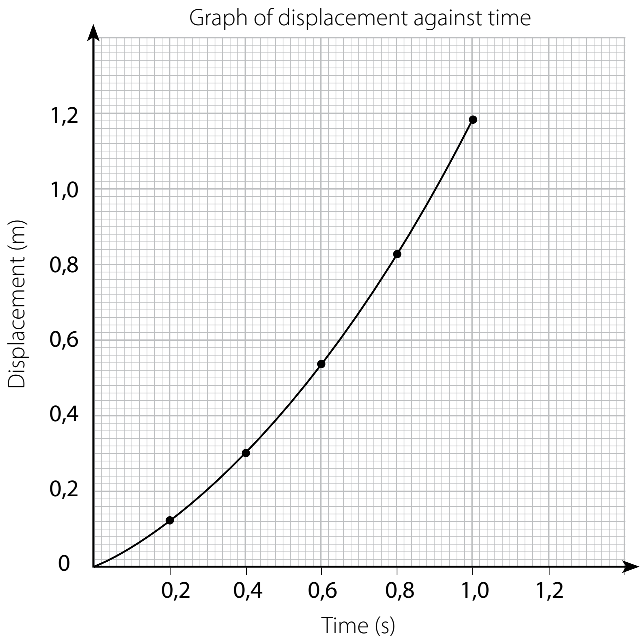
Assessment criteria	**Rating**			
	4	**3**	**2**	**1**
Presentation: standard and quality	High standard, to the point, clear organisation	Good standard, some parts clear and well arranged	Satisfactory, too simplistic, some parts confusing	Poor quality, no clear organisation or vision
Processing results	Process results correctly	Most results processed correctly	Some results processed correctly	Results not processed correctly
Data tables	1. Suitable heading 2. Correct format 3. Units correct 4. Data entered correctly	Three of the four criteria correct	Two of the four criteria correct	One of the four criteria correct
Calculations	Understand concepts; all calculation done correctly	Understand some concepts, some calculations done correctly	Don't understand some concepts, some calculations done correctly	Don't understand concepts, calculations wrong
Graph	1. Suitable heading 2. Size and scale correct 3. Axes labelled and with units 4. Graph correct	Three of the four Criteria correct	Two of the four Criteria correct	One of the four Criteria correct

a) Use the ticker-tape that you obtained in Run 2 of Activity 3 to determine the acceleration of the trolley.
An example of a ticker-tape is shown below.



b) The values of the distances can be tabulated and a graph of displacement against time drawn.

Time (s)	0,2	0,4	0,6	0,8	1,0
Displacement (m)	0,125	0,303	0,541	0,833	1,186



Use the time and displacement values to calculate velocity and acceleration.

Interval	**Displacement Δx (m)**	**Time between 10 dots Δt (s)**	**Average velocity $\bar{v} = \frac{\Delta x}{\Delta t}$ ($m{\cdot}s^{-1}$)**	**Instantaneous velocity v ($m{\cdot}s^{-1}$)**	**Change in velocity Δv ($m{\cdot}s^{-1}$)**	**Acceleration $a = \frac{\Delta v}{\Delta t}$ ($m{\cdot}s^{-2}$)**
A to C	0,125 + 0,178 = 0,303	0,2	0,303 ÷ 0,4 = 0,758			
B				0,758		
B to D	0,178 + 0,238 = 0,416	0,2	0,416 ÷ 0,4 = 1,040		1,040 – 0,758 = 0,282	0,282 ÷ 0,2 = 1,41
C				1,040		
C to E	0,238 + 0,292 = 0,530	0,2	0,530 ÷ 0,4 = 1,325		1,325 – 1,040 = 0,285	0,285 ÷ 0,2 = 1,43
D				1,325		
D to F	0,292 + 0,353 = 0,645	0,2	0,645 ÷ 0,4 = 1,613		1,613 – 1,325 = 0,288	0,288 ÷ 0,2 = 1,44
E				1,613		

Activity 5 Test yourself

Cognitive level 3

Calculations using equations of motion

General method for solving these problems:

Step 1: Write down the quantities given and which quantity must be calculated.

Step 2: Choose the equation that links these quantities. This will be the one where all the quantities are known, except for the unknown asked quantity.

Step 3: Substitute the symbols in the equations with values.

Step 4: Calculate the unknown quantity.

Note:

- It is easier to substitute first and then to change the subject of the equation if necessary.
- Units may be left out when substituting into the equations.

1 $v_i = 20\ \text{m·s}^{-1}$; $a = 0{,}5\ \text{m·s}^{-2}$; $\Delta t = 30\ \text{s}$; $\Delta x = ?$

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$= (20\ \text{m·}\cancel{\text{s}^{-1}} \times 30\ \cancel{\text{s}}) + (\frac{1}{2} \times 0{,}5\ \text{m·}\cancel{\text{s}^{-2}} \times (30\ \cancel{\text{s}})^{\cancel{2}})$

$= 600\ \text{m} + 225\ \text{m}$

$= 825\ \text{m}$ in a forward direction/direction of motion

2 a) $v_i = 0\ \text{m·s}^{-1}$; $a = 2\ \text{m·s}^{-2}$; $\Delta t = 10\ \text{s}$; $v_f = ?$

$v_f = v_i + a\Delta t$

$= 0\ \text{m·s}^{-1} + (2\ \text{m·s}^{\cancel{-2}} \times 10\ \cancel{\text{s}})$

$= 20\ \text{m·s}^{-1}$ forward

b) $v_i = 0\ \text{m·s}^{-1}$; $v_f = 20\ \text{m·s}^{-1}$; $a = 2\ \text{m·s}^{-2}$; $\Delta t = 10\ \text{s}$

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$= (0\ \text{m·}\cancel{\text{s}^{-1}} \times 10\ \cancel{\text{s}}) + (\frac{1}{2} \times 2\ \text{m·}\cancel{\text{s}^{-2}} \times (10\ \cancel{\text{s}})^{\cancel{2}})$

$= 100\ \text{m}$ forward

OR $v_f^2 = v_i^2 + 2a\Delta x$

$(20\ \text{m·s}^{-1})^2 = (0\ \text{m·s}^{-1})^2 + (2 \times 2\ \text{m·s}^{-2})\ \Delta x$

$400\ \text{m}^2\text{·s}^{-2} = 4\ \text{m·s}^{-2}\ \Delta x$

$\Delta x = 100\ \text{m}$ forward

c) $v_i = 0\ \text{m·s}^{-1}$; $a = 2\ \text{m·s}^{-2}$; $v_f = 24\ \text{m·s}^{-1}$; $\Delta t = ?$

$v_f = v_i + a\Delta t$

$24\ \cancel{\text{m}}\text{·s}^{-1} = 0\ \cancel{\text{m}}\text{·s}^{-1} + (2\ \cancel{\text{m}}\text{·s}^{-2})\ \Delta t$

$\Delta t = 12\ \text{s}$

3 a) $v_i = 4\ \text{m·s}^{-1}$; $v_f = 20\ \text{m·s}^{-1}$; $\Delta t = 100\ \text{s}$; $a = ?$

$v_f = v_i + a\Delta t$

$20\ \text{m·s}^{-1} = 4\ \text{m·s}^{-1} + a\ (100\ \text{s})$

$a = \frac{(20 - 4)\ \text{m·s}^{-1}}{100\ \text{s}}$

$= 0{,}16\ \text{m·s}^{-2}$ forward

b) average $v = \frac{v_i + v_f}{2}$

$= \frac{(4 + 20)\ \text{m·s}^{-1}}{2}$

$= 12\ \text{m·s}^{-1}$ forward

c) $v_i = 4\ \text{m·s}^{-1}$; $v_f = 20\ \text{m·s}^{-1}$; $\Delta t = 100\ \text{s}$; $a = 0{,}16\ \text{m·s}^{-2}$; $\Delta x = ?$

$v_f^2 = v_i^2 + 2a\Delta x$

$(20\ \text{m·s}^{-1})^2 = (4\ \text{m·s}^{-1})^2 + (2 \times 0{,}16\ \text{m·s}^{-2})\ \Delta x$

$400\ \text{m}^2\text{·s}^{-2} = 16\ \text{m}^2\text{·s}^{-2} + 0{,}32\ \text{m·s}^{-2}\ \Delta x$

$\Delta x = 1\ 200\ \text{m}$ in direction of motion

OR $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$= (4\ \text{m·s}^{\cancel{-1}} \times 100\ \text{s}) + (\frac{1}{2} \times 0{,}16\ \text{m·s}^{\cancel{-2}} \times (100\ \text{s})^2)$

$= 1\ 200\ \text{m}$ in direction of motion

EXTENSION ACTIVITIES

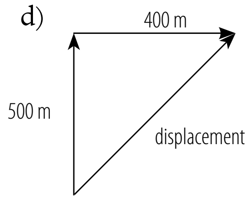
LB p. 290

Activity 6 Case study

Cognitive levels 3–4

Comparing indigenous and modern tracking devices

1. The Khoisan hunters read the signs in the veld and work out the direction that they must take. We use a compass or GPS to find the correct direction. Khoisan hunters cannot use compasses or GPS to find their wounded prey.
2. The Khoisan hunters must develop the skill of fine observation of the natural habitat and have an intimate knowledge of animals, their behaviour and the veld in general.
3. The global positioning system (GPS) consists of 24 well-spaced satellites that orbit Earth and make it possible for people with ground receivers to pinpoint their geographic position. A GPS receiver gets bearings from three satellites and then works out a position.
4. Police use trackers to find missing people or fugitives in the veld. Armies use trackers to find enemy troops. Conservationists use trackers to find animals that are wounded or killed.
5. a) The origin is the position of the kudu when the arrow hit it.
   b) 500 m + 400 m = 900 m
   c) Smaller
   d)



   e) $\overline{v} = \frac{D}{\Delta t} = \frac{900 \text{ m}}{2 \times 60 \text{ s}} = 0{,}75 \text{ m·s}^{-1}$

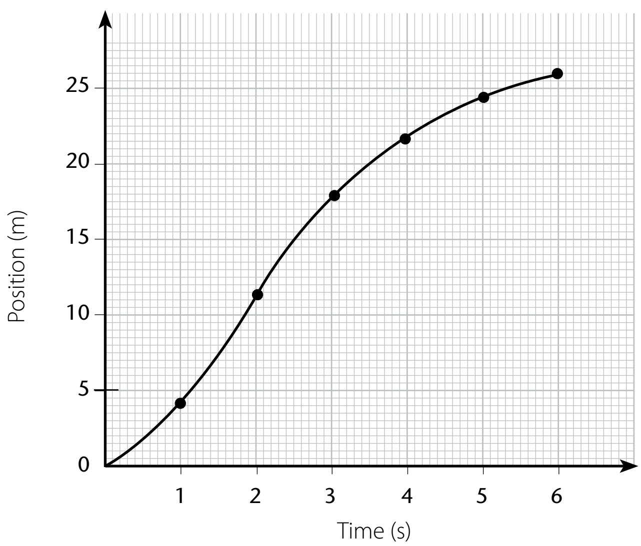
LB p. 290

Activity 7 Practical investigation

Cognitive levels 3–4

Investigating motion graphically

1. Dependent variable: change in position
2. Independent variable: time
3. Graph of position against time



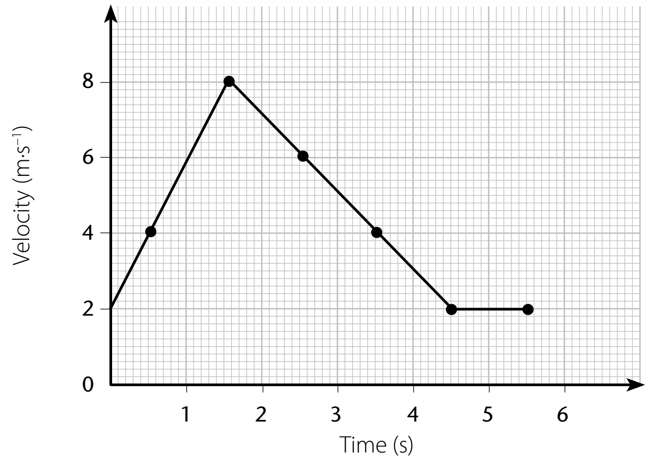
4

x (m)	0	4	12	18	22	24	26
t (s)	0	1	2	3	4	5	6

5

t (s)	0	0,5	1,5	2,5	3,5	4,5	5,5
v (m·s^{-1})	0	4	8	6	4	2	2

6 Graph of velocity against time



7 Sipho's initial velocity was 2 m·s^{-1}.

8 a) 0–2 s: Sipho's velocity increases from 2 m·s^{-1} to 8 m·s^{-1} at a constant rate, so he is speeding up; he has a positive acceleration.

b) 3–5 s: Sipho's velocity decreases from 8 m·s^{-1} to 2 m·s^{-1} at a constant rate, so he is slowing down; he has a negative acceleration.

c) 5–6 s: Sipho has a constant velocity of 2 m·s^{-1}; his acceleration is zero.

9 $\mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t} = \frac{(8-4)\ \text{m·s}^{-1}}{1\ \text{s}} = 4\ \text{m·s}^{-2}$

10 Sipho's acceleration is the greatest during 0 to 1,5 s because the gradient of the graph is the steepest during that time period.

11 The first part of the track is downhill and the second part is uphill.

12 a)
- Passing vehicles might not see him and run him over.
- He may fall and injure himself.
- He may ride into obstacles or vehicles if he cannot stop in time.

b)
- Wear protective clothing and a helmet.
- Wear bright and reflective colours.
- Constantly be aware of the traffic.
- Preferably skateboard in areas specially set aside for the sport.

Learner's Book page 292

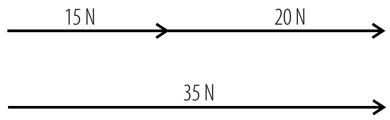
Units 1 to 3 Summative assessment task answers

TERM 3, MODULE 5

1 Place the quantities in the correct column:

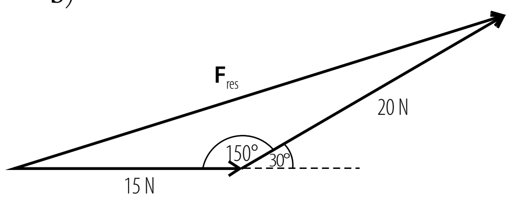
Vector quantity	**Scalar quantity**
Displacement	Speed
Acceleration	Time
Velocity	Distance
Force	Mass
Weight	

2 a)



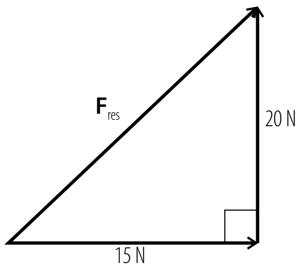
$\mathbf{F}_{res} = 15\text{ N} + 20\text{ N} = 35\text{ N}$

b)



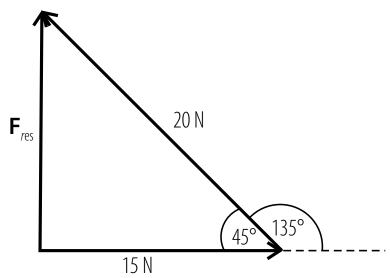
$\mathbf{F}_{res} \approx 34\text{ N}$

c)



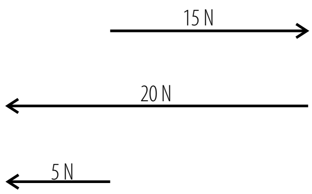
$\mathbf{F}_{res} = \sqrt{15^2 + 20^2} = 25\text{ N}$

d)



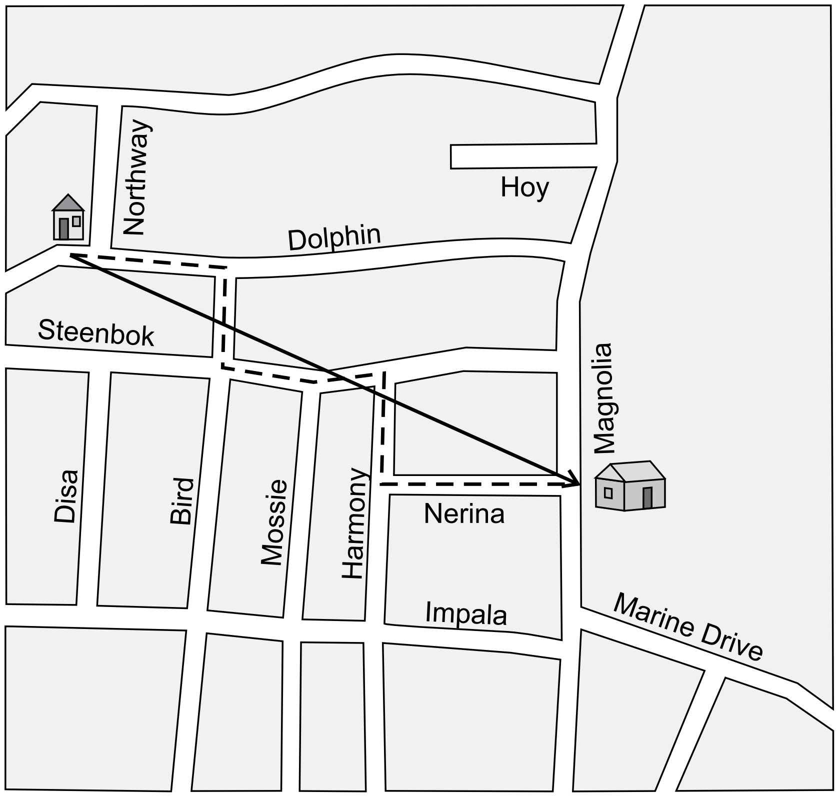
$\mathbf{F}_{res} \approx 14\text{ N}$

e)



$\mathbf{F}_{res} = 20\text{ N} - 15\text{ N} = 5\text{ N}$

3 a)



b) 18 min $= \frac{18}{60}$ h $= 0{,}3$ h

speed $= \frac{D}{\Delta t} = \frac{1{,}5 \text{ km}}{0{,}3 \text{ h}} = 5 \text{ km·h}^{-1}$

18 min $= 18 \times 60 = 1\,080$ s;

1,5 km = 1 500 m

speed $= \frac{1\,500 \text{ m}}{1\,080 \text{ s}} = 1{,}39 \text{ m·s}^{-1}$

c) speed $= \frac{D}{\Delta t} = \frac{1\,500 \text{ m}}{12 \times 60 \text{ s}} = 2{,}08 \text{ m·s}^{-1}$

4 a) i) $\overline{\mathbf{v}} = \frac{\Delta \mathbf{x}}{\Delta t} = \frac{60 \text{ m}}{1 \times 60 \text{ s}} = 1 \text{ m·s}^{-1}$ forward

ii) Nelson did not move for 2 minutes so his velocity was zero.

iii) $\Delta \mathbf{x} = 220 - 60 = 160$ m

iv) C

v) The slope of graph is steepest for section C. (Slope of a displacement–time graph = velocity.)

vi) $\overline{\mathbf{v}} = \frac{\Delta \mathbf{x}}{\Delta t} = \frac{160 \text{ m}}{40 \text{ s}} = 4 \text{ m·s}^{-1}$ forward

b) i) Distance from the school to the tree

ii) Read off the final displacement at the end of section A on the y-axis of the graph.

iii) $\mathbf{v} = 0$; Nelson is not moving.

iv) Nelson's speed is greater during Section C because the slope of the displacement–time graph is steeper. He travelled nearly four times further, because the area of Block C in the velocity–time graph is about four times larger than Block A.

5 a) $\overline{v} = \frac{D}{\Delta t} = \frac{100 \text{ m}}{9{,}7 \text{ s}} = 10{,}31 \text{ m·s}^{-1}$

b) $\mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t} = \frac{12 \text{ m·s}^{-1}}{3 \text{ s}} = 4 \text{ m·s}^{-2}$ forward

Formal Assessment Task

For the formal assessment task give the learners the Control test for Term 3 which you will find in the Assessment section on pages B19–B20. You will find the answers to this formal assessment task on pages B21–B22.

This unit introduces the learners to potential and kinetic energy and the conservation of mechanical energy. They have done these concepts before in the Senior Phase, so should find it relatively easy.
We use the following terminology in this unit:

- Energy is *transformed* when it is converted from one form to another.
- Energy is *transferred* from one object to another, or from place to place.

LB p. 302

Activity 1 Test yourself

Cognitive levels 1–4 P

Investigating energy transformation in a roller-coaster

1 The force of gravity pulls the cars downwards. External energy from an electric motor is needed to work against gravity to get them up the slope.
2 Gravitational potential energy
3 Principle of Conservation of Mechanical Energy
4 a) It must be an isolated system with no dissipative forces.
b) No, the system is not isolated.
c) Sound energy, thermal energy (heat) due to friction.
5 $E_p = mgh$
At B: $E_p = 1\,000 \text{ kg} \times 9{,}8 \text{ m·s}^{-2} \times 5 \text{ m} = 49\,000 \text{ J}$
At C: 31 360 J
At D: 96 040 J
6 Loss = E_p at B – E_p at C = 49 000 − 31 360 = 17 640 J
7 If mechanical energy is conserved, loss in E_p = gain in E_K = 17 640 J.
8 $E_K = \frac{1}{2} mv^2$
$17\,640 \text{ J} = \frac{1}{2} \times 1\,000 \text{ kg} \times v^2$
$v^2 = \frac{2 \times 17\,640 \text{ J}}{1\,000 \text{ kg}} = 35{,}28 \text{ m}^2\text{·s}^{-2}$
$v = \sqrt{35{,}28 \text{ m}^2\text{·s}^{-2}} = 5{,}94 \text{ m·s}^{-1}$
9 $E_{K1} + E_{P1} = E_{K2} + E_{P2}$
$(\frac{1}{2}mv^2)_{\text{at D}} + (mgh)_{\text{at D}} = (\frac{1}{2}mv^2)_{\text{at E}} + (mgh)_{\text{at E}}$
$(\frac{1}{2} \times 1\,000 \text{ kg} \times (0 \text{ m·s}^{-1})^2) + (1\,000 \text{ kg} \times 9{,}8 \text{ m·s}^{-2} \times 9{,}8 \text{ m}) =$
$(\frac{1}{2} \times 1\,000 \text{ kg} \times v^2) + (1\,000 \text{ kg} \times 9{,}8 \text{ m·s}^{-2} \times 0 \text{ m})$
$0 \text{ J} + 96\,040 \text{ J} = (500 \text{ kg} \times v^2) + 0 \text{ J}$
$v^2 = 192{,}08 \text{ m}^2\text{·s}^{-2}$
$v = 13{,}86 \text{ m·s}^{-1}$

LB p. 303

Activity 2 Test yourself

Cognitive level 3 I

Calculating energy

1 $m = 50$ kg; $g = 9{,}8 \text{ m·s}^{-2}$; $h = 900 \text{ m} – 400 \text{ m} = 500 \text{ m}$
$E_p = mgh = 50 \text{ kg} \times 9{,}8 \text{ m·s}^{-2} \times 500 \text{ m} = 245\,000 \text{ J} = 245 \text{ kJ}$
2 a) $E_K = \frac{1}{2} mv^2 = \frac{1}{2} \times 2\,000 \text{ kg} \times (10 \text{ m·s}^{-1})^2 = 100\,000 \text{ J} = 100 \text{ kJ}$
b) $E_K = \frac{1}{2} mv^2 = \frac{1}{2} \times 2\,000 \text{ kg} \times (20 \text{ m·s}^{-1})^2 = 400\,000 \text{ J} = 400 \text{ kJ}$
the change in E_K = 400 kJ – 100 kJ = 300 kJ
3 a) $E_p = mgh = 0{,}3 \text{ kg} \times 9{,}8 \text{ m·s}^{-2} \times 15 \text{ m} = 44{,}1 \text{ J}$
b) All the potential energy at the top is transformed to kinetic energy when it hits the ground.

$E_M = E_P$ at top $= E_k$ at bottom $= \frac{1}{2}mv^2$
$44{,}1\text{ J} = \frac{1}{2} \times 0{,}3\text{ kg} \times v^2$
$v^2 = 294\text{ m}^2{\cdot}\text{s}^{-2}$
$v = 17{,}1\text{ m}{\cdot}\text{s}^{-1}$

c) In the absence of dissipative forces mechanical energy is conserved, so the initial velocity of the ball is $17{,}1\text{ m}{\cdot}\text{s}^{-1}$.

d) $E_{K1} + E_{P1} = E_{K2} + E_{P2}$
$(\frac{1}{2}mv^2)_{\text{at top}} + (mgh)_{\text{at top}} = (\frac{1}{2}mv^2)_{\text{at 10 m}} + (mgh)_{\text{at 10 m}}$
$(\frac{1}{2} \times 0{,}3\text{ kg} \times (0\text{ m}{\cdot}\text{s}^{-1})^2) + (0{,}3\text{ kg} \times 9{,}8\text{ m}{\cdot}\text{s}^{-2} \times 15\text{ m}) =$
$(\frac{1}{2} \times 0{,}3\text{ kg} \times v^2) + (0{,}3\text{ kg} \times 9{,}8\text{ m}{\cdot}\text{s}^{-2} \times 10\text{ m})$
$0\text{ J} + 44{,}1\text{ J} = (0{,}15\text{ kg} \times v^2) + 29{,}4\text{ J}$
$v^2 = 98\text{ m}^2{\cdot}\text{s}^{-2}$
$v = 9{,}9\text{ m}{\cdot}\text{s}^{-1}$

Learner's Book page 304

Unit 4 Summative assessment

TERM 4, MODULE 5

1 a) $E_P = mgh = 2\text{ kg} \times 9{,}8\text{ m}{\cdot}\text{s}^{-2} \times 40\text{ m} = 784\text{ J}$

b) $E_P = E_K = 784\text{ J}$
$E_K = \frac{1}{2}mv^2 = 784\text{ J}$
$\therefore v^2 = \frac{2E_k}{m} = \frac{(2 \times 784\text{ J})}{2\text{ kg}} = 784\text{ m}^2{\cdot}\text{s}^{-2}$
$\therefore v = 28\text{ m}{\cdot}\text{s}^{-1}$

2 a) $E_P = mgh = 0{,}5\text{ kg} \times 9{,}8\text{ m}{\cdot}\text{s}^{-2} \times 0{,}03\text{ m} = 0{,}15\text{ J}$

b) In the absence of dissipative forces E_M is conserved: $E_K = E_P = 0{,}15\text{ J}$.

c) Law of Conservation of Mechanical Energy

d) $E_P = mgh = 0{,}5\text{ kg} \times 9{,}8\text{ m}{\cdot}\text{s}^{-2} \times 0{,}015\text{ m} = 0{,}075\text{ J}$

e) $E_{K1} + E_{P1} = E_{K2} + E_{P2}$
$(\frac{1}{2}mv^2)_{\text{at A}} + (mgh)_{\text{at A}} = (\frac{1}{2}mv^2)_{\text{at B}} + (mgh)_{\text{at B}}$
$(\frac{1}{2} \times 0{,}5\text{ kg} \times (0\text{ m}{\cdot}\text{s}^{-1})^2 + (0{,}5\text{ kg} \times 9{,}8\text{ m}{\cdot}\text{s}^{-2} \times 0{,}03\text{ m}) =$
$(\frac{1}{2} \times 0{,}5\text{ kg} \times v^2) + (0{,}5\text{ kg} \times 9{,}8\text{ m}{\cdot}\text{s}^{-2} \times 0{,}015\text{ m})$
$0\text{ J} + 0{,}147\text{ J} = (0{,}25\text{ kg} \times v^2) + 0{,}0735\text{ J}$
$v^2 = 0{,}294\text{ m}^2{\cdot}\text{s}^{-2}$
$v = 0{,}54\text{ m}{\cdot}\text{s}^{-1}$

3 a) $E_P = mgh = 60\text{ kg} \times 9{,}8\text{ m}{\cdot}\text{s}^{-2} \times 4\text{ m} = 2\,352\text{ J}$

b) $E_{K1} + E_{P1} = E_{K2} + E_{P2}$
$(\frac{1}{2}mv^2)_{\text{at top}} + (mgh)_{\text{at top}} = (\frac{1}{2}mv^2)_{\text{at bottom}} + (mgh)_{\text{at bottom}}$
$(\frac{1}{2} \times 60\text{ kg} \times (0\text{ m}{\cdot}\text{s}^{-1})^2) + (60\text{ kg} \times 9{,}8\text{ m}{\cdot}\text{s}^{-2} \times 4\text{ m}) =$
$(\frac{1}{2} \times 60\text{ kg} \times v^2) + (60\text{ kg} \times 9{,}8\text{ m}{\cdot}\text{s}^{-2} \times 0\text{ m})$
$0\text{ J} + 2\,352\text{ J} = (30\text{ kg} \times v^2) + 0\text{ J}$
$v^2 = 78{,}4\text{ m}^2{\cdot}\text{s}^{-2}$
$v = 8{,}85\text{ m}{\cdot}\text{s}^{-1}$

c) E_P left $= 2\,352 - 550 = 1\,802\text{ J}$
$h = \frac{E_P}{mg} = \frac{1\,802\text{ J}}{60\text{ kg} \times 9{,}8\text{ m}{\cdot}\text{s}^{-2}} = 3{,}06\text{ m}$

MODULE 6 CHEMICAL SYSTEMS

Background information for Module 6

In this module emphasise that learners should take ownership and responsibility for our Earth that we live on. The Grade 10 part of chemical systems looks at the hydrosphere. At the end of the module the learners should:

- demonstrate an appreciation for the importance of water in our country
- understand the sensitivity of our water reservoirs
- understand the importance of clean and available water for all people.

Module 6 on **Chemical systems** has only one unit, and this is on the hydrosphere. You should spend 8 hours on this module which makes up 5% of the Grade 10 Physical Sciences curriculum.

The focus on this section should not be the chemical equations or rote learning, but should encourage application, interpretation and awareness of environmental impact. We have included a number of activities to encourage awareness, for example, a case study on indigenous knowledge and investigations on water quality and water-based activities.

LB p. 311

Activity 1 Research project

Cognitive levels 3–4

Studying the ecology of a dam

The information presented by learners will depend on the area where they live and how much information is available. We have included some background information on the Drakensberg Pumped Storage Scheme. If there is no time to allow learners to do independent research, you can present the information on the Drakensberg Pumped Storage Scheme as part of the lesson.

Drakensberg Pumped Storage Scheme

Water is a limited resource in South Africa. There is always a risk of water shortages and restrictions that limit social development and economic growth.

In the early 1970s, demands for water from the Vaal River grew rapidly as the Gauteng area and its industries developed. The potential of the Vaal River that flows towards the Atlantic Ocean was exploited to the utmost. On the other side of the watershed that gives rise to the Vaal River, the Tugela River carried its waters almost unused to the Indian Ocean.

The transfer of water across the Drakensberg required the construction of reservoirs, channels and pumps. This opened the way to build a hydroelectric power station to further exploit the potential of water resources that were made available. The work on the scheme started in 1974 and was completed in 1982. The project operates as a pumped storage scheme to generate electricity and as a pumping station to transfer water over the Drakensberg from the Tugela to the Vaal.

Most of the complex was constructed underground. Only the dam wall, lift shaft building and transmission lines are visible on the surface.

A pumped storage scheme is a power station that is built on a waterway between an upper and a lower reservoir. Electricity is generated during peak demand periods. During periods of low energy demand the same water is pumped back from the lower reservoir to the upper storage reservoir.

South Africa's major industrial and mining activities are centred in the Gauteng area, which depend on the Vaal River for its water supplies. The Sterkfontein Dam is deep with a smaller surface area than that of the large but shallow Vaal Dam. By storing the water in the Sterkfontien Dam and pumping it to the Vaal River on demand, evaporation losses are minimised.

The Department of Water Affairs and Forestry are presently undertaking a feasibility study of the Thukela Water Project. This project will form part of the Drakensberg scheme and will supplement water supplies into the Vaal River system. A comprehensive feasibility study is necessary because the area is large and complex. The following issues must be investigated.

- Attention must be given to poverty alleviation, job creation, land reform and economic empowerment of previously disadvantaged people.
- Environmental issues needing consideration are:
  - sediment movement processes, their cause and affect
  - loss of endemic and threatened veld types
  - loss of habitat and fauna that live there.
- The effect of such a system will be for a long period of time and will directly affect the quality of life of a large number of people.

- Flooding of the impoundments will cause economic, physical and cultural disruption to landowners, farm labourers and communities currently resident in the potential dam basins.
- There will be a loss of arable and grazing land.
- Resettlement is a highly emotive and sensitive issue.
- Costs of resettlement must be taken into account.

LB p. 314

Activity 2 Case study

Cognitive level 2 I

Considering indigenous knowledge about collecting water

1 Well-oxygenated water contains a high level of dissolved oxygen.

2 Floating bacteria and other debris as well as surface dwelling insects can contaminate the surface layer of the water. These particles of contamination can be caught up in the forces between the water molecules that cause the surface tension. To avoid the contamination, scientists take water samples below the surface of the water.

3 When conditions are unfavourable for bacteria to multiply, they often form spores that are encapsulated in a calcium deposit. When conditions are favourable again, the spores can break free from the capsule and multiply. Scouring clay pots was a way to remove potential bacterial infections.

4
- They collected water only from sources where the water was running. Stagnant water harbours diseases.
- They avoided the high bacterial contamination at the surface and in the sediment by collecting water just below the surface.
- They kept water in clay pots that can 'breathe'. Evaporation through the porous clay cools the water. Bacteria cannot live in cool, dark conditions.
- They used environment-friendly containers that could not pollute the rivers and streams.
- They cleaned the insides of the clay pots regularly to remove spores of bacteria.
- They collected rainwater and avoided river water after heavy rains.

5 Many rural people have to rely on untreated water from rivers and streams for their everyday use. By following the basic rules for collecting 'sweet water', they can minimise the chances of bacterial contamination of their water.

LB p. 314

Activity 3 Practical investigation

Cognitive levels 3–4 P

Investigating water quality

1 Malaria is transmitted by the *Anopheles* mosquito. When the female mosquito bites a person with malaria, she draws up a small amount of the infected blood. The malarial parasites then pass through several stages of development within the mosquito's body, and finally find their way to the mosquito's salivary glands. There they lie in wait for the opportunity to enter the bloodstream of their next victim. The parasite infects the red blood cells of the person and multiplies there.
Mosquitoes breed in stagnant water. Swamps and marshes can be treated with chemicals to kill the mosquito larvae, but the chemicals will also kill other useful water life. Water surfaces can also be sprayed with detergent. The soap breaks the surface tension of the water and the mosquito larvae cannot breathe. The best method of protection against the disease is to wear protective clothing at night when mosquitoes are more active. Apply insect repellent onto the skin to ward off the mosquitoes. A mosquito net over the bed will also keep mosquitoes from biting you.

2 Find out in advance if clean treated water will be available. It is always safe to take commercially manufactured chlorine tablets with you. Always carry a water bottle with clean water on hikes. Do not swim or wash in water where there might be bilharzia pollution.
4 Use any of these factors that are applicable to your area: informal settlements, agriculture, wetland destruction, commercial forestry, littering, chemical pollution and industry.

LB p. 319

Activity 4 Case study

Cognitive levels 2–3 *I*

Studying water-based activities

1 Light industries downstream might pollute the river water.
2 The power station uses cold water from the river as a coolant for equipment during the power generation process. The warm water is discharged into the river and causes thermal pollution.
3 Water plants will flourish in nutrient-rich water. The effluent from the sewage works and the fertiliser factory contains large amounts of nutrients.
4 Apart from food, fish need oxygen-rich water to live. Oxygen is less soluble in warmer water and an increase in temperature will result in a decrease in oxygen levels in the water. The breakdown process of complex molecules also requires oxygen. The nutrients discharged from the sewage works and fertiliser factory will decompose in the water and use up some of the available oxygen.
5 There are no rights or wrongs here. The best motivation should score the highest marks.
6 'Parts per million' is used to indicate low levels of contamination, usually in a liquid.
7 Any value close to 7 is acceptable.

LB p. 321

Activity 5 Experiment

Cognitive levels 3–4 *G* *RPA*

Testing the composition of water samples

Checklist for teacher's assessment of individual in a group during experiment

Task skills	Yes	No	Comments
Valuable member of team			
Understands experimental method			
Uses microscope/ magnifying glass correctly			
Diagrams of microscopic life accurate			
Records results correctly in suitable tables			

1 Learners can draw any small live organisms they see using a magnifying glass in the water sample.
2 Learners can draw any microscopic living organisms in a drop of water that they can see using a microscope.
3 Learners record which water samples contained suspended solids and left a residue on the filter paper.

4 Learners test the filtrate for halides, carbonates, nitrates, nitrites and pH and record their results.
5 Accept any correct balanced ionic equations for any positive chemical result in Question 4.
6 Learners will have to decide which water samples are safe to drink according to their results and from where the water was collected.

LB p. 321

Activity 6 Prescribed project

Cognitive levels 3–4 P PPA

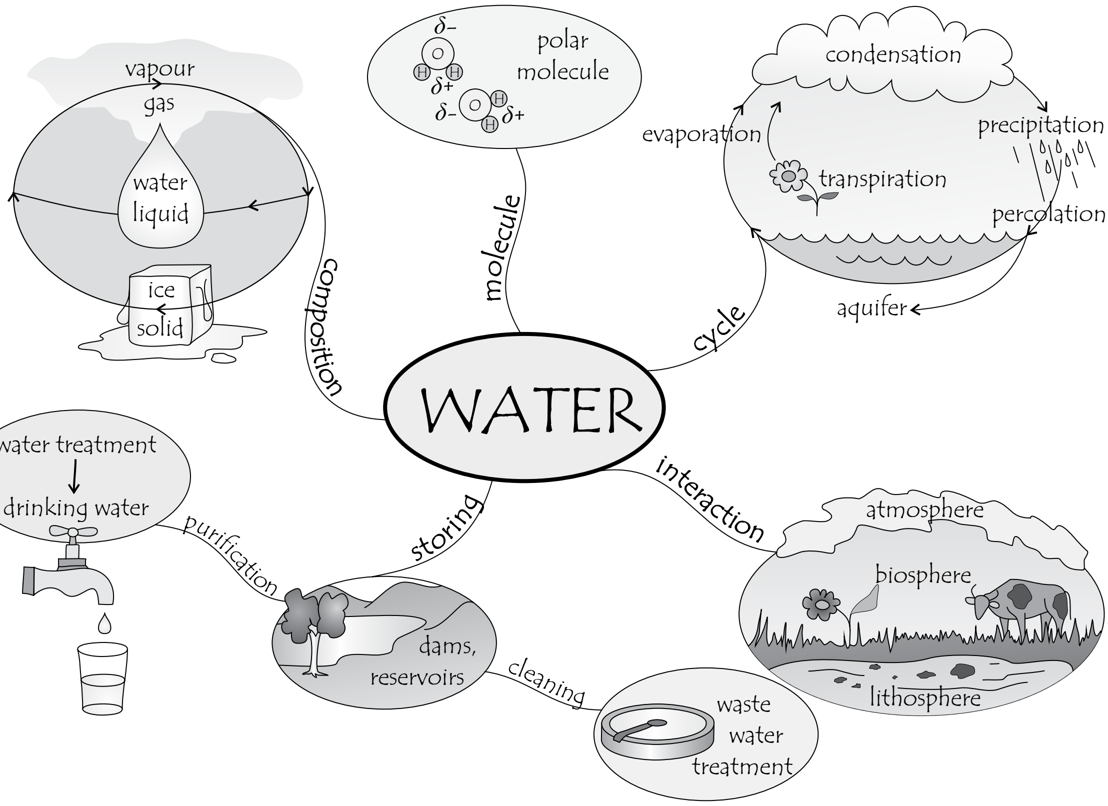
Researching the purification and quality of water

Rubric for formal assessment of prescribed project

Total: 20 marks

Assessment criteria	Rating			
	4	3	2	1
Presentation, standard and quality	High standard, to the point, good organisation	Good standard, some parts clear and well organised	Satisfactory, too simplistic, some parts confusing	Poor quality, no clear organisation or vision
Media and other resources used	Large variety of resources accessed	Sufficient resources accessed	Limited/ insufficient resources accessed	No resources accessed
Writing skills	Effective use of language, facts clearly expressed	Correct use of language, some parts unclear	Correct use of language, but grammatical and spelling errors	Incorrect use of language, many grammatical and spelling errors
Scientific correctness	All facts scientifically correct	Most facts scientifically correct	Some facts scientifically correct	Most facts not scientifically correct
Relevancy of facts	Relevant and covers project brief	Covers most of project brief	Does not cover all facts of project brief	Not in line with project brief

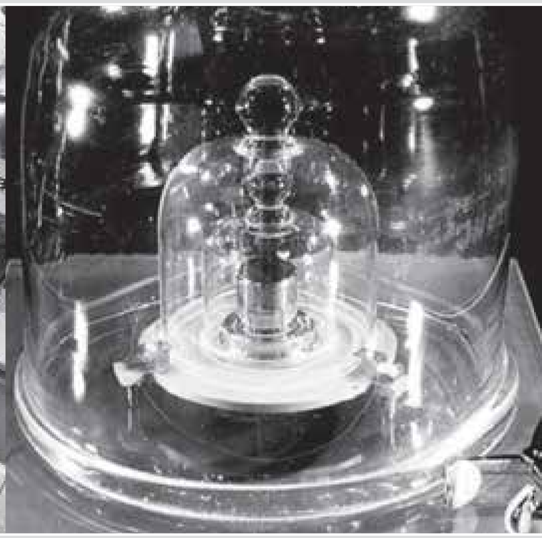
The Learners' Book contains a flow diagram of a general water treatment process. Use the information in the diagram as a guide and adapt it to your local conditions. It is strongly recommended that you contact the local municipality to gather information on these processes as they apply to their specific situation. You can adapt the learning content to suit the special circumstances of the wide variety of conditions and environments found in our country. Class excursions to the water works are also highly recommended.


vapour
gas
water
liquid
ice
solid
composition
δ−
δ+
δ−
δ+
polar
molecule
molecule
condensation
evaporation
precipitation
transpiration
percolation
aquifer
cycle
WATER
water treatment
drinking water
purification
storing
interaction
atmosphere
biosphere
lithosphere
dams,
reservoirs
cleaning
waste
water
treatment

SECTION E

PHOTOCOPIABLE RESOURCES

The Lesson plan grid, Periodic Table, rubrics and assessment grids on the following pages may be photocopied for use with the Physical Sciences Grade 10 Learner's Book.



Lesson plan

Lesson plan			
Teacher:	**Grade:**	**School:**	
Time			
Knowledge area			
Knowledge/prior beliefs			
Core knowledge and concepts			
Teacher activities	**Learner activities**	**Resources**	**Assessment methods**

PERIODIC TABLE OF THE ELEMENTS

13 – atomic number
Al – symbol
27,0 – atomic mass

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1,0																	2 **He** 4,0
7 **Li** 6,9	9 **Be** 9,0											5 **B** 10,8	6 **C** 12,0	7 **N** 14,0	8 **O** 16,0	9 **F** 19,0	10 **Ne** 20,2
11 **Na** 23,0	12 **Mg** 24,3											13 **Al** 27,0	14 **Si** 28,1	15 **P** 31,0	16 **S** 32,1	17 **Cl** 35,5	18 **Ar** 39,9
19 **K** 39,1	20 **Ca** 40,1	21 **Sc** 45,0	22 **Ti** 47,9	23 **V** 50,9	24 **Cr** 52,0	25 **Mn** 54,9	26 **Fe** 55,8	27 **Co** 58,9	28 **Ni** 58,7	29 **Cu** 63,5	30 **Zn** 65,4	31 **Ga** 69,7	32 **Ge** 72,6	33 **As** 74,9	34 **Se** 79,0	35 **Br** 79,9	36 **Kr** 83,8
37 **Rb** 85,5	38 **Sr** 87,6	39 **Y** 88,9	40 **Zr** 91,2	41 **Nb** 92,9	42 **Mo** 96,0	43 **Tc** (98)	44 **Ru** 101,1	45 **Rh** 102,9	46 **Pd** 106,4	47 **Ag** 107,9	48 **Cd** 112,4	49 **In** 114,8	50 **Sn** 118,7	51 **Sb** 121,8	52 **Te** 127,6	53 **I** 126,9	54 **Xe** 131,3
55 **Cs** 132,9	56 **Ba** 137,3	57 **La** 138,9	72 **Hf** 178,5	73 **Ta** 180,9	74 **W** 183,8	75 **Re** 186,2	76 **Os** 190,2	77 **Ir** 192,2	78 **Pt** 195,1	79 **Au** 197,0	80 **Hg** 200,6	81 **Tl** 204,4	82 **Pb** 207,2	83 **Bi** 209,0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **Ac** (227)	104 **Rf** (265)	105 **Db** (268)	106 **Sg** (271)	107 **Bh** (270)	108 **Hs** (277)	109 **Mt** (276)	110 **Ds** (281)	111 **Rg** (280)	112 **Uub** (285)	113 **Uut** (284)	114 **Uuq** (289)	115 **Uup** (288)	116 **Uuh** (293)	117 **Uus** (294)	118 **Uuo** (294)

lanthanides	58 **Ce** 140,1	59 **Pr** 140,9	60 **Nd** 144,2	61 **Pm** (145)	62 **Sm** 150,4	63 **Eu** 152,0	64 **Gd** 157,3	65 **Tb** 158,9	66 **Dy** 162,5	67 **Ho** 164,9	68 **Er** 167,3	69 **Tm** 168,9	70 **Yb** 173,0	71 **Lu** 175,0
actinides	90 **Th** 232,0	91 **Pa** 231,0	92 **U** 238,0	93 **Np** 237,0	94 **Pu** (244)	95 **Am** (234)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (258)	103 **Lr** (262)

Generic rubric for constructing models

Assessment criteria	Rating			
	4	3	2	1
Scientific correctness	Accurate, scientifically sound and complete	Some elements correct and accurate	Model complete but incorrect	Model incomplete
Size and scale	Correct size and scale	Correct size or scale	Too big/too small	Complete lack of scale
Use of colour and contrast	Creative and effective use of colour and contrast	Only addressed one of the aspects	Dull with little contrast	No use of colour and contrast
Use of recycled/ recyclable material	Excellent use of recycled/ recyclable material	Fairly effective use of recycled/ recyclable material	Ineffective use of recycled/ recyclable material	Only new/ expensive material used
Clear and accurate explanation	Clear and accurate explanation	Complete but vague explanation	Incomplete and/or vague explanation	No explanation

Generic rubric for projects

Assessment criteria	Rating			
	4	**3**	**2**	**1**
Teamwork	Effective teamwork and good team spirit	All members participated to some extent	Not all members participated	Conflict between members
Relevancy/ important current issue	Relevant and covers an important current issue	Relevant and meaningful	Relevant but not current, or current but not relevant to science topic	Not an appropriate research project
Project design	Clear vision and organisation; to the point	Some parts are clear and well arranged; others are confusing	Too simplistic	No clear organisation or vision
Media resources accessed	Large variety of resources accessed	Sufficient resources accessed	Limited/ insufficient resources accessed	No resources accessed
Material resources used	Large variety of resources used	Sufficient resources used	Limited/ insufficient resources used	No resources used
Standard/ quality	Excellent standard achieved	Good standard achieved	Satisfactory, but can improve	Poor quality
Effective use of time	Compiled timetable and efficiently used the time frames	Did not adhere to the timetable/time limits agreed on	Did not compile a timetable or time frame	No consideration of time limits apparent
Sensitivity towards cultural differences and differing viewpoints	Acceptance of cultural differences; differing viewpoints accommodated	Sensitivity and awareness displayed	Lack of sensitivity and awareness	No allowance for cultural differences, differing viewpoints made, lack of sensitivity

Generic rubric for oral presentations

Assessment criteria	**Rating**			
	4	**3**	**2**	**1**
Capture audience interest	Fun! Stimulates interest	Interesting at times	Lacking in fun or stimulating impact	No connection with audience
Introduction	Stimulating introduction with clear links to content	Clear introduction but links with content not clearly shown	Introduction muddled	No introduction
Body of presentation	Clear, coherent and to the point	Clear and coherent	Clear at times (sometimes coherent)	Muddled; unclear (not coherent)
Summary	Effectively highlighting key points	Summary not highlighting key points	Summary muddled	No summary
Variety of support materials	Brought and used, is linked to content	Brought and used, but not linked to content	Brought but not used	None
Effective use of time	Highly effective use of time	Good use of time, could be improved	Too fast/slow	No account of time usage
Responses to questions	Answers to interpretation and application questions	Answers to recall questions	Answers to questions, but inaccurate	No answers to questions provided
Enthusiasm/ effort	Worthwhile effort and enthusiasm displayed	Evidence of effort made and enthusiasm displayed	Little effort/lack of enthusiasm	No effort or enthusiasm
Creativity	Completely new and progressive ideas	Very creative	Some creativity	No creativity

Generic rubric for tables

Assessment criteria	Rating			
	4	3	2	1
Suitable heading for table describing variables	Complete and suitable	Complete, but unsuitable	Incomplete	Not present
Descriptive column headings	Complete and appropriate	Complete	Incomplete	Not present
Descriptive row headings	Complete and appropriate	Complete	Incomplete	Not present
Units in heading, and not in body of table		Present in heading	Present, but in body of table	Not present at all
Format of table	Complete	Incomplete	No horizontal or vertical lines and borders	Table incorrectly drawn
Data entered in table	Completely and correctly placed	Incompletely placed	Not correctly placed	Not entered

Generic rubric for experiments

Assessment criteria	Rating			
	4	3	2	1
Organisation – work through procedure in orderly manner	Procedure efficiently organised	Procedure partly organised	Procedure disorganised	No idea how to follow procedure
Efficient use of allocated time	Experiment completed efficiently and in time	Experiment completed in time; fairly efficient	Experiment just completed in time; could be more efficient	Experiment not completed in time
Ability to use apparatus or equipment	All apparatus used correctly and with care	All apparatus used correctly	Apparatus sometimes used incorrectly	Apparatus always used incorrectly
Results/final product	All results correct	Partly correct results	Results inaccurate	No results
Responses to questions based on experimental work	Can answer interpretation and application questions	Can answer recall questions correctly	Answers provided but incorrect	No answers provided to questions

Generic rubric for written experiment reports

Assessment criteria	Rating			
	4	3	2	1
Aim	Clearly stated	Not clearly stated	Incorrectly stated	Not stated
Apparatus	Correctly listed	Partly correct	Incorrectly listed	None listed
Method	Correctly described	Partly correct	Confused description	None
Results (in tables, graphical form)	All provided and correct	Provided and partly correct	Provided, but incorrect	None provided
Results recorded in most appropriate way (tabular, graphical or other)	Correctly recorded in most appropriate manner	Correctly recorded	Incorrectly recorded	Not recorded
Conclusion	Excellent conclusion provided	Conclusion stated correctly	Incorrect conclusion	No conclusion
Discussion	Shows understanding of experiment and is clearly explained	Shows understanding of experiment	Shows partial understanding of experiment	Shows no understanding of experiment
Evaluation of method (procedure) and results	Effective evaluation	Partly correct	Attempted, but incorrect	Not attempted
Use of resources/ background information	Reference to more than one resource and background information provided	Reference to more than one resource	Reference to one resource	None used
Neatness/ presentation	Excellent presentation and neatness	Tidy and clearly presented	Mostly tidy, but unclear in places	Untidy

Generic rubric for writing skills

Assessment criteria	Rating				
	5	**4**	**3**	**2**	**1**
Inclusion of facts	13–15 facts	10–12 facts	5–9 facts	1–4 facts	No facts
Ability to select relevant content and link facts to form argument	Facts relevant and linked effectively	Most facts relevant, facts linked quite well	A few relevant facts, made attempt to link ideas	A few relevant facts, no link	Facts not relevant
Use of paragraphs, expression, grammar and spelling	Effective use of paragraphs; facts clearly expressed	Paragraphs used, no grammatical or spelling errors	Attempt at writing paragraphs, few grammatical and spelling errors	No paragraphs, many grammatical errors, fewer or no spelling errors	No paragraphs, many grammatical and spelling errors

Generic rubric for posters

Assessment criteria	Rating			
	4	3	2	1
Content – main points	All main points included	Points selected relevant	Some points irrelevant	Points selected irrelevant
Facts/ concepts	All facts correct and concepts clear	Facts correct	Some facts incorrect	Facts incorrect
Expressing facts	Clearly expressed and logical	Fairly clearly expressed	Partly expressed	Poorly expressed
Presentation – size of poster (A3)	Correct size and space optimally used	Correct size and all space used	Correct size but not all space used	Incorrect size
Headings	Very descriptive	Fairly descriptive	Partly descriptive	Not descriptive
Print size/font	All large enough to read at 1 m, clear font	Some large enough, clear font	Too small, but clear font chosen	Too small, font not appropriate
Organisation/ layout	Organisation clear, logical and well designed	Organisation clear and logical	Some organisation evident	Muddled
Use of colour	Contrasting colour used to good effect	Good colour usage	More than one colour used, but not to good effect	Poor – one colour used
Public appeal	Eye-catching	Appealing to most	May appeal to some, but room for improvement	Not appealing
Personal information	Included and relevant	Included	Some included	Not included

Generic checklist for graphs

Assessment Criteria	Rating		
	2	1	Comments
Correct type of graph (bar/histogram/line/pie chart)	Correct type	Not correct type	
Suitable heading describing variables	Complete	Not present or incomplete	
Independent variable on x-axis (horizontal)	Present	Not present	
Suitable scale on x-axis (horizontal)	Correct	Incorrect	
Labelling x-axis (horizontal)	Correct	Incorrect	
Units for independent variable on x-axis (horizontal)	Correct	Incorrect	
Dependent variable on y-axis (vertical)	Present	Not present	
Suitable scale on y-axis (vertical)	Correct	Incorrect	
Labelling y-axis (vertical)	Correct	Incorrect	
Units for independent variable on y-axis (vertical)	Correct	Incorrect	
Plotting points (check any three)	All correct	All incorrect or 1–2 correct	
Neatness (joining points)	Tidy	Untidy	
Size of graph	Large, clear	Small, unclear	

GRID **A**

Teacher assessment

Summative assessment: Practical work

Class: ______________________________ Date: ____________________

(Add marks in the appropriate column)

Learner's Name	Experiment 1: Chemistry Total marks 20	Experiment 2: Physics Total marks 20	Project Total marks 20	TOTAL 60 marks

Teacher assessment

Summative assessment: Control tests

Class: ______________________________ Date: ____________________

(Add marks in the appropriate column)

Learner's Name	Control test 1		Control test 2		Total marks out of 20
	Total marks 50	Marks out of 10	Total marks 50	Marks out of 10	

GRID C

Teacher assessment

Summative assessment: Assessment tasks

Class: ______________________________ Date: ____________________

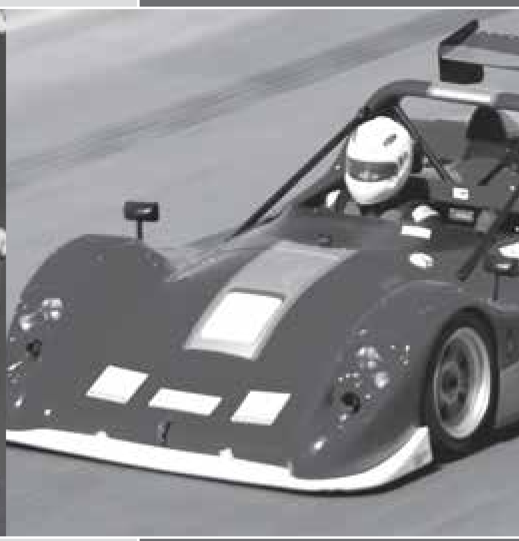
(Add marks in the appropriate column)

Learner's Name	Control tests Total marks 20	Mid-year examination Total marks 20	Practical work Total marks 60	TOTAL 100 marks

SECTION F

DOCUMENTS

This section is for you to file the Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences. You may add any other documents you receive in this section and list them here for easy reference.



Grade 10

Study & Master

Physical Sciences

Study & Master Physical Sciences Grade 10 has been especially developed by an experienced author team for the Curriculum and Assessment Policy Statement (CAPS). This new and easy-to-use course helps learners to master essential content and skills in Physical Sciences.

The comprehensive Learner's Book:

- explains key concepts and scientific terms in accessible language and provides learners with a glossary of scientific terminology to aid understanding
- provides for frequent consolidation in the Summative assessments at the end of each module
- includes case studies that link science to real-life situations and present balanced views on sensitive issues
- includes 'Did you know?' features providing interesting additional information
- highlights examples, laws and formulae in boxes for easy reference.

The innovative Teacher's Guide includes:

- guidance on the teaching of each lesson of the year
- answers to all activities in the Learner's Book
- assessment guidelines
- photocopiable templates and resources for the teacher.

CIDA EMPOWERMENT FUND
PROUD PARTNERS

CAMBRIDGE UNIVERSITY PRESS
www.cup.co.za