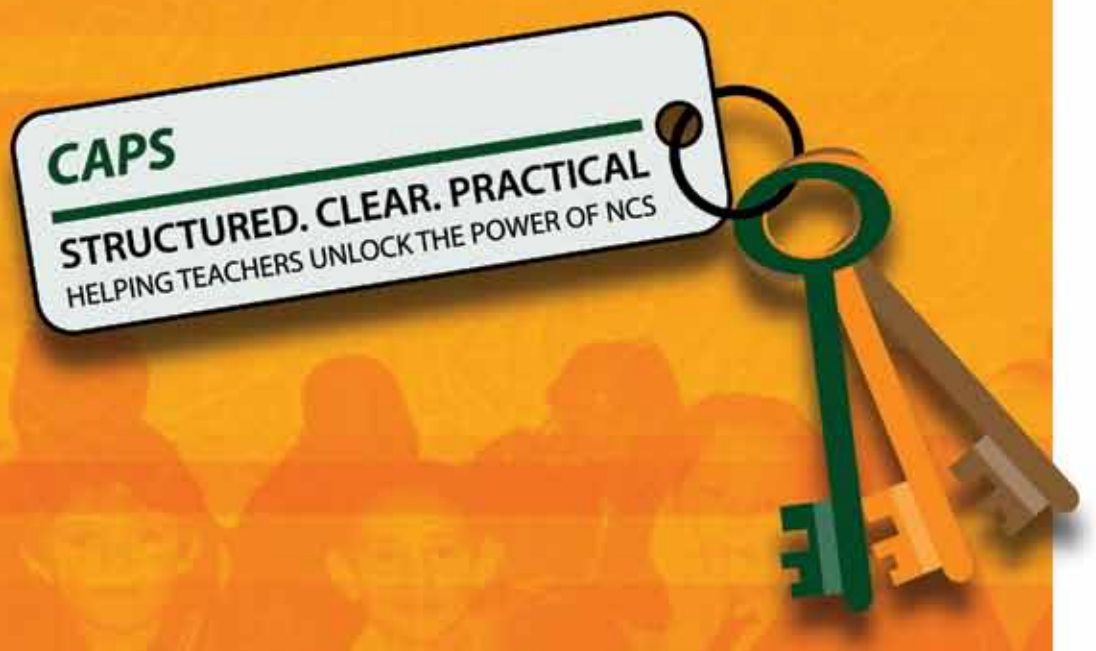
PHYSICAL SCIENCES

National Curriculum Statement (NCS)

Curriculum and Assessment Policy Statement



Further Education and Training Phase Grades 10-12

basic education
Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

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CURRICULUM AND ASSESSMENT POLICY STATEMENT

GRADES 10-12

PHYSICAL SCIENCES

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FOREWORD BY THE MINISTER

Our national curriculum is the culmination of our efforts over a period of seventeen years to transform the curriculum bequeathed to us by apartheid. From the start of democracy we have built our curriculum on the values that inspired our Constitution (Act 108 of 1996). The Preamble to the Constitution states that the aims of the Constitution are to:

- heal the divisions of the past and establish a society based on democratic values, social justice and fundamental human rights;
- improve the quality of life of all citizens and free the potential of each person;
- lay the foundations for a democratic and open society in which government is based on the will of the people and every citizen is equally protected by law; and
- build a united and democratic South Africa able to take its rightful place as a sovereign state in the family of nations.

Education and the curriculum have an important role to play in realising these aims.

In 1997 we introduced outcomes-based education to overcome the curricular divisions of the past, but the experience of implementation prompted a review in 2000. This led to the first curriculum revision: the *Revised National Curriculum Statement Grades R-9* and the *National Curriculum Statement Grades 10-12* (2002).

Ongoing implementation challenges resulted in another review in 2009 and we revised the *Revised National Curriculum Statement* (2002) and the *National Curriculum Statement Grades 10-12* to produce this document.

From 2012 the two National Curriculum Statements, for *Grades R-9* and *Grades 10-12* respectively, are combined in a single document and will simply be known as the *National Curriculum Statement Grades R-12.* The *National Curriculum Statement for Grades R-12* builds on the previous curriculum but also updates it and aims to provide clearer specification of what is to be taught and learnt on a term-by-term basis.

The *National Curriculum Statement Grades R-12* represents a policy statement for learning and teaching in South African schools and comprises of the following:

(a) Curriculum and Assessment Policy Statements (CAPS) for all approved subjects listed in this document;

(b) *National policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R-12*; and

(c) *National Protocol for Assessment Grades R-12.*

MRS ANGIE MOTSHEKGA, MP
MINISTER OF BASIC EDUCATION

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SECTION 1

INTRODUCTION TO THE CURRICULUM AND ASSESSMENT POLICY STATEMENTS FOR PHYSICAL SCIENCES GRADES 10-12

1.1 Background

The *National Curriculum Statement Grades R-12 (NCS)* stipulates policy on curriculum and assessment in the schooling sector.

To improve implementation, the National Curriculum Statement was amended, with the amendments coming into effect in January 2012. A single comprehensive Curriculum and Assessment Policy document was developed for each subject to replace Subject Statements, Learning Programme Guidelines and Subject Assessment Guidelines in Grades R-12.

1.2 Overview

(a) The *National Curriculum Statement Grades R-12 (January 2012)* represents a policy statement for learning and teaching in South African schools and comprises the following:

(i) Curriculum and Assessment Policy Statements for each approved school subject;

(ii) The policy document, National policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R-12; and

(iii) The policy document, National Protocol for Assessment Grades R-12 (January 2012).

(b) The *National Curriculum Statement Grades R-12 (January 2012)* replaces the two current national curricula statements, namely the

(i) Revised National Curriculum Statement Grades R-9, Government Gazette No. 23406 of 31 May 2002, and

(ii) National Curriculum Statement Grades 10-12 Government Gazettes, No. 25545 of 6 October 2003 and No. 27594 of 17 May 2005.

(c) The national curriculum statements contemplated in subparagraphs b(i) and (ii) comprise the following policy documents which will be incrementally repealed by the *National Curriculum Statement Grades R-12 (January 2012)* during the period 2012-2014:

(i) The Learning Area/Subject Statements, Learning Programme Guidelines and Subject Assessment Guidelines for Grades R-9 and Grades 10-12;

(ii) The policy document, National Policy on assessment and qualifications for schools in the General Education and Training Band d, promulgated in Government Notice No. 124 in Government Gazette No. 29626 of 12 February 2007;

(iii) The policy document, the National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF), promulgated in Government Gazette No.27819 of 20 July 2005;

(iv) The policy document, An addendum to the policy document, the National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF), regarding learners with special needs, published in Government Gazette, No.29466 of 11 December 2006, is incorporated in the policy document, National policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R-12; and

(v) The policy document, An addendum to the policy document, the National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF), regarding the National Protocol for Assessment (Grades R-12), promulgated in Government Notice No.1267 in Government Gazette No. 29467 of 11 December 2006.=

(d) The policy document, *National policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R-12*, and the sections on the Curriculum and Assessment Policy as contemplated in Chapters 2, 3 and 4 of this document constitute the norms and standards of the *National Curriculum Statement Grades R-12.* It will therefore, in terms of *section 6A* of the *South African Schools Act, 1996 (Act No. 84 of 1996,)* form the basis for the Minister of Basic Education to determine minimum outcomes and standards, as well as the processes and procedures for the assessment of learner achievement to be applicable to public and independent schools.

1.3 General aims of the South African Curriculum

(a) The *National Curriculum Statement Grades R-12* gives expression to the knowledge, skills and values worth learning in South African schools. This curriculum aims to ensure that children acquire and apply knowledge and skills in ways that are meaningful to their own lives. In this regard, the curriculum promotes knowledge in local contexts, while being sensitive to global imperatives.

(b) The National Curriculum Statement Grades R-12 serves the purposes of:

- equipping 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;
- providing access to higher education;
- facilitating the transition of learners from education institutions to the workplace; and
- providing employers with a sufficient profile of a learner's competences.

(c) The National Curriculum Statement Grades R-12 is based on the following principles:

- Social transformation: ensuring that the educational imbalances of the past are redressed, and that equal educational opportunities are provided for all sections of the population;
- Active and critical learning: encouraging an active and critical approach to learning, rather than rote and uncritical learning of given truths;
- High knowledge and high skills: the minimum standards of knowledge and skills to be achieved at each grade are specified and set high, achievable standards in all subjects;

- Progression: content and context of each grade shows progression from simple to complex;
- Human rights, inclusivity, environmental and social justice: infusing the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South Africa. The National Curriculum Statement Grades R-12 is sensitive to issues of diversity such as poverty, inequality, race, gender, language, age, disability and other factors;
- Valuing indigenous knowledge systems: acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution; and
- Credibility, quality and efficiency: providing an education that is comparable in quality, breadth and depth to those of other countries.

(d) The National Curriculum Statement Grades R-12 aims to produce learners that 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; and
- demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.

(e) 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.

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).

1.4 Time Allocation

1.4.1 Foundation Phase

(a) The instructional time in the Foundation Phase is as follows:

SUBJECT	GRADE R (HOURS)	GRADES 1-2 (HOURS)	GRADE 3 (HOURS)
Home Language	10	7/8	7/8
First Additional Language		2/3	3/4
Mathematics	7	7	7
Life Skills	**6**	**6**	**7**
• Beginning Knowledge	(1)	(1)	(2)
• Creative Arts	(2)	(2)	(2)
• Physical Education	(2)	(2)	(2)
• Personal and Social Well-being	(1)	(1)	(1)
TOTAL	**23**	**23**	**25**

(b) Instructional time for Grades R, 1 and 2 is 23 hours and for Grade 3 is 25 hours.

(c) Ten hours are allocated for languages in Grades R-2 and 11 hours in Grade 3. A maximum of 8 hours and a minimum of 7 hours are allocated for Home Language and a minimum of 2 hours and a maximum of 3 hours for Additional Language in Grades 1-2. In Grade 3 a maximum of 8 hours and a minimum of 7 hours are allocated for Home Language and a minimum of 3 hours and a maximum of 4 hours for First Additional Language.

(d) In Life Skills Beginning Knowledge is allocated 1 hour in Grades R-2 and 2 hours as indicated by the hours in brackets for Grade 3.

1.4.2 Intermediate Phase

(a) The instructional time in the Intermediate Phase is as follows:

SUBJECT	HOURS
Home Language	6
First Additional Language	5
Mathematics	6
Natural Science and Technology	3,5
Social Sciences	3
Life Skills	**4**
• Creative Arts	(1,5)
• Physical Education	(1)
• Personal and Social Well-being	(1,5)
TOTAL	**27,5**

1.4.3 Senior Phase

(a) The instructional time in the Senior Phase is as follows:

SUBJECT	HOURS
Home Language	5
First Additional Language	4
Mathematics	4,5
Natural Science	3
Social Sciences	3
Technology	2
Economic Management Sciences	2
Life Orientation	2
Creative Arts	2
TOTAL	**27,5**

1.4.4 Grades 10-12

(a) The instructional time in Grades 10-12 is as follows:

SUBJECT	TIME ALLOCATION PER WEEK (HOURS)
Home Language	**4.5**
First Additional Language	**4.5**
Mathematics	**4.5**
Life Orientation	**2**
A minimum of any three subjects selected from **Group B** Annexure B, Tables B1-B8 of the policy document, *National policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R-12,* subject to the provisos stipulated in paragraph 28 of the said policy document.	**12 (3x4h)**
TOTAL	**27,5**

The allocated time per week may be utilised only for the minimum required NCS subjects as specified above, and may not be used for any additional subjects added to the list of minimum subjects. Should a learner wish to offer additional subjects, additional time must be allocated for the offering of these subjects.

SECTION 2

PHYSICAL SCIENCES

2.1 WHAT IS PHYSICAL SCIENCES?

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

This subject also deals with society's need to understand how the physical environment works in order 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 been passed on through generations and has been a source of many innovations and developments including scientific developments. Some concepts found in Indigenous Knowledge Systems lend themselves to explanation using the scientific method while other concepts do not; this is still knowledge however.

2.2 SPECIFIC AIMS OF PHYSICAL SCIENCES

The purpose of Physical Sciences is to make learners aware of their environment and to equip learners with investigating skills relating to physical and chemical phenomena, for example, lightning and 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 promotes knowledge and skills in 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.

Physical Sciences prepares 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 10-12, including those with barriers to learning, can have improved access to: academic courses in Higher Education; professional career paths related to applied science courses and vocational career paths. Physical Sciences plays an increasingly important role in the lives of all South Africans owing to their influence on scientific and technological development, which are necessary for the country's economic growth and the social wellbeing of its people.

Six main knowledge areas inform the subject Physical Sciences. These are:

- Matter and Materials
- Chemical Systems
- Chemical Change
- Mechanics
- Waves, Sound and Light

- Electricity and Magnetism

Assessment Taxonomy

Application exercises should be done at all cognitive levels in all knowledge areas.

Refer to Appendix 1 for the assessment taxonomy at cognitive levels one to four.

Recommended Informal Assessment

1. Give learners at least two problem-solving exercises on a frequent basis (every day as far as possible). These should collectively cover all cognitive levels and could be done as homework and/or class work.

2. Learners should do at least ONE practical activity per term.

3. Learners should be given at least ONE informal test per term.

NOTE

- **Informal assessment tasks** are homework, class work, practical investigations, experiments and informal tests.

- Informal assessment tasks will **assess** structured problem solving involving calculations, practical investigations, experiments, projects, scientific arguments, ability to predict, observe and explain. Informal assessment tasks should also include problem-solving exercises that do not involve calculations.

- **Formal assessment tasks** are control tests, examinations, experiments and projects.

- "**Practical activities**" as used in this document will refer to practical demonstrations, experiments or projects used to strengthen the concepts being taught.

- **"Experiment**" will refer to a set of outlined instructions for learners to follow in order to obtain results to verify established theory.

- **"Practical investigations**" will require learners to go through the scientific process.

2.3 TIME ALLOCATION OF PHYSICAL SCIENCES IN THE CURRICULUM

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

GRADE	NO. OF WEEKS ALLOCATED	CONTENT, CONCEPTS & SKILLS (WEEKS)	FORMAL ASSESSMENT (WEEKS)
10	40	30	10
11	40	30	10
12	40	29	11

2.4 OVERVIEW OF TOPICS

Topic	Content	
Mechanics	Grade 10	**Introduction to vectors & 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**
	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 & Power** (work , work-energy theorem, conservation of energy with non-conservative forces present, power) **28 hours**
Waves, Sound & 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 & 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 & 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 quantization),**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**
Matter & Materials	Grade 10	**Revise matter and classification** (materials; heterogeneous and homogeneous mixtures; pure substances; names and formulas; metals and non-metals; electrical and thermal conductors and insulators; magnetic and nonmagnetic 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 quantization 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) (**6 hours for physics) 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**

Topic	Content	
Chemical Systems	Grade 10	**Hydrosphere 8 hours**
	Grade 11	**Lithosphere** (mining; energy resources) **8 hours**
	Grade 12	**Chemical industry** (fertilizer 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).**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**). 20 hours**
	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**
Skills for practical investigations	Grade 12	Skills for practical investigations in physics and chemistry. **4 hours**

2.5 OVERVIEW OF PRACTICAL WORK

Practical work must be integrated with theory to strengthen the concepts being taught. These may take the form of simple practical demonstrations or even an experiment or practical investigation. There are several practical activities outlined alongside the *content, concepts and skills* columns throughout **Section 3.** Some of these practical activities will be done as part of formal assessment and others can be done as part of informal assessment. Below is a table that lists prescribed practical activities for formal assessment as well as recommended practical activities for informal assessment across grades 10 to 12.

Grade	Term	Prescribed Practical Activities Formal Assessment	Recommended Practical Activities Informal Assessment
10	Term1	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.
	Term 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.
	Term 3	Project: You may do any of these topics or any other topic based on the Grade 10 content. Chemistry: Purification and quality of water. **OR** Physics: Acceleration. Example: Roll a ball down an inclined plane and using measurements of time and position obtain a velocity+time graph and hence determine the acceleration of the ball. The following variations could be added to the investigation: i. Vary the angle of inclination and determine how the inclination impacts on the acceleration ii. Keep the angle fixed and use inclined planes made of different materials to determine how the different surfaces impact on the acceleration. One could also compare smooth and rough surface etc.	Experiment (Physics) Roll a trolley down an inclined plane with a ticker tape attached to it and use the data to plot a position vs. time graph. **OR** Experiment (Chemistry) Reaction types: precipitation, gas forming, acid-base and redox reactions.
	Term 4		Experiment (Chemistry) Test water samples for carbonates, chlorides, nitrates, nitrites, pH and look at water samples under the microscope. Experiment (Physics) Conservation of Energy (qualitative)
11	Term1	Experiment (Physics): Investigate the relationship between force and acceleration (Verification of Newton's second law)	Practical Demonstration (Physics) Investigate the relationship between normal force and maximum static friction. Investigate the effect of different surfaces on maximum static friction by keeping the object the same. **OR** Experiment (Chemistry) Investigate the physical properties of water (density, BP, MP, effective as solvent, …)
	Term 2	Experiment (Chemistry): The effects of intermolecular forces: boiling points, melting points, surface tension, solubility, capillarity,...	Experiment (physics) Determine the critical angle of a rectangular glass (clear) block. **OR** Experiment (Chemistry) Boyle's law OR preparation of PbO_2 from $Pb(NO_3)_2$
	Term 3	Project: You may do any of these topics or any other topic based on the Grade 11 content. Chemistry: Exothermic and endothermic reactions (examples and applications) **OR** Physics: Snell's Law	Experiment (physics) Obtain current and voltage data for a resistor and a light bulb and determine which one obeys Ohm's law. **OR** Experiment (Chemistry) Investigate natural indicators for acids and bases
	Term 4		Experiment (Chemistry) Redox reactions - one synthesis, one decomposition and one displacement reaction.

Grade	Term	Prescribed Practical Activities Formal Assessment	Practical Activities Informal Assessment
12	Term1	Experiment (Chemistry) Preparation of esters	Experiment (physics) Draw a graph of position vs. time and velocity vs. time for a free falling object. **AND** Use the data to determine the acceleration due to gravity. **OR** Experiment (Chemistry) Reaction of alkanes and alkenes with bromine and potassium permanganate **OR** making a polymer like “slime” or “silly putty”.
	Term 2	Experiment (Chemistry) How do you use the titration of oxalic acid against sodium hydroxide to determine the concentration of the sodium hydroxide? **OR** Experiment (Physics) Conservation of linear momentum.	Investigation (Physics) Perform simple experiments to determine the work done in walking up (or running up a flight of stairs). By timing the run and walk (same flight of stairs) one can enrich the concept of power. **OR** Investigate Conservation of linear Momentum **OR** Experiment (Chemistry) Rate of chemical reactions with sodium sulphite and hydrochloric acid **OR** chemical equilibrium.
	Term 3	Experiment (physics) Part 1 Determine the internal resistance of a battery. Part 2 Set up a series-parallel network with known resistor. Determine the equivalent resistance using an ammeter and a voltmeter and compare with the theoretical value.	Investigation (Physics): Set up a series-parallel network with an ammeter in each branch and external circuit and voltmeters across each resistor, branch and battery, position switches in each branch and external circuit. Use this circuit to investigate short circuits and open circuits. **OR** Experiment (Chemistry) Investigate electrolytic and galvanic cells.
	Term 4		

2.6 WEIGHTING OF TOPICS [40 WEEK PROGRAMME]

	GRADE 10	GRADE 11	GRADE 12
	%	%	%
Mechanics	18.75	16.87	17.50
Waves, Sound & Light	10.00	8.13	3.75
Electricity & Magnetism	8.75	12.5	7.50
Matter & Materials	17.50	15.00	11.5 Chem & 3.75 Phys
Chemical Change	15.00	17.50	17.50
Chemical Systems	5.00	5.00	3.5
Teaching Time (Theory and Practical Work)	**75.00**	**75.00**	**65.00**
Time for Examinations and Control Tests	**25**	**25**	**35**

Total time = 40 hrs/Term x 4 Terms = 160 Hours (per year)

2.7 OVERVIEW OF FORMAL ASSESSMENT AND RECOMMENDED INFORMAL EXPERIMENTS

For grades 10 and 11 TWO prescribed experiments are done per year, ONE Physics experiment and ONE Chemistry experiment as formal assessment (one experiment per term for term 1 and 2).For grade 12 THREE prescribed experiments are done per year, ONE or TWO Physics experiments and ONE or TWO Chemistry experiments as formal assessment (one experiment per term for terms 1, 2 and 3). TWO control tests and TWO examinations are written as formal assessment in each of grades 10 and 11. ONE control test, ONE midyear examination, ONE trial examination and ONE final examination are written as formal assessment for grade 12.

ONLY in grade 10 and grade 11 ONE project is done per year as formal assessment either in Chemistry or in Physics or an integrated Chemistry/Physics project (started in term 1 and assessed in term 3). Any ONE of the recommended projects can be done or any ONE of the experiments can be done as a practical investigation or any other topic of choice can be used as a project.It is recommended that the project topic is given to learners 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. In grade 12 NO project is done.

There are four recommended informal experiments for grades 10 and 11 and three recommended informal experiments for grade 12.

2.8 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 (LoLT) 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 (but not only) in the informal assessments **for** learning.

PHYSICAL SCIENCES CONTENT (GRADES 10 -12)

TERM 1 GRADE 10					
GRADE 10 CHEMISTRY *(MATTER & MATERIALS)* TERM 1					
Time	**Topics Grade 10**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
2 HOURS	**<u>Revise Matter & classification (from grade 9)</u>**	Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity. See appendix 2 for skills that need to be infused with content in all grades.			Observing, describing, classifying and using materials - a macroscopic view (do this in detail in grade 9 if possible)
0.25 hour	The material(s) of which an object is composed	• Revise the properties of material, e.g. 1. Strength 2. Thermal and electrical conductivity 3. Brittle, malleable or ductile 4. Magnetic or non-magnetic 5. Density (lead / aluminium) 6. Melting points and boiling points	**Activity:** **What materials are products made of?** If you have a sand dune, the material out of which the dune is made is sand. Look at the labels on the containers of food or on medicine bottles, or the wrapper of chocolate. Note the ingredients of the material in the container. What do the different compounds tell you about the material in the container? Why do the manufacturers give the ingredients of the material? Use safety data to learn about the compounds contained in your food and medicines	An activity that classifies a range of materials and combines all these properties could be useful to revise the content	The introduction of the topic was moved to grade 9 and is **only revised in grade 10** Learners are encouraged to look at food additives and preservatives. This should be contrasted with indigenous ways of food preservation

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0.25 hour	Mixtures: heterogeneous and homogeneous.	• Revise the properties of a mixture • Revise the properties of a heterogeneous mixture. • Revise the properties of a homogeneous mixture • Give examples of heterogeneous and homogeneous mixtures	**Which mixtures are heterogeneous and which mixtures are homogeneous?** • Make mixtures of sand and water, potassium dichromate and water, iodine and ethanol, iodine and water. Which mixtures are heterogeneous and which mixtures are homogeneous? • Let learners make their own homogeneous and heterogeneous mixtures and motivate or defend their choices		
0.25 Hour	Pure substances: elements and compounds.	• 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 • Devise criteria for purity. Use melting point and boiling points as evidence of purity. Use chromatography as evidence of purity	• Decide which of the following substances are pure substances: water, tea, salt water, copper, brass, air, oxygen • Use molecular models to build pure substances, elements and compounds **Activity:** • Do experiment with paper chromatography to show that water soluble ink-pens or “Smarties” are not pure colours, but are mixtures of colours	Use the periodic table to identify the elements. Test tubes, glass beaker, filter paper and water soluble ink-pens.	

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0.25 hour	Names and formulae of substances.	• Revise the names of compounds using the names of the elements from which they are made • Revise the cation and anion table • Revise the writing of names when given the formulae. • Revise the writing of formulae when given the names • Revise the meaning of the name endings like -ide, -ite and -ate • Understand the meaning of prefixes di-, tri- etc	**Activity:** • Why do we have scientific names? • Identify the elements that make up a compound on the food labels collected by the learners • Compare the scientific names with traditional names for compounds known by learners		Indicate the relationship between names and chemical formulae and chemical bonding to learners. **Use cation and anion tables in appendix 4** Pay attention to the names of covalent compounds and the names of ionic compounds.
0.25 hour	Metals, metalloids and non-metals.	• Revise the classification of substances as metals, metalloids and non-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	• Identify the metals, non-metals and metalloids on the periodic table. • Test copper, lead, aluminium, zinc, iron, sulphur, carbon, iodine, graphite and silicon to determine whether they have metallic, metalloid or non-metallic character. How are these elements used in industry?		Metalloid is the more scientific name for semi-metal. Give preference to the use of the name metalloids, but do not penalize learners for the use of the name semi-metals.

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		• 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 hours	Electrical conductors, semiconductors and insulators	• 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 semi-conductors)	• Test the following substance to classify them as conductors, semiconductors or insulators: glass, wood, graphite, copper, zinc, aluminium and materials of your own choice		
0.25 hours	Thermal conductors and insulators	• Revise how to test and classify materials as thermal conductors and insulators • Give examples of materials that are thermal conductors and insulators	• Test the following substance to classify them as heat conductors, or insulators: glass, wood, graphite, copper, zinc, aluminium and materials of your own choice		

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0.25 hours	Magnetic and nonmagnetic materials.	• 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 the use we make of magnets in daily life (in speakers, in telephones, electric motors, as compasses)	• Test the following substance to classify them as magnetic, or nonmagnetic: glass, wood, graphite, copper, zinc, aluminium, iron nail and materials of your own choice		
2 HOURS	**States of Matter and the Kinetic Molecular Theory**	Physical state is only one of the ways of classifying matter. The Kinetic-molecular theory and intermolecular forces are the basis for solid, liquid, gas and solution phenomena.			Revision of matter and states of matter is the bigger picture.
1 hour	Three states of matter	• Verify the particulate nature of matter by investigating diffusion and Brownian motion • List and characterize 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	**Prescribed experiment for formal assessment** • Draw the heating and cooling curve for water. Start with ice in a glass beaker and use a thermometer to read the temperature every 1 minute when you determine the heating curve of water. Do the same with the cooling curve of water starting at the boiling point. Give your results on a graph	**Materials:** Burner, glass beaker, ice water and a thermometer.	An activity that classifies a variety of compounds and combines all these properties, including KMT, would be useful to revise the content. To save teaching time it is recommended that integates teachings and practical work is used as strategy for this topic and all other topics
1 hour	Kinetic Molecular Theory	• Describe a solid, a liquid, and a gas according to the Kinetic Molecular Theory in terms of particles of matter	• Use play dough or marbles to represent gases liquids and and solids.explain the levels: macroscopic, sub-microscopic and use use symbols effectively		

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 HOURS	**<u>The Atom: basic building block of all matter</u>** **(Atomic structure)**	All matter is made up of atoms. Everything around you, including your own body, your hair, your organs and even the air you breathe is made up of atoms. Atomic theory is the foundation for understanding the interactions and changes in matter. The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. Everything in the world is made up of different combinations of atoms from the elements on the periodic table			Visualization is very important in Chemistry to demystify the subject and make it easier to understand. Always move between macroscopic and sub-microscopic and use symbols effectively
0.5 hour	Models of the atom.	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 Greeks and other nations' 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?	**Activity:** (1) Make a list of key discoveries about atomic structure Do this as a library assignment. Look at work from JJ Thomson, Ernest Rutherford, Marie Curie, JC Maxwell, Max Planck, Albert Einstein, Niels Bohr, Lucretius, LV De Broglie, CJ Davisson, LH Germer, Chadwick, Werner Heisenberg, Max Born, Erwin Schrödinger, John Dalton, Empedocles, Leucippus, Democritus, Epicurus, Zosimos, Maria the Jewess, Geber, Rhazes, Robert Boyle, Henry Cavendish, A Lavoisier, H Becquerel State the key discovery in ONE sentence and match the discovery to the influence on the description of the atom (2) The class can make a flow chart on the discoveries or construct a time line to display the discoveries		<u>Note to the teacher</u>: This type of activity (1) should be used to introduce or practice report writing and/or presentation skills. This topic could also be used as a cooperative learning activity. You don't need information on all the names mentioned: you can choose the names of the scientists you want information on. Make a list of key discoveries and discoverers (this is NOT for rote learning in exams. This is an activity that is **NOT FOR EXAM PURPOSES**. It gives learners a real life experience of the construction of knowledge over time.)

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
0.5 hour	Atomic mass and diameter.	• 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	**Activity:** (1) Note the correct use of scientific notation and the meaning of the values obtained when giving atomic mass or atomic radius (2) Use analogies to show how small the nucleus is compared to the atom		Simulate the α-particle scattering experiment with a nucleus of marbles (glued together) and BB gun pellets as electrons and shoot with marbles as α-particles.
1 hour	Structure of the atom: protons, neutrons, electrons.	• 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/adding electrons from the atom. - Calculate the number of neutrons present - Calculate the mass number for an isotope of an element	**Activities:** (1) Use the PT to make a Science puzzle to clarify and strengthen concepts (2) Describe the structure of the atom in terms of protons, neutrons and electrons. Make a drawing to show your interpretation of the structure of an atom	PT must have values with at least one decimal point.	**Note:** The Periodic Table has been introduced superficially in grade 9 and can be used as such in atomic structure. Deeper study on the PT is done in term 2.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Isotope	• 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 $^{Z}_{A}E$	**Activities:** (1) Identify isotopes among elements with relevant information (2) Perform calculations related to isotopic masses and relative atomic masses		Do simple calculations to improve learners understanding of the concept isotopes. Z = atomic number and A = mass number
1 hour	Electron configuration.	• 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 Aufbau principle) • Describe atomic orbitals and the shapes of the s-orbitals and the p-orbitals • Sate Hund's rule and Pauli's Exclusion Principle	**Activities:** (1) Understand and deduce the electronic arrangement of atoms (2) Represent the electronic arrangements of atoms using electron diagrams **<u>Recommended experiment for informal assessment</u>** (3) Do flame tests to identify some metal cations and metals	**Materials** Watch glass, burner, propette, methanol, bamboo sticks, metal salts to be tested including NaCl, $CuCl_2$, $CaCl_2$, KCl and metals copper powder, magnesium, zinc powder, iron powder etc.	Energy is seen as the energy of the electron in ground state and excited state. The Aufbau principle (building-up principle) is the principle that the orbital that fills first is the orbital with the lowest energy. In atoms the order for filling of orbitals is 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p……electronic structure. (Aufbau is German for building-up.)
4 HOURS	**<u>Periodic Table</u>**	The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. Student should develop an understanding about the importance of the periodic table in Chemistry. Knowledge and concepts about periodic trends of physical properties of some elements are required.		The atomic properties of an element are related to its electronic configuration and hence to its position on the periodic table.	

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 hours	The position of the elements in the periodic table related to their electronic arrangements	• 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 • Relate the position of an element in the PT to its electronic structure and vice versa • Understand periodicity by looking at the following 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 ionization energy. • What is the influence of periodicity on electron-affinity and electronegativity? • Define atomic radius, ionization energy, electron-affinity and electronegativity	**Activities:** (1) Use the PT to make a Science puzzle to clarify and strengthen concepts (2) Searching for an d presenting information on elements and the development of the PT (3) Pack your own PT and discover the missing elements. The concepts you are investigating are periodicity, predicting properties, groups, and periods. Get paint colour samples from a hardware store. Use an empty PT grid to pack your colour chips according to the following rules: Basic colour represents chemical properties; the shade of the paint chip represents atomic mass; similar intensities of shade are in the same period. Sequence metals to non-metals according to the colour of the visible spetrum form red violet. Remove a few paint chips and pack the periodic table again. Can you describe the properties of the missing chips (elements)	**Information for Periodic Table activity:** On you colour cards for the PT you can also add information like density, melting point, boiling point, heat conductivity, physical appearance, reaction with oxygen, reaction with water, etc	How the periodic table is organized is not as important as what information can be derived from the PT. Information like bonding, valency, orbitals, electronic structure. This section is crucial as it provides the basis for conceptual understanding of bonding. Teachers should ensure that learners understand the structure of the PT and not only know how to use it. Enough time must be spent on this NB!! Learners must know the names and all the formulae of all the elements from Hydrogen (atomic nimber 1) to Krypton (atomic number 36), plus the common elements silver (Ag), cadnium (Cd), tin (Sn), iodine (I), platinum (PT), gold (Au), mercury (Hg), and lead (Pb)

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 hours	Similarities in chemical properties among elements in Groups 1, 2, 17 and 18	• 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 periodic table • Indicate where nonmetals are to be found on the periodic table • Indicate where transition metals are to be found on the periodic table			

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4 HOURS	**<u>Chemical bonding</u>**	Interactions between matter generate substances with new physical and chemical properties.			
4 hours	Covalent bonding, ionic bonding and metallic bonding	• Draw Lewis dot diagrams of elements • **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:** 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:** - Sharing a delocalized electron cloud among positive nuclei in the metal - Revise the cation and the anion table done in grade 9 - Revise the names of compounds - Revise relative molecular mass for covalent molecules - Revise relative formula mass for ionic compounds	**Activities:** (1) Describe and draw the formation of a covalent bond (2) Describe, using electron diagrams, the formation of single, double and triple bonds (3) Write the names and formulae of covalent compounds in terms of the elements present and the ratio of their atoms (4) Describe, using electron diagrams, the formation of ions and ionic bonds (5) Draw the electron diagrams of cations and anions (6) Predict the ions formed by atoms of metals and non-metals by using information in the PT (7) Name ionic compounds based on the component ions (8) Describe the structure of an ionic crystal (9) Describe the simple model of metallic bonding	Ionic crystal lattices can be made with polystyrene balls and wooden sticks and displayed in the classroom	You need to have an explanation of chemical bonding before you describe molecular substances and ionic substances. Ensure that the correct terminology is used here, e.g. ionic substances do not form *molecules* **Electron diagrams refer to Lewis dot diagrams of elements.** **Under Chemical Bonding here <u>only the definitions</u> of covalent bonding, ionic bonding and metallic bonding are done.** On page 25 the applications or the effect of this kind of bonding is done. Given 4 hours, but 2 hours would also be enough

GRADE 10 PHYSICS *(WAVES, SOUND & LIGHT)* TERM 1

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 HOURS	**Transverse pulses on a string or spring**				
2 hours	Pulse, amplitude	• Define a pulse • Define a transverse pulse • Amplitude • Define amplitude as maximum disturbance of a particle from its rest (equilibrium) position • Know that for a transverse pulse the particles of the medium move at right angles to the direction of propagation of the pulse	Practical Demonstration: Let learners observe the motion of a single pulse travelling along a long, soft spring or a heavy rope	**Materials:** Slinky spring, rope	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.
2 hours	Superposition of Pulses	• Explain that superposition is the addition of the disturbances of the two pulses that occupy the same space at the same time • Define constructive interference • Define destructive 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	**Recommended experiment for informal assessment:** Use a ripple tank to demonstrate constructive and destructive interference of two pulses	**Materials:** Ripple tank apparatus.	

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 HOURS	**<u>Transverse waves</u>**				
2 hours	Wavelength, frequency, amplitude, period, wave speed;	• 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	**Practical Demostration** Generate a transverse wave in a slinky spring	slinky spring	For a wave the distance travelled in one period is one wavelength, and frequency is 1/period.
2 HOURS	**<u>Longitudinal waves:</u>**				
1 hour	On a spring	• 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	**Practical Demonstration:** Generate a longitudinal wave in a spring	**Materials:** Slinky spring	

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hours	Wavelength, frequency, amplitude, period, wave speed.	• Define the wavelength and amplitude of a longitudinal wave • Define compression and rarefaction • Differentiate between longitudinal and transverse waves • Define the period and frequency of a longitudinal wave and the relationship between the two quantities $f = \frac{1}{T}$ • Use the equation for wave speed, $v = f\lambda$ to solve problems involving longitudinal waves			
4 HOURS	**<u>Sound</u>**				
2 hour	Sound waves	• 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) • Understand that sound waves undergo reflection. • Understand what are echoes • Use the equation for wave speed, $v = f\lambda$ to solve problems involving sound waves that also include echoes, sonar and bats	**Recommended Informal Assessment** **Practical Demonstration:** How to make sound using a vuvuzela, string, tuning-fork, loud-speaker, drum-head **Practical Activity (Project):** Making a string (or wire) telephone **Practical Activity:** Determine the speed of sound in air. You could repeat this on different days in order to vary the temperature	**Materials:** Vuvuzela, string, tuning-fork, loud-speaker, drum-head **Materials:** Two 340ml drink cans, 2 nails, string or copper wire (not too thick) **Materials:** Stop-watch, toy pistol like the ones used in athletics.	Learners should understand that sound waves are pressure waves. For this reason, the more closely spaced the molecules of the medium, the faster the wave travels. That is why sound travels faster in water than in air and faster in steel than in water.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Pitch, loudness, quality (tone)	• 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	**Practical Activity:** 1. Compare the sounds made by blowing on different vuvuzelas of different sizes 2. Compare the sounds made by blowing on a vuvuzela versus the sounds produced by a flute 3. Use a function generator to produce sounds of different frequencies and amplitudes and use the oscilloscope to display the different characteristics of the sounds that are produced	**For 1 and 2:** Vuvuzelas of different sizes, flutes Or Tuning forks Or Vuvuzelas, flutes, microphone, oscilloscope, loudspeaker, cables. **For 3:** Oscilloscope, function generator, loud- speaker, cables.	The human ear is more sensitive to some frequencies than to others. Loudness thus depends on both the amplitude of a sound wave and its frequency (where it lies in a region where the ear is more or less sensitive).
1 hour	Ultrasound	• 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, part is absorbed and part is transmitted • Describe some of the medical benefits and uses of ultrasound, e.g. safety, diagnosis, treatment, pregnancy			When an ultrasound wave travels inside an object comprising different materials such as the human body, each time it encounters a boundary, e.g. between bone and muscle, or muscle and fat, part of the wave is reflected and part of it is transmitted. The reflected rays are detected and used to construct an image of the object.
3.5 HOURS	**<u>Electromagnetic Radiation</u>**				
0.5 hour	Dual (particle/wave) nature of EM radiation	• 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			This is also known as the wave-particle duality.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Nature of EM radiation	• Describe the source of electromagnetic waves as an accelerating charge • Use words 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 $3x10^8$m/s, represented by c			Mention that unlike sound waves, EM waves do not need a medium to travel through.
1 hour	EM spectrum	• 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			Show learners a diagram with the different types of EM radiation. Make the link between EM radiation and everyday life

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• 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 ultra-violet radiation on skin • Discuss radiation from cell-phones			
1 hour	Nature of EM as particle - energy of a photon related to frequency and Wavelength	• Define a photon • Calculate the energy of a photon using $E = hf = \frac{hc}{\lambda}$ Where h = 6.63 x10^{-34} J.s is Planck's constant, c=3x10^{8} m.s^{-1} is the speed of light in a vacuum and λ is the wavelength			Inform learners that this will be further discussed when studying the photoelectric effect in grade 12
0.5 HOUR	**<u>Waves, legends and folklores</u>**				
0.5 hour	Detection of waves associated with natural disasters	Discuss qualitatively animal behavior related to natural disasters across at most two different cultural groups and within current scientific studies			Discuss legends and folklores about animal behaviour related to natural disasters using any one of the following: earthquakes, tsunamis or floods.
ASSESSMENT TERM 1	**<u>TERM 1: Prescribed Formal Assessment</u>** 1. Experiment (Chemistry): Heating and cooling curve of water. 2. Control Test				

TERM 2 GRADE 10

GRADE 10 CHEMISTRY *(MATTER AND MATERIALS)* TERM 2

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**<u>Particles substances are made of</u>**	Matter is described as anything that has mass and occupies space. All matter is made up of atoms. Atoms can combine to form compounds: molecular compounds (molecules) or ionic compounds (salts) or metals (copper or iron or …)			Describe matter from the concepts: atoms, elements, compounds, chemical reactions.
	Atoms and compounds. • Molecules (molecular substances) are due to covalent bonding. • Ionic substances are due to ionic bonding. (The EFFECT of the different types of chemical bonding are emphasized here.)	• Describe atoms as the 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 different atoms that are attracted to each other by relatively strong forces or bonds. The atoms are combined in definite proportions • 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 nonmetallic elements	**Experiment:** (1) Identify elements and compounds in chemical reactions. Elements and compounds are investigated by doing experiments (2) Determine the products of the electrolysis of water (sodium sulphate added). Identify the elements and the compounds **Demonstration:** (1) Demonstrate visual representations of atoms, molecules, elements and compounds. Use "Jelly Tots" and tooth picks or play dough to make visual presentations of atoms, molecules, compounds, elements, (2) Demonstrate chemical bonding. Use atomic model kits to demonstrate chemical bonding in elements and compounds Visual representations, preferably 3D, is important here to ensure conceptual understanding of the formation of the different types of compounds	**Materials:** (For exp.1) Cal-C-Vita tablets, water, glass beaker, candle, limewater, zinc metal and hydrochloric acid, blue copper (II) sulphate, test tubes and burner. <u>Class activity</u>: different groups can investigate different crystal shapes, building models for each shape and presenting or displaying it in the classroom. This could include covalent molecular and network structures	DON'T explain concepts from atoms to molecules, this leads to misconceptions! Both molecules and ionic substances are COMPOUNDS, respectively due to DIFFERENT chemical bonding! **Remember** these concepts are very abstract to learners. The more visual you can make the concepts, even by using models, the more logical the concepts will become to the learners. Description of molecules and ionic substances make it important to do this section after the concept of chemical bonding. The terms simple molecules and giant molecules are confusing (sugar being anything but a simple molecule if water is seen as a simple molecule!)

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• 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 nonmetallic elements (usually forming negative ions) • When metal atoms lose their outer electrons to form a lattice of regularly spaced positive ions and the outer electrons form a delocalized "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 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)			The terms **covalent molecular structures** and **covalent network structures** can be used instead.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 hours		• Covalent network structures consist of giant repeating lattices of covalently bonded atoms: diamond, graphite, SiO_2, some boron compounds • Give **examples of ionic substances** (solids, salts, ionic compounds) based on the above description e.g. • A sodium chloride crystal, potassium permanganate crystal, … • Give **examples of metals** based on the above description e.g. • a metal crystal like a piece of copper, or zinc, or iron, • Recognize molecules from models (space filling, ball and stick, …) • Draw diagrams to represent molecules using circles to represent atoms • Represent molecules using • Molecular formula for covalent molecular 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			.

GRADE 10 CHEMISTRY *(CHEMICAL CHANGE)* TERM 2					
Time	**Topics Grade 10**	**Content, Concepts & Skills**	**Practical Activities**	**Resource material**	**Guidelines for Teachers**
4 HOURS	**Physical and Chemical Change**	The properties of matter determine how matter interacts with energy.			A chemical change is a change that involves the transformation of one or more substances into one or more different substances.
3 hours	Separation of particles in physical change and chemical change.	• Define a physical change as a change that does not alter the chemical nature of the substance (no new chemical substances are formed) • Describe that the rearrangement of molecules occurs during **physical changes** e.g. - 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 • Define a chemical change as a change in which the chemical nature of the substances involved changes (new chemical substances are formed) • Describe examples of a **chemical change** that could include - the decomposition of hydrogen peroxide to form water and oxygen; and	**Practical Demonstration:** (1) Show macroscopically what happens when ice is heated in a glass beaker to liquid and further to gas (2) Show with small plastic pellets or marbles the arrangement of the particles in ice, in water and in water vapour (3) Separation reactions like distillation, filtration and paper-chromatography can be used to indicate physical change (4) Mix iron and sulphur and separate with a magnet (5) Heat iron and sulphur with a burner and test the new substance that formed to see whether the product is a new substance (result of a chemical reaction)	**Materials:** Burner, glass beaker, ice. Marbles of plastic pellets **Materials:** MnO_2, hydrogen peroxide, test tubes, gas delivery tube, stopper and water bowl. Zinc, hydrochloric acid and stopper for hydrogen combustion.	Explain the process of physical change by means of the kinetic molecular theory. The use of models to demonstrate is crucial in this section. This helps learners to 'see' into the submicroscopic world of matter. Explain the energy transformations carefully.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		- 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	**Practical experiments:** (1) Add H_2O_2 to manganese dioxide (catalyst) and collect the oxygen by the downwards displacement of water in the test tube. Is this a physical change or a chemical change? (Explain) (2) Use apparatus for hydrogen combustion to burn hydrogen in oxygen. Is this a physical change or a chemical change? (Explain)		
1 hour	Conservation of atoms and mass.	• Illustrate the **conservation of atoms** and **non-conservation of molecules** during chemical reactions using models of reactant molecules (coloured marbles stuck to each other with 'prestik' will suffice) • Draw diagrams representing molecules at a sub-microscopic level to show how particles rearrange in chemical reactions and atoms are conserved	**Recommended experiment for informal assessment** (1) Prove the law of Conservation of matter by (1) reacting lead(II) nitrate with sodium iodide, and (2) reacting sodium hydroxide with hydrochloric acid and (3) reacting Cal-C-Vita tablet with water	**Materials:** Test tubes, glass beaker, lead(II) nitrate, sodium iodide, sodium hydroxide, hydrochloric acid, bromothymol blue, 1 Cal-C-Vita tablet, a plastic bag, rubber band and mass meter.	Marbles and prestik or Jelly Tots and tooth picks can be used to indicate Conservation of Mass in chemical reaction equations. All schools may not have mass meters, but the experiment can still be done without the direct comparison of mass of reactants and products

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
	Law of constant composition	• State the law of constant proportions • Explain that **the ratio** in a particular compound **is fixed** as represented by its chemical formula	**Experiment:** (1) Investigate the ratio in which the following elements combine: $AgNO_3$ and NaCl; $Pb(NO_3)_2$ and NaI; and $FeCl_3$ and NaOH to form products	**Materials:** 10 Test tubes, glass beaker, 2 propettes, glass beaker, silver nitrate, sodium chloride, lead(II) nitrate, sodium iodide, iron(III) chloride, sodium hydroxide, mass meter.	A propette is a graduated medicine dropper with which to transfer liquids from one container to another.
4 HOURS	**<u>Representing chemical change</u>**	Balanced chemical equations represent chemical change and concur with the Law of Conservation of Matter. Balanced chemical equations are fundamentally important for understanding the quantitative basis of chemistry. Always start with a balanced chemical reaction equation before carrying out a quantitative study of the chemical reaction.			
4 hours	Balanced chemical equations	• 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 (coloured marbles stuck to each other with 'prestik' will suffice) and rearranging the 'atoms' to form the products while conserving atoms	**Experiment:** (1) Test the Law of Conservation of Matter. Amount of product is related to amount of reactant according to balanced equation (sodium hydrogen carbonate and dilute sulphuric acid). Conservation of matter	**Materials:** Glass beaker, propette, 2 test tubes, 2 propettes, water bowl, filter paper, measuring cylinder (10 ml), long gas delivery tube, stopper for gas production, syringe, sodium hydrogen carbonate, dilute sulphuric acid, mass meter.	Use chemical reactions that learners are familiar with like combustion reations, reactions of metals and non-metals with oxygen (sulphur, carbon, and magnesium with oxygen), reactions of acids (with metals, metal oxides, metal carbonates, metal hydroxides) and simple precipitation reations and redox reactions.
		- representing molecules at a sub-microscopic level using coloured circles and simply rearranging the pictures to form the product molecules while conserving atoms'. - by inspection using reaction equations • Interpret balanced reaction equations in terms of - conservation of atoms - conservation of mass (use relative atomic masses)			

GRADE 10 PHYSICS *(ELECTRICITY & MAGNETISM)* TERM 2

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 HOURS	**Magnetism**				
0.5 hour	Magnetic field of permanent magnets	• Explain that a magnetic field is a region in space where another magnet or ferromagnetic material will experience a force (non-contact) • Know that an electric field is a region in space where an electric charge will experience an electric force. Know that the gravitational field is a region in space where a mass will experience a gravitational force. Compare the magnetic field with the electric and gravitaional fields			Electrons moving inside any object have magnetic fields associated with them. In most materials these fields point in all directions, so the net field is zero. In some materials (ferromagnetic) there are domains, which are regions where these magnetic fields line up. In permanent magnets, many domains are lined up, so there is a net magnetic field.
1 hour	Poles of permanent magnets, attraction and repulsion, magnetic field lines.	• 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	**Recommended practical activity for informal assessment:** Determine the pattern and direction of the magnetic field around a bar magnet	**Materials:** Sheet of A4 paper, a bar magnet, iron filings **Materials:** Sheet of A4 paper, a bar magnet, several small compasses	Magnetic fields are different from gravitational and electric fields because they are not associated with a single particle like a mass or a charge. It is never possible to find just a north pole or just a south pole in nature i.e. a magnetic monopole does not exist. At the microscopic level, magnetic fields are a product of the movement of charges.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• 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			Field lines are a way of representing fields. The more closely spaced the field lines are at a point the greater the field at that point. Arrows drawn on the field lines indicate the direction of the field. A magnetic field points from the north to the south pole. Field lines never cross and can be drawn in all three dimensions. For simplicity, only two dimensions are usually shown in drawings
0.5 hour	Earth's magnetic field, compass	• Explain how a compass indicates the direction of a magnetic field • Compare the magnetic field of the 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 the Earth • Give examples of phenomena that are affected by Earth's magnetic field e.g. Aurora Borealis (Northern Lights), magnetic storms • Discuss qualitatively how the earth's magnetic field provides protection from solar winds			The geographic North and South Poles are the northernmost and southernmost points respectively of the Earth's axis of rotation.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 HOURS	**<u>Electrostatics</u>**				
0.5 hour	Two kinds of charge	• Know that all materials contain positive charges (protons) and negative charges (electrons) • Know that an object that has an equal number of electrons and protons is neutral (no net charge) • Know that positively charged objects are electron deficient and negatively charged objects have an excess of electrons • Describe how objects (insulators) can be charged by contact (or rubbing) - tribo-electric charging			It is reasonable to call the two types of charge “positive” and “negative” because when they are added the net charge is zero (i.e. neutral). Be sure that learners know that all objects contain both positive and negative charges, but we only say an object is charged when it has extra positive charges (electron deficient) or negative charges (excess of electrons).

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Charge conservation	• Know that the SI unit for electric charge is the coulomb • State the principle of conservation of charge as: *The net charge of an isolated system remains constant during any physical process*. e.g. two charges making contact and then separating. • Apply the principle of conservation of charge • Know that when two identical conducting objects having charges Q_1 and Q_2 on insulating stands touch, that each has the same final charge on seperation. final charge: after separation $Q = \frac{Q_1 + Q_2}{2}$, **NOTE:** This equation is only true of identically sized conductors on insulated stands			
1 hour	Charge quantization	• State the principle of charge quantization • Apply the principle of charge quantization			Every charge in the universe consists of integer multiples of the electron charge. $Q=nq_e$, where $q_e = 1.6 \times 10^{-19}$ C and n is an integer.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
0.5 hour	Force exerted by charges on each other (descriptive) Attraction between charged and uncharged objects (polarisation)	• Recall that like charges repel and opposite charges attract • Explain how charged objects can attract uncharged insulators because of the polarization of molecules inside insulators	**Practical Demonstration:** 1. Rub a balloon against dry hair to charge it. Bring the charged balloon, rubbed against dry hair, near a stream of smooth flowing water (laminar flow) 2. Demonstrate everyday examples of the effect of electrostatics	**Materials:** Balloon, plastic pen, small pieces of paper, stream of smooth flowing water	In materials that comprise polarised molecules, these molecules may rotate when brought near to a charged object, so that one side of the object is more positive and the other side more negative, even though the object as a whole remains neutral.
8 HOURS	**<u>Electric circuits</u>**				
1 hour	emf, Terminal Potential Difference (terminal pd)	• Define potential difference in terms of work done and charge. V = W/Q • 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 terminal potential difference (terminal pd). • Know that emf and pd are measured in volts (V) • Do calculations using V = W/Q	**Practical Demonstrations:** Demonstrate how to measure emf and terminal potential difference: Set up a circuit to measure the emf and terminal potential difference and get learners to try to account for the discrepancy	**Materials:** Light bulbs, resistors, batteries, switches, connecting leads, ammeters, voltmeters	If possible, give learners the opportunity to connect meters in circuits. If the meters have more than one scale, always connect to the largest scale first so that the meter will not be damaged by having to measure values that exceed its limits. Note that voltage and potential difference are synonmous

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Current	• 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)			The direction of current in a circuit is from the positive end of the battery, through the circuit and back to the negative end of the battery. In the past, this was called conventional current to distinguish it from electron flow. However, it is sufficient to call it the direction of the current and just mention that this is by convention. A very common misconception many learners have is that a battery produces the same amount of current no matter what is connected to it. While the emf produced by a battery is constant, the amount of current supplied depends on what is in the circuit.
1 hour	Measurement of voltage (pd) and current	• 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	**Practical Demonstrations:** Set up a circuit to measure the current flowing through a resistor or light bulb and also to measure the potential difference across a light bulb or resistor	**Materials:** Light bulbs, resistors, batteries, switches, connecting leads, ammeters, voltmeters	Make sure that learners know that the positive side of the meter needs to be connected closest to the positive side of the battery. An ammeter must be connected in series with the circuit element of interest; a voltmeter must be connected in parallel with the circuit element of interest.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Resistance	• 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. • State and explain factors that affect the resistance of a substance • Explain why a battery in a circuit goes flat eventually by referring to the energy transformations that take place in the battery and the resistors in a circuit			One of the important effects of a resistor is that it converts electrical energy into other forms of energy, such as heat and light. A battery goes flat when all its chemical potential energy has been converted into other forms of energy.
2 hours	Resistors in series	• Know that current is constant through each resistor in 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: $R_s = R_1 + R_2 + ...$	**Prescribed experiment:** (Part 1 and part 2) **Part 1** Set up a circuit to show that series circuits are voltage dividers, while current remains constant	**Materials:** Light bulbs, resistors, batteries, switches, connecting leads, ammeters, voltmeters	When resistors are connected in series, they act as obstacles to the flow of charge and so the current through the battery is reduced. The current in the battery is inversely proportional to the resistance.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 hours	Resistors in parallel	• 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: $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	**Prescribed experiment:** **Part 2** Set up a circuit to show that parallel circuits are current dividers, while potential difference remains constant,	**Materials:** Light bulbs, resistors, batteries, switches, connecting leads, ammeters, voltmeters	When resistors are connected in parallel, they open up additional pathways. The current through the battery therefore increases according to the number of branches.
		• Know that for <u>two resistors</u> connected in parallel, the total resistance can be calculated using: $R_p = \frac{product}{sum} = \frac{R_1 R_2}{R_1 + R_2}$			

ASSESSMENT TERM 2	**<u>TERM 2: Prescribed Formal Assessment</u>** 1. Experiment (Physics): Prescribed Physics experiments Part 1 and Part 2: Electric circuits with resistors in series and parallel measuring potential difference and current 2. Midyear Examinations

TERM 3 GRADE 10

GRADE 10 CHEMISTRY *(CHEMICAL CHANGE)* TERM 3

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**<u>Reactions in aqueous solution</u>**	Chemical reactions can be investigated and described through their stoichiometric, kinetic, equilibrium, and thermodynamic characteristics. Many reactions in chemistry and the reactions in living systems are carried out in aqueous solution. We shall study chemical reactions that occur in aqueous solutions where water is the solvent.			
2 hours	Ions in aqueous solution: their interaction and effects.	• 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)	**Practical work:** • Investigate different types of solutions (table salt in water, $KMnO_4$ in water, NaOH in water, KNO_3 in water) and write balanced equations for each • Investigate different types of reactions in aqueous medium and write balanced ionic equations for the different reaction types **Activity:** (1) Explain what is meant by ion exchange reactions and use an experiment to illustrate the concept of ion-exchange reactions	**Materials:**	**Note:** The chemistry of hard water can be used as an application of ions in aqueous solution. This topic can be investigated as a practical investigation: (not to be examined) • What is 'hard water'? Why is this a problem? Where in SA is hard water a problem and how is the problem addressed? (Explain the chemistry and how we deal with it). • What is acid rain - the chemistry and the impact on our lives/ the environment? (as application for ions in aqueous solution)
		• Define the process of hydration where ions become surrounded with water molecules in water solution (don't go into intermolecular forces; just use the polarity of the water molecule and the charge of the ions)			

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Electrolytes and extent of ionization as measured by conductivity	• Describe a simple circuit to measure conductivity of solutions • Relate conductivity to - the **concentration of ions** in 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	**Activity:** Find in literature the different definitions of chemical change and physical change. Discuss the definitions and come to a conclusion about the most correct definition **Experiment:** Determine the electrical conductivity and the physical or chemical change of the following solutions. Dissolve respectively 500 mg sugar, sodium chloride, calcium chloride and ammonium chloride in 1 ml water. Measure the temperature each time. What does this tell you about the reaction taking place? Evaporate the water afterwards. What does this tell you about the reaction?		A physical property can be measured and observed without changing the composition or identity of a substance. Water differs from ice only in appearance, not in composition, so going from ice to water to water vapour and back, is a physical change. A chemical property of a substance involves a chemical change where the products of the reaction have completely different chemical and physical characteristics than the reactants. The composition of the reactant and the product differ from each other.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours	Precipitation reactions.	• Write balanced reaction equations to describe precipitation of insoluble salts • Explain how to test for the presence of the following anions in solution: - Chloride - using silver nitrate and nitric acid - Bromide- using silver nitrate and nitric acid - Iodide -using silver nitrate and nitric acid - Sulphate - 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	**Experiment:** 1. Do some qualitative analysis tests of cations and anions (e.g. chlorides, bromides, iodides, sulphates, carbonates) 2. Prepare a salt (e.g. $CuCO_3$) from its soluble reagents		The emphasis should not be rote learning of the equations or tests, but how to write balanced equations accurately

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 hours	Other chemical reaction types. In water solution	• Ion exchange reactions - Precipitation reactions - Gas forming reaction - Acid-base reactions • and redox reactions which are an electron transfer reaction. (Use the charge of the atom as an indication of electron transfer, no redox reaction terminology is required here.) Use the charge of the atom to demonstrate how losing or gaining electrons affect the overall charge of an atom	**Recommended experiment for informal assessment** (1) Identify CHEMICAL REACTION TYPES experimentally: - precipitation - gas forming reactions - acid-base reactions - redox reactions (2) What is the driving force of each reaction type? (The formation of an insoluble salt; the formation of a gas; the transfer of protons; the transfer of electrons) (3) Identify each reaction type in a group of miscellaneous chemical reactions	**Materials:** Soluble salts to form precipitations, acids and bases, sodium carbonate and hydrochloric acid, silver nitrate and sodium bromide, sodium metal, manganese dioxide, burner, copper(II) sulphate and thin copper wire.	Include the basic reaction types here to make chemical reaction equations easier. for learners. This section is just an introduction and should be done superficially. Spend the time teaching concepts like ion formation well to lay the foundation for grade 11 work. Acids and bases, redox is done again in Grade 11 and further studies in Grade 12. Reaction types are done **to create awareness of the types** of reactions and to make it easier for learners to write balanced chemical equations. Ion-exchange reactions are reactions where the positive ions exchange their respective negative ions due to a driving force like the formation of an insoluble salt in precipitation reactions; the formation of a gas in gas-forming reactions; the transfer of protons in an acid-base reaction. The use of the terminology single displacement reactions and double displacement reactions leads to misconceptions with redox reactions where displacement reactions take place due to electron transfer. “Displacement reactions” in ion-exchange reactions and displacement in redox reactions differ due to no change in oxidation numbers of elements (in ion-exchange reactions) and change in oxidation numbers of elements (in displacement reactions in redox reactions).

GRADE 10 CHEMISTRY *(CHEMICAL CHANGE)* TERM 3

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**<u>Quantitative aspects of chemical change:</u>**	Learners should recognise that owing to the small size of the atoms, molecules and ions, properties of these species are often compared on a mole basis and that the Avogadro constant is a number which chemists commonly use in the comparison of physical and chemical properties. Stoichiometry is the study of quantitative composition of chemical substances and the qualitative changes that take place during chemical reactions.			
1 hour	Atomic mass and the MOLE CONCEPT;	• 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 • Conceptualize 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			Refer back to atomic mass earlier in grade 10 Do the mole concept thoroughly. <u>Note to the teacher</u>: The term atomic *mass* should be used and not atomic *weight*. Avogadro's number = 602 200 000 000 000 000 000 000 1 dozen = 12 eggs(e.g.) 1 gross = 144 eggs 1 million = 1000 000 eggs 1 mole = Avogadro's number = 6,022 x 10^{23} eggs Molar mass is the mass of one mole of any substance under discussion. Relative molecular mass is the mass of ONE MOLECULE (e.g. water H_2O) relative to the mass of carbon -12. Relative formula mass is the mass of ONE FORMULA UNIT (e.g. NaCl) of an ionic substance relative to the mass of carbon-12.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 hours	Molecular and formula masses;	• 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 crystallization** in salts like $AlCl_3.nH_2O$	**Experiment:** Do an experiment to remove the water of crystallization from copper(II) sulphate or cobalt(II) chloride and determine the number of moles of water removed from the crystals		Refer back to Dalton's reasoning in the history of atomic theory in grade 10
2 hours	Determining the composition of substances	• Determine **percent composition** of an element in a compound • Define and determine concentration as moles per volume	• Describe practical quantitative methods for determining chemical composition • Determine the percentage composition from the chemical formula of the substance	**Materials:** Glass beaker spatula, propette, water bowl, filter paper, mass meter, sodium hydrogen carbonate, dilute sulphuric acid. **Materials** Glass beaker, spatula, propette, burner, heating stand, mass meter, boiling stones, water, magnesium powder, vinegar.	
1 hour	Amount of substance (mole), molar volume of gases, concentration of solutions.	• 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 0^0C (273 K) and 1 atmosphere (101.3 kPa) • Calculate the molar concentration of a solution			Link to gas laws in grade 11. Express as SI units

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 hours	Basic stoichiometric calculations	• 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			Make sure learners understand the basic concepts and keep to the sstated content of the CAPS document.

GRADE 10 PHYSICS *(MECHANICS)* TERM 3

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 HOURS	**Vectors and scalars**				
4 hours	Introduction to vectors & scalars.	• List physical quantities for example time, mass, weight, force, charge etc. • Define a vector and a scalar quantity • Differentiate between vector and scalar quantities • Understand that $\vec{F}$ represents the force factor, whereas F represents the magnitude of the force factor • Graphical representation of vector quantities. • Properties of vectors like equality of vectors, negative vectors, addition and subtraction of vectors using the force vector as an example. N.B. This is to be done in one dimension only. • Define resultant vector • Find resultant vector graphically using the tail-to-head method as well as by calculation for a maximum of four force vectors **in one dimension only**			

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**<u>Motion in one dimension:</u>**				
3 hours	Reference frame, position, displacement and distance.	• 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 for one dimensional motion	**Practical Demonstration**: Use a long straight track, a curved track, a toy car and a meter rule to illustrate the concept of position, distance and displacement. Make cardboard arrows to represent vector quantities	**Materials:** Long track, toy car, meter rule, cardboard, scissors, prestik, tape	Restrict problems and contexts to 1D only. Use the symbol x (or y) for position and Δx (or Δy) for displacement to emphasise that displacement is a change in position. Use D for distance. Also restrict problem solving to 1D only i.e. do not do examples or problems involving circular motion.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
5 hours	Average speed, average velocity, acceleration	• 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.Use $\bar{v}$ as a symbol for average velocity • 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	**Experiment**: Measurement of velocity	**Materials:** Ticker timer and tape, power supply, trolley, inclined plane, retort stand, ruler. **Materials:** Ticker timer and tape, power supply, trolley, inclined plane, retort stand, ruler.	We are dealing only with motion that involves zero or constant acceleration. Do NOT include problems with changing acceleration. Mathematically velocity is defined as $v = \frac{\Delta x}{\Delta t}$ For uniformly accelerated motion in one dimension, average acceleration and instantaneous acceleration are one and the same and will be referred to as “acceleration” Note that the symbol separating compound units can be a multiplication dot or a full stop. Also $m.s^{-1}$, m/s and $m.s^{-1}$ will be accepted. Note: Deceleration is an English word that means that the object is slowing down, whilst ‘acceleration’ is a scientific term. Negative acceleration does not necessarily mean slowing down. eg if both the acceleration and the velocity of an object. are negative, then this object will be speeding up. However if the acceleration is negative and the velocity is positive then this object is slowing down.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**Instantaneous speed and velocity and the equations of motion.**				
2 hours	Instantaneous velocity, instantaneous speed,	• 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			Instantaneous velocity is the gradient (slope) of the tangent at a point on the x-t graph.
6 hours	Description of motion in words, diagrams, graphs and equations.	• Describe in words and distinguish between motion with uniform velocity and uniformly accelerated motion • Describe the motion of an object given its position *vs* time, velocity *vs* time and acceleration *vs* time graph • Determine the velocity of an object from the gradient of the position *vs* time graph • Know that the slope of a tangent to a position *vs*. time graph yields the instantaneous velocity at that particular time	**Recommended project for formal assessment** Acceleration: E.g. You could use the following example or any other topic on acceleration: Roll a trolley down an inclined plane with a ticker tape attached to it and use the data to plot a position vs. time graph. The following variations could be added to the investigation: i. Vary the angle of inclination and determine how the inclination impacts on the acceleration ii. Keep the angle fixed and use inclined planes made of different materials to determine how the different surfaces impact on the acceleration. One could also compare smooth and rough surface etc	**Materials:** Trolley, ticker tape apparatus, tape, ticker-timer, graph paper, ruler	The emphasis should be on concept formation and testing understanding. A description of the motion represented by a graph should include, where possible, an indication of whether the object is moving in the positive or negative direction, speeding up, slowing down, moving at a constant speed (uniform motion) or remaining at rest. The three graphs are very different representations of a motion. Learners need to reason both, from graphs to words and from words to graphs.

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Determine the acceleration of an object from the gradient of the velocity vs time graph • Determine the displacement of an object by finding the area under a velocity *vs* time graph • Use the kinematics equations to solve problems involving motion in one dimension (horizontal only) $v_f = v_i + a\Delta t$ $\Delta x = v_i\Delta t + \frac{1}{2}a(\Delta t)^2$ $v_f^2 = v_i^2 + 2a\Delta x$ $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ • Demonstrate an understanding of motion of a vehicle and safety issues, such as the relationship between speed and stopping distance			For example, reference to using area under a velocity time curve need not be difficult and examples can be made concrete if calculating displacement is confined to adding up squares (the area of a square represents displacement; a car traveling at 20 m s^{-1} for 3 s travels 60 m. - the addition of three squares of dimensions 20 m«s^{-1} by 1 s). Note: The following kinematic equations are also acceptable. $v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ $s = \left(\frac{v + u}{2}\right)t$ u = initial velocity v = final velocity a = acceleration s = displacement t = time interval Problem-solving strategies should be taught explicitly. Problem solutions should include a sketch of the physical situation, including an arrow to indicate which direction is chosen as positive. Physical understanding should be stressed together with mathematical manipulations

ASSESSMENT TERM 3	**<u>TERM 3: Prescribed Formal Assessment</u>** **1. Physics project OR Chemistry project** **2. Control test**

TERM 4 GRADE 10

GRADE 10 PHYSICS *(MECHANICS)* TERM 4

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**Energy:**				
1.5 hours	Gravitational potential Energy	• Define gravitational potential energy of an object as the energy it has because of its position in the gravitational field relative to some reference point • Determine the gravitational potential energy of an object using $E_P = mgh$			Fundamentally, there are only two kinds of energy viz. potential and kinetic (excluding rest mass energy). Inform learners that $g = 9{,}8 m \cdot s^{-2}$ and that this will be further studied in grade 11 and 12. This value is used to calculate gravitational potential energy
1.5 hours	Kinetic energy	• Define kinetic energy as the energy an object possess as a result of its motion • Determine the kinetic energy of an object using $E_K = \frac{1}{2}mv^2$			Introduce kinetic energy as the energy an object has because of its motion. The same notation used for kinetic and potential energy in Physics, will also be used for those concepts in Chemistry.
1 hour	Mechanical energy (E_M)	• Define mechanical energy as the sum of the gravitational potential and kinetic energy Use equation: $E_M = E_K + E_P$			

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 hours	Conservation of mechanical energy (in the absence of dissipative forces).	• State the law of the 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 viz. objects dropped or thrown vertically upwards, the motion of a pendulum bob, roller coasters and inclined plane problems Use equation: $E_{K1} + E_{P1} = E_{K2} + E_{P2}$	**Practical Demonstration:** Conversion of Energy (qualitative)	**Materials:** A length of plastic pipe approx 20mm diameter, a marble, masking tape, measuring tape.	In conservation of energy problems, the path taken by the object can be ignored. The only relevant quantities are the object's velocity and height above the reference point.

GRADE 10 CHEMISTRY *(CHEMICAL SYSTEMS)* TERM 4

Time	Topics Grade 10	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**The hydrosphere**	The hydrosphere consists of the earth's water. It is found as liquid water (both surface and underground), ice (polar ice, icebergs, and ice in frozen soil layers called permafrost), and water vapour in the atmosphere.			The focus of this section should not be the chemical equations or any rote learning, but should encourage application, interpretation, and environmental impact.
8 hours	Its composition and interaction with other global systems.	• Identify the hydrosphere and give an overview of its 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 • Explain how the building of dams affect the lives of the people and the ecology in the region	**Activity:** Study the ecology of the dams built to provide water for communities For this activity learners will have to rely on interviews with the people who have lived in the area under investigation for many years or rely on literature about their areas • Study the ecology of rivers in your area • Study the ecology of the dams built to provide water for communities Investigate how the building of dams has changed the ecology of rivers and the livelihood of people in the areas around them by applying the science you learnt this year **<u>Recommended experiment for informal assessment</u>** Test water samples for carbonates, chlorides, nitrates, nitrites, pH and look at water samples under the microscope **<u>Recommended project for formal assessment.</u>** The purification and quality of water	**Materials** Use TETRA-test strips to test for water (buy from pet shop for fish tanks). Silver nitrate, microscope or magnifying glass, filter paper and funnel.	The hydrosphere is not a global cycle. The emphasise should be on the CHEMISTRY of the hydrosphere. This topic can be given as a **project** to save teaching time.

ASSESSMENT TERM 4	**<u>TERM 4: Prescribed Formal Assessment</u>** **1. Final Examinations**

TERM 1 GRADE 11					
GRADE 11 PHYSICS *(MECHANICS)* TERM 1					
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
4HOURS	**Vectors in two dimensions**				
2 hours	Resultant of perpendicular vectors	• On a Cartesian plane, draw a sketch of the vectical (y-axis) and horizontal (x-axis) • Add co-linear vertical vectors and co-linear horizontal vectors to obtain the net vertical vector (R_y) and net horizontal vector (R_x) • Sketch R_x and R_y on a Cartesian plane • Sketch the resultant (R) using either the tail-to-head or tail-to-tail method. • Determine the magnitude of the resultant using the theorem of Pythagoras. • Find resultant vector graphically using the tail-to-head method as well as by calculation (by component method) for a maximum of four force vectors in both 1-Dimension and 2-Dimension • Understand what is a closed vector diagram • Determine the direction of the resultant using simple trigonometric ratios	**Recommended Informal Assessement** **Experiment** Determine the resultant of three non-linear force vectors	force board, assortment of weights (10g to 200g), gut or string, two pulleys	Use examples involving force and displacement vectors. Recall Theorem of Pythagoras
2 hours	Resolution of a vector into its horizontal and vertical components	• Draw a sketch of the vector on the Cartesian plane showing its magnitude and the angle (θ) between the vector and the x-axis • Use $R_x = R\cos(\theta)$ for the resultant x-component • Use $R_y = R\sin(\theta)$ for the resultant y-component			Use examples involving force and displacement vectors.

Time	Topics Grade 11	Contents, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
23 HOURS	**Newton's Laws and Application of Newton's Laws.**				
5 hours	Different kinds of forces: weight, normal force, frictional force, applied (push, pull), tension (strings or cables)	• Define normal force, N, as the force exerted by a surface on an object in contact with it • Know that the normal force acts perpendicular to the surface irrespective of whether the plane is horizontal or inclined • Define frictional force, *f*, as the force that opposes the motion of an object and acts parallel to the surface the object is in contact with • Distinguish between static and kinetic friction forces • Explain what is meant by the maximum static friction, f_s^{max} • Calculate the value of the maximum static frictional force for objects at rest on a horizontal and inclined planes using: $f_s^{\max} = \mu_s N$ • Know that static friction $f_s < \mu_s N$	**Recommended investigation for informal assessment** 1 Investigate the relationship between normal force and maximum static friction Investigate the effect of different surfaces on maximum static friction by keeping the object the same. and/or 2 Investigate the relationship between normal force and force of dynamic friction	**Materials:** Spring balance, several blocks (of the same material) of varying sizes with hooks attached on one end. Different textures; rough, smooth surfaces. Various surfaces at various angles of inclination etc.	The force of static friction can have a range of values from zero up to a maximum value, μ_s N. The force of dynamic friction on an object is constant for a given surface and equals μ_k N. Friction forces can be explained in terms of the interlocking of the irregularities in surfaces, which impedes motion. **Indigenous Knowledge Systems** First people to make fire did so using friction.
		• Calculate the value of the kinetic friction force for moving object on horizontal and inclined planes using: $f_k = \mu_k N$			

Time	Topics Grade 11	Contents, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours	Force diagrams, free body diagrams	• Know that a force diagram is a picture of the object(s) of interest with all the forces acting on it (them) drawn in as arrows • Know that in a free-body diagram, the object of interest is drawn as a dot and all the forces acting on it are drawn as arrows pointing away from the dot • Resolve two-dimensional forces (such as the weight of an object with respect to the inclined plane) into its parallel (x) and perpendicular (y) components • The resultant or net force in the x-direction is a vector sum of all the components in the x-direction • The resultant or net force in the y-direction is a vector sum of all the components in the y-direction			

Time	Topics Grade 11	Contents, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
11 hours	Newton's first, second and third laws.	• State Newton's first law: *An object continues in a state of rest or uniform (moving with constant) velocity unless it is acted upon by an unbalanced (net or resultant) force.* • Discuss why it is important to wear seatbelts using Newton's first law • State Newton's second law: *When a net force, F_{net}, is applied to an object of mass, m, it accelerates in the direction of the net force. The acceleration, a, is directly proportional to the net force and inversely proportional to the mass* $\vec{F}_{net} = m\vec{a}$ • Draw force diagrams for objects that are in equilibrium (at rest or moving with constant velocity) and accelerating (non-equilibrium) • Draw free body diagrams for objects that are in equilibrium (at rest or moving with constant velocity) and accelerating (non-equilibrium)	**<u>Prescribed experiment for formal assessment</u>** Investigate the relationship between force and acceleration (Verification of Newton's second law)	**Materials:** Trolleys, different masses, incline plane, rubber bands, meter rule, ticker tape apparatus, ticker timer and graph paper.	For objects that are in equilibrium (at rest or moving with constant velocity) all forces along the plane of the motion and the forces in the direction perpendicular to the plane of the motion must add up to zero. This is another context in which the idea of **superposition** can be applied. When an object accelerates, the equation F_{net}=ma must be applied separately in the x and y directions. If there is more than one object, a free body diagram must be drawn for each object and Newton 2 must be applied to each object separately. NOTE: Sum of forces perpendicular to the plane of the motion will always add up to zero.

Time	Topics Grade 11	Contents, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Apply Newton's laws to a variety of equilibrium and non-equilibrium problems including a single object moving on a horizontal/ inclined plane (frictionless and rough), vertical motion (lifts, rockets etc.) and also two-body systems such as two masses joined by a light (negligible mass) string • Understand apparent weight • State Newton's third law: *When object A exerts a force on object B, object B simultaneously exerts an oppositely directed force of equal magnitude on object A* • Identify action-reaction pairs e.g. donkey pulling a cart, a book on a table • List the properties of action-reaction pairs			

Time	Topics Grade 11	Contents, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 hours	Newton's Law of Universal Gravitation	• State Newton's Law of Universal Gravitation • Use the equation for Newton's Law of Universal Gravitation to calculate the force two masses exert on each other $F = G\frac{m_1 m_2}{d^2}$ • Describe weight as the gravitational force the Earth exerts on any object on or near its surface • Calculate the acceleration due to gravity on Earth using the equation : $g_{Earth} = G\frac{M_{Earth}}{d_{Earth}^2}$ *N.B. This formula can be used to calculate g on any planet using the appropriate planetary data* • Calculate weight using the expression W= mg, where g is the acceleration due to gravity. Near the earth the value is approximately 9.8 $m{\cdot}s^{-2}$ • Calculate the weight of an object on other planets with different values of gravitational acceleration • Distinguish between mass and weight. Know that the unit of weight is the newton (N) and that of mass is the kilogram (kg) • Understand weightlessness	**Experiment:** Verify the value for g	Ticker timer apparatus, ticker tape (preferably self - carbonating tape), stop watch You could include automated data logging apparatus as alternative materials	

GRADE 11 CHEMISTRY *(MATTER & MATERIALS)* TERM 1

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
6 HOURS	**<u>Atomic combinations: molecular structure</u>**	The type of chemical bond in a compound determines the physical and chemical properties of that compound. Through studying the structures of atoms, molecules and ions, and the bonding in elements and compounds, learners will acquire knowledge of some basic chemical principles. By learning the properties of metals, giant ionic substances, simple molecular substances and giant covalent substances, you can appreciate the interrelation between bonding, structures and properties of substances.			
2 hours	A chemical bond (is seen as the net electrostatic force two atoms sharing electrons exert on each other)	• Recall the role of models in science and describe the explanations of chemical bonding in this course as an application of a model • Deduce the number of valence electrons in an atom of an element • Represent atoms using Lewis diagrams • Explain, referring to diagrams showing electrostatic forces between protons and electrons, and in terms of energy considerations, why - two H atoms form an H_2 molecule, but - He does not form He_2 • Draw a Lewis diagram for the hydrogen molecule • Describe a covalent chemical bond as a shared pair of electrons	**Activity:** Draw Lewis structures of the elements and determine the number of bonds the element can make. **Activity:** (1) Describe the formation of the dative covalent (or co-ordinate covalent) bond by means of electron diagram using H_3O^+ and NH_4^+ as examples.	Use any suitable Teacher Support material that discusses the use of models in science, its benefits and short-comings	The role **of models in scie**nce is a very important issue, it must be handled very well. Bonding is introduced in grade 10. The atom, the arrangement of electrons into core and valence electrons. ********** **NB!!!** **Increased stability due to lower potential energy (and higher entropy) to be used as the main reason for bonding.** ********** The mainstay of Lewis diagrams is the “rule of two”, that is two electrons for a bond rather than the “octet” rule which only applies rigorously to the second period.

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Describe and apply simple rules to deduce bond formation, viz. - different atoms, each with an unpaired valence electron can share these electrons to form a chemical bond - different atoms with paired valence electrons called lone pairs of electrons, cannot share these four electrons and cannot form a chemical bond - different atoms, with unpaired valence electrons can share these electrons and form a chemical bond for each electron pair shared (multiple bond formation) - atoms with an incomplete complement of electrons in their valence shell can share a lone pair of electrons from another atom to form a **co-ordinate covalent or dative covalent bond** (e.g. NH_4^+, H_3O^+) Draw Lewis diagrams, given the formula and using electron configurations, for • simple molecules (e.g. F_2, H_2O, NH_3, HF, OF_2, HOCℓ) • molecules with multiple bonds e.g. (N_2, O_2 and HCN)			Start with a known molecule like water, H_2O, and start with the concepts of two H-atoms bond to one O-atom. This leads to the octet rule of electrons. This can again lead to the **Lewis electron pair presentati**on. The "two electrons" per bond is just as untrue as the "octet" rule. Both are just USEFUL MODELS to explain chemical bonding. The octet rule is only problematic if it is taught as an absolute. It is a useful rule of thumb for any but the 'd' block elements. Exceptions are for example BF_3. It is more useful than it is problematic if it is used as a general guideline rather than a rule Co-ordinate covalent or dative covalent bonds must NOT be done in detail, ONLY the definition and an example of the concept is required

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 hours	Molecular shape as predicted using the Valence Shell Electron Pair Repulsion (VSEPR) theory.	• State the major principles used in the VSEPR The five ideal molecular shapes according to the VSEPR model. (Ideal shapes are found when there are NO lone pairs on the central atom ONLY bond pairs.) A is always the central atom and X are the terminal atoms - linear shape AX_2 (e.g. CO_2 and $BeCl_2$) - trigonal planar shape AX_3 (e.g. BF_3) - tetrahedral shape AX_4 (e.g. CH_4) - trigonal bipyramidal shape AX_5 (e.g. PCl_5) - octahedral shape AX_6 (e.g. SF_6) Molecules with lone pairs on the central atom CANNOT have one of the ideal shapes e.g. water molecule • Deduce the shape of - molecules like CH_4, NH_3, H_2O, BeF_2 and BF_3 - molecules with more than four bonds like $PC\ell_5$ and SF_6, and - molecules with multiple bonds like CO_2 and SO_2 and C_2H_2 from their Lewis diagrams using VSEPR theory	**Activity:** (1) Build the five ideal molecular shapes with Atomic Model kits or with Jelly Tots and tooth picks (2) If you have a lone pair on the central atom, remove one of the tooth picks. The shape that remains represents the shape of the molecule (3) If you have two lone pairs on the central atom remove two tooth picks. What is the shape of the resulting structure? This structure represents the molecule (e.g. water)	**NOTE:** If you have a lone pair on the central atom ONE "leg" of the ideal shape disappears (represented by the lone pair) and that will be the shape of your molecule.	Determine what learners know about VSEPR and what do they need to know. <u>Definition</u> Valence shell electron pair repulsion (VSEPR) model: is a model for predicting the shapes of molecules in which structural electron pairs are arranged around each atom to maximize the angles between them. Structural electron pairs are bond pairs plus lone pairs. OR Valence shell electron pair repulsion (VSEPR) model: is a model for predicting the shapes of molecules in which the electron pairs from the outer shell of a reference atom are arranged around this atom so as to minimize the repulsion between them. <u>Note:</u> You only need Lewis diagrams of the molecule to be able to decide the shape of the molecules according to VSEPR. (Hybridization is NOT needed.)

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Electronegativity of atoms to explain the polarity of bonds.	• Explain the concepts - Electronegativity - Non-polar bond with examples, e.g. H-H - Polar bond with examples e.g. H-Cℓ • Show polarity of bonds using partial charges δ+ H - Cl δ- • Compare the polarity of chemical bonds using a table of electronegativities • With an electronegativity difference ΔEN > 2.1 electron transfer will take place and the bond would be ionic • With an electronegativity difference ΔEN > 1 the bond will be covalent and polar • With an electronegativity difference ΔEN < 1 the bond will be covalent and very weakly polar • With an electronegativity difference ΔEN = 0 the bond will be covalent and nonpolar • Show how polar bonds do not always lead to polar molecules	**Activity:** (1) Look at ideal molecular shapes (build with atomic model kits) with all the **end atoms the same** (look at electronegativity) and the bond polarity and molecular polarity (2) Look at ideal molecular shapes (build with atomic model kits) **with DIFFERENT end atoms** (look at electronegativity) and the bond polarity and molecular polarity		Link back to intermolecular forces. **NOTE:** The indications about electronegativety differences are given NOT as exact scientific knowledge but as a guideline for learners to work with in deciding polarity of a molecule. (For teachers: All bonds have covalent and ionic character.)

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Bond energy and length	• Give a definition of bond energy • Give a definition of bond length • Explain what is the relationship between bond energy and bond length • Explain the relationship between the strength of a bond between two chemically bonded atoms and - the length of the bond between them - the size of the bonded atoms - the number of bonds (single, double, triple) between the atoms			Link to potential energy diagram used to explain bonding above and point out the bond energy and bond length on the diagram. BEWARE!! That you don't elevate the Lewis presentations as physical truths in chemical bonding. There are NO PHYSICAL BONDS; the chemical bond just represents an area of high electron density and low potential energy.
10 HOURS	**<u>Intermolecular forces</u>**	In a liquid or a solid there must be forces between the molecules causing them to be attracted to one another, otherwise the molecules would move apart and become a gas. These forces are called intermolecular forces (forces between molecules).			Note: This section falls shortly after electronegativity and polarity have been discussed - this section therefore provides a great rationale for the importance of understanding these concepts

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
6 hours	Intermolecular and interatomic forces (chemical bonds). Physical state and density explained in terms of these forces. Particle kinetic energy and temperature.	• Name and explain the different intermolecular forces: (i) ion-dipole forces, (ii) ion-induced dipole forces and (iii) dipole-dipole forces (iv) dipole-induced dipole forces (v) induced dipole forces with hydrogen bonds a special case of dipole-dipole forces. The last three forces (involving dipoles) are also called Van der Waals forces • Explain hydrogen bonds (dipole-dipole) • Revise the concept of a <u>covalent molecule</u> • Describe the difference between intermolecular forces and interatomic forces - using a diagram of a group of small molecules; and in words • Represent a common substance, made of small molecules, like water, using diagrams of the molecules, to show microscopic representations of ice $H_2O(s)$, water liquid $H_2O(\ell)$ and water vapour $H_2O(g)$	**<u>Prescribed experiment</u>** **<u>for formal assessment</u>** (1) Investigate and explain intermolecular forces and the effects of intermolecular forces on evaporation, surface tension, solubility, boiling points, and capillarity **Activity:** (1) Read the labels of different machine oils and motor oils: 15W 40 multi grade SAE 30 mono grade What does the 15W40 stand for? What is the difference between mono grade and multi grade oil? (2) Look at the liquid level in a measuring cylinder (water, oil, mercury…). What do you observe about the meniscus? Explain **Activity:** (3) Consider copper and graphite and explain how heat conductivity works in both cases	**Materials:** **Evaporation** of ethanol, water, nail polish remover and methylated spirits. **Surface tension** of water, oil, glycerine, nail polish remover and methylated spirits **Solubility** of sodium chloride, iodine, potassium permanganate in water, ethanol and chloroform. **Boiling points** of water, oil, glycerine, nail polish remover and methylated spirits **Capillarity** of water, oil, glycerine, nail polish remover and methylated spirits <u>Viscosity</u> becomes quite tricky when predictions need to be made as intermolecular forces are not the only factor influencing viscosity.	This section primarily applies to small covalent molecules (for the purposes here a small molecule is a molecule which has a fixed molecular formula - a polymer is not a small molecule). In ionic compounds the ion-ion electrostatic attraction (400-4000 kJ mol^{-1}) is an order of magnitude greater than any of the intermolecular forces described below. The 3 most common types of intermolecular forces should be described in this section: **Hydrogen bonding** (10-40 kJ mol^{-1}) - hydrogen bonding occurs when hydrogen is bonded to an atom which has significantly greater electronegativity eg. Oxygen. The hydrogen bond is an electrostatic attraction between the partial negative charge on the electronegative atom and the partial positive charge on the hydrogen from a second molecule. (presuming that there are not two such groups on a single molecule) Example - water. **Dipole-dipole interaction** - (5-25 kJ mol^{-1} i.e. weaker than hydrogen bonding). This is the small electrostatic attraction which exists between two permanent dipoles.

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Illustrate the proposition that intermolecular forces increase with increasing molecular size with examples e.g. He, O_2, C_8H_{18} (petrol), $C_{23}H_{48}$(wax). (Only for van der Waals forces.) • Explain density of material in terms of the number of molecules in a unit volume, e.g. compare gases, liquids and solids • Explain the relationship between the strength of intermolecular forces and melting points and boiling points of substances composed of small molecules • Contrast the melting points of substances composed of small molecules with those of large molecules where bonds must be broken for substances to melt • Describe thermal expansion of a substance and how it is related to the motion of molecules in a substance composed of small molecules e.g. alcohol in a thermometer • Explain the differences between thermal conductivity in non-metals and metals			Example I-Cl. Iodine is less electronegative than chlorine and therefore iodine has a partial positive charge and chlorine a partial negative charge. I-Cl will have a higher boiling point than either I_2 or Cl_2 . **Induced dipole-induced forces (or dispersion forces or London forces)** -(0.05-40 kJ mol^{-1}) When two non-polar molecules approach each other this is slight distortion in the electron cloud of both molecules which results in a small attraction between the two molecules eg CH_4. The larger the molecule the greater the dispersion force. Dispersion forces are only significant in the absence of any other interaction. Also note that molecular size is only a significant factor in dispersion forces.

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 hours	The chemistry of water (Macroscopic properties of the three phases of water related to their sub-microscopic structure.)	• Describe the shape of the water molecule and its polar nature • Water's unique features are due to the hydrogen bonding in solid, liquid and gaseous water • Indicate the number of H_2O molecules in 1 litre of water • The hydrogen bonds require a lot of energy to break; therefore water can absorb a lot of energy before the water temperature rises • The hydrogen bonds formed by the water molecules enable water to absorb heat from the sun. The sea acts as reservoir of heat and is able to ensure the earth has a moderate climate • Explain that because of its polar nature and consequent hydrogen bonding that there are strong forces of attraction between water molecules that cause a high heat of vaporization, (water needs a lot of energy before it will evaporate) and an unusually higher than expected boiling point when compared to other hydrides • A decrease in density when the water freezes helps water moderate the temperature of the earth and its climate	**Activity:** (1) Build a water molecule with marbles and prestik or with Jelly Tots and tooth picks. Or with atomic model kits (2) Build models of ice, water and water vapour with atomic model kits. What does the structure of the different states of matter of water tell you? (3) Measure the boiling point and melting point of water and determine the heating curve and cooling curve of water **<u>Recommended experiment for informal assessment</u>** Investigate the physical properties of water (density, BP, MP, effectivity as solvent, …)	A very useful PHET simulation of the phase changes of water is available for those schools with access	Explain the extraordinary properties of water and the effects this have in nature. Fits in well after concepts of polarity and IMF. Use the water molecule to summarise bonding, polarity, link between physical properties and chemical properties, IMF, etc. The properties of water play an important role in the use of the following traditional apparatus: (a) Water bag on the outside of your car or camel. (b) Clay pots and carafes to keep food or water. (c) "Safe" or "cool room" to keep food cool and prevent decay. Explain how the properties of water influence the function of the apparatus.

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• The density of the ice is less than the density of the liquid and ice floats on water forming an insulating layer between water and the atmosphere keeping the water from freezing and preserving aquatic life (the only liquid which freezes from the top down)			
ASSESSMENT ***TERM 1***		**<u>TERM 1: Prescribed Formal Assessment</u>** **1. Investigate the relationship between force and acceleration (Verification of Newton's second law)** **2. Control Test**			

TERM 2 GRADE 11

GRADE 11 PHYSICS *(WAVES, SOUND & LIGHT)* TERM 2

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
10 HOURS	**<u>Geometrical optics:</u>**				
3 hours	Refraction	• Revision: explain reflection • Revision: State the law of reflection • Define the speed of light as being constant when passing through a given medium and having a maximum value of $c = 3 \times 10^8\ m \cdot s^{-1}$ in a vacuum. • Define refraction • Define refractive index as $n = \frac{c}{v}$ • Define optical density • Know that the refracted index is related to the optical density. • Explain that refraction is a change of wave speed in different media, while the frequency remains constant • Define Normal • Define angle of incidence • Define angle of refraction • Sketch ray diagrams to show the path of a light ray through different media	**Practical Demonstration or Experiment or Investigation**: Propagation of light from air into glass and back into air Propagation of light from one medium into other medium	**Materials:** Rectangular glass block, ray box, colour filters, glass blocks of other shapes, water, paper, pencil, ruler, protractor	Revise reflection from mirrors done in previous grades

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 hours	Snell's Law	• State the relationship between the angles of incidence and refraction and the refractive indices of the media when light passes from one medium into another (Snell's Law) $n_1 \sin\theta_1 = n_2 \sin\theta_2$ • Apply Snell's Law to problems involving light rays passing from one medium into another • Draw ray diagrams showing the path of light when it travels from a medium with higher refractive index to one of lower refractive index and vice versa	**Recommended project:** Verifying Snell's Laws and determine the refractive index of an unknown solid transparent material using Snell's law	**Materials:** Glass block, Ray box, 0-360^0 protractor, A4 paper **Materials:** Glass block, Ray box, 0-360^0 protractor, A4 paper, different solid transparent materials	It is useful to use analogies to explain why light waves bend inwards towards the normal when they slow down (pass into a medium with higher refractive index) or outwards when they speed up (pass into a medium with lower refractive index). One analogy is a lawnmower that moves from a patch of short grass to a patch of long grass. The tyre in the long grass will go slower than the one in the short grass, causing the path of the lawnmower to bend inwards.
3 hours	Critical angles and total internal reflection	• Explain the concept of critical angle • List the conditions required for total internal reflection • Use Snell's Law to calculate the critical angle at the surface between a given pair of media • Explain the use of optical fibers in endoscopes and telecommunications	**Recommended experiment for informal assessment:** Determine the critical angle of a rectangular glass (clear) block	**Materials:** Glass block, Ray box	

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 HOURS	**2D and 3D Wavefronts**				
3 hours	Diffraction	• Define a wavefront as an imaginary line that connects waves that are in phase (e.g. all at the crest of their cycle) • State Huygen's principle. • Define diffraction as the ability of a wave to spread out in wavefronts as they pass through a small aperture or around a sharp edge • Apply Huygen's principle to explain diffraction qualitatively. Light and dark areas can be described in terms of constructive and destructive interference of secondary wavelets • Sketch the diffraction pattern for a single slit • Understand that degree of diffraction $\propto \frac{\lambda}{w}$ where w = slit width • Understand that diffraction of light demonstrates the wave nature of light	**Experiment / Demonstration** Demonstrate diffraction using a single slit	**Materials:** Single slit (learner's can make this using a small plane mirror or using a small rectangular plane sheet of glass that is painted black on one side) Straight filament bulb, colour filters	It is very helpful to use water waves in a ripple tank to demonstrate diffraction.

GRADE 11 CHEMISTRY *(MATTER & MATERIALS)* TERM 2

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**<u>Ideal gases and thermal properties:</u>**	Students are expected to know the ideal gas equation, which describes the pressure, volume, and temperature relationship of gases. The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases.			
1 hour	Motion of particles; Kinetic theory of gases;	• Describe the motion of individual molecules i.e. - collisions with each other and the walls of the container - molecules in a sample of gas move at different speeds • Explain the idea of 'average speeds' in the context of molecules of a gas • Describe an ideal gas in terms of the motion of molecules • Explain how a real gas differs from an ideal gas • State the conditions under which a real gas approaches ideal gas behavior • Use kinetic theory to explain the gas laws			Integrate the teaching of this section into the treatment of the ideal gas laws that follows Link this section to KMT from grade 10

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
6 hours	Ideal gas law	• Describe the relationship between volume and pressure for a fixed amount of a gas at constant temperature (Boyle's Law) • Describe the relationship between volume and temperature for a fixed amount of a gas at constant pressure (Charles' Law) and • Describe the relationship between pressure and temperature for a fixed amount of a gas at constant volume (Gay Lussac) - practically using an example - by interpreting a typical table of results - using relevant graphs (introducing the Kelvin scale of temperature where appropriate) - using symbols ('$\propto$') and the words 'directly proportional' and 'inversely proportional' as applicable - writing a relevant equation • Combine the three gas laws into the ideal gas law, $PV = nRT$ • Use the gas laws to solve problems, $P_1V_1/T_1 = P_2V_2/T_2$	**Recommended experiment for informal assessment** (1) Verify Boyle's law **Experiment:** (2) Verify Charles' law (exp2)	**Materials:** Pressure gauge. 10 ml syringe, 3 cm silicone tubing to attach syringe to pressure gauge, water bowl. **Materials:** Burner, glass beaker, 10 ml syringe, stopper for syringe, thermometer (-10^0 - 100^0C), water bowl, ice.	This section is an excellent opportunity to show the relationship between macro and micro, e.g. explain the pressure volume relationship in terms of particle motions. It is an important section for illustrating and assessing understanding of investigative process, the relationship between theory and experiment, the importance of empirical data and mathematical modelling of relationships. Link to skills topic in grade 10

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Give the conditions under which the ideal gas law does not apply to a real gas and explain why • Convert Celsius to Kelvin for use in ideal gas law			
1 hour	Temperature and heating, pressure;	• Explain the temperature of a gas in terms of the average kinetic energy of the molecules of the gas • Explain the pressure exerted by a gas in terms of the collision of the molecules with the walls of the container			

GRADE 11 CHEMISTRY *(CHEMICAL CHANGE)* TERM 2

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
12 HOURS	**<u>Quantitative aspects of chemical change</u>**	The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.			**(Stoichiometry)**
3 hours	Molar volume of gases; concentration of solutions.	• 1 mole of gas occupies 22.4 dm^3 at 0^0C (273 K) and 1 atmosphere (101.3 kPa) • Interpret balanced reaction equations in terms of volume relationships for gases under the same conditions of temperature and pressure (volume of gases is directly proportional to the number of particles of the gases) • Calculate molar concentration of a solution	**Experiment:** (1) Make standard solutions of ordinary salts **Activity:** (2) Do titration calculations (3) Precipitation calculations: calculate the mass of the precipitate		Make a flow diagram of all the stoichiometry calculations. Link back to gas laws. Express as SI units
6 hours	More complex Stoichiometric calculations	• Perform stoichiometric calculations using balanced equations that may include limiting reagents • Do stoichiometric calculation to determine the percent yield of a chemical reaction • Do calculations to determine empirical formula and molecular formula of compounds (revise empirical formula calculations done in grade 10) • Determine the percent $CaCO_3$ in an impure sample of sea shells (purity or percent composition)	**<u>Recommended experiment for informal assessment</u>** (1) Determine the mass of PbO_2 prepared from a certain mass of $Pb(NO_3)_2$	**Materials:** Heating stand, watch glass, test tubes, spatula, propettes, glass beaker, burner, funnel, filter paper, measuring cylinder, stirring rod, lead(II) nitrate, water, sodium hydroxide, dilute nitric acid, mass meter, bleaching agent.	Use sub microscale representations to explain how stoichiometric ratios work. **Remember!** Mass meter experiments can also be done without mass meters!! Electronic pocket scale (0,1g to 500g).

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours	Volume relationships in gaseous reactions.	• Do stoichiometric calculations with explosions as reactions during which a great many molecules are produced in the gas phase so that there is a massive increase in volume e.g. ammonium nitrate in mining or petrol in a car cylinder. $2NH_4NO_3 \rightarrow 2N_2(g) + 4H_2O(g) + O_2(g)$ $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ Give the reactions and use it in stoichiometric calculations • Do as application the functioning of airbags. Sodium azide reaction: $2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$ Reaction must be given when used in calculations			The thermal decomposition of ammonium nitrate. $2NH_4NO_3 \rightarrow 2N_2(g) + 4H_2O(g) + O_2(g)$ Reaction must be given when used in calculations.

ASSESSMENT TERM 2	**TERM 2: Prescribed Formal Assessment** **1. Experiment (Chemistry): The effects of intermolecular forces.** **2. Midyear Examination**

TERM 3 GRADE 11

GRADE 11 PHYSICS *(ELECTRICITY & MAGNETISM)* TERM 3

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
6 HOURS	**Electrostatics**				
3 hours	Coulomb's Law	• State Coulomb's Law, which can be represented mathematically as $F = \frac{kQ_1Q_2}{r^2}$ • Solve problems using Coulomb's Law to calculate the force exerted on a charge by one or more charges in one dimension (1D) and two dimensions (2D).			Here is another context in which to apply superposition—the forces exerted on a charge due to several other charges can be superposed to find the net force acting on the charge. Get learners to draw free body diagrams showing the forces acting on the charges. Also link to N3- two charges exert forces of equal magnitude on one another in opposite directions. When substituting into the Coulomb's Law equation, it is not necessary to include the signs of the charges. Instead, select a positive direction. Then forces that tend to move the charge in this direction are added, while forces that act in the opposite direction are subtracted. Make a link with Grade 11 Mechanics, Newton's Law of Universal Gravitation i.e. Coulomb's Law is also an inverse square law. The two equations have the same form. They both represent the force exerted by particles (masses or charges) on each other that interact by means of a field.

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
					NOTE: Restrict 2D problems to three charges in a right angled formation and look at the net force acting on the charge positioned at the right angle.
3 hours	Electric field	• Describe an electric field as a region of space in which an electric charge experiences a force. The direction of the electric field at a point is the direction that a positive test charge (+1C) would move if placed at that point • Draw electric field lines for various configurations of charges • Define the magnitude of the electric field at a point as the force per unit charge E = F/q $\vec{E}$ and $\vec{F}$ are vectors			Discuss the fact that electric field lines, like magnetic field lines (see Grade 10), are a way of representing the electric field at a point. Arrows on the field lines indicate the direction of the field, i.e. the direction a positive test charge would move. Electric field lines therefore point away from positive charges and towards negative charges. Field lines are drawn closer together where the field is stronger. Also, the number of field lines passing through a surface is proportional to the charge enclosed by the surface.
		• Deduce that the force acting on a charge in an electric field is F = qE • Calculate the electric field at a point due to a number of point charges, using the equation $E = \frac{kQ}{r^2}$ to determine the contribution to the field due to each charge			The electric fields due to a number of charges can be superposed. As with Coulomb's Law calculations, do not substitute the sign of the charge into the equation for electric field. Instead, choose a positive direction, and then either add or subtract the contribution to the electric field due to each charge depending upon whether it points in the positive or negative direction, respectively.

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
6 HOURS	**<u>Electromagnetism</u>**				
3 hours	Magnetic field associated with current carrying wires	• Provide evidence for the existence of a magnetic field (B) near a current carrying wire • Use the Right Hand Rule to determine the magnetic field (B) associated with: (i) a straight current carrying wire, (ii) a current carrying loop (single) of wire and (iii) a solenoid • Draw the magnetic field lines around (i) a straight current carrying wire, (ii) a current carrying loop (single) of wire and (iii) a solenoid • Discuss qualitatively the environmental impact of overhead electrical cables	**Practical Demonstration:** Get learners to observe the magnetic field around a current carrying wire **Project:** Make an electromagnet	**Materials:** Power supply, wire, retort stand, cardboard, several compasses. Iron nail, thin insulated copper wire, two or more D-cell batteries, one pair of wire stripper, paper clips	A simple form of evidence for the existence of a magnetic field near a current carrying wire is that a compass needle placed near the wire will deflect.

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours	Faraday's Law.	• State Faraday's Law. • Use words and pictures to describe what happens when a bar magnet is pushed into or pulled out of a solenoid connected to a galvanometer • Use the Right Hand Rule to determine the direction of the induced current in a solenoid when the north or south pole of a magnet is inserted or pulled out • Know that for a loop of area A in the presence of a uniform magnetic field B, the magnetic flux (Ø) passing through the loop is defined as: Ø = BAcosθ, where θ is the angle between the magnetic field B and the normal to the loop of area A • Know that the induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux	**Practical Demonstration:** Faraday's law	**Materials:** Solenoid, bar magnet, galvanometer, connecting wires.	Stress that Faraday's Law relates induced emf to the rate of change of *flux*, which is the product of the magnetic field and the cross-sectional area the field lines pass through. When the north pole of a magnet is pushed into a solenoid the flux in the solenoid increases so the induced current will have an associated magnetic field pointing out of the solenoid (opposite to the magnet's field). When the north pole is pulled out, the flux decreases, so the induced current will have an associated magnetic field pointing into the solenoid (same direction as the magnet's field) to try to oppose the change. The directions of currents and associated magnetic fields can all be found using only the Right Hand Rule. When the fingers of the right hand are pointed in the direction of the current, the thumb points in the direction of the magnetic field. When the thumb is pointed in the direction of the magnetic field, the fingers point in the direction of the current.

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Calculate the induced emf and induced current for situations involving a changing magnetic field using the equation for Faraday's Law: $\varepsilon = -N\frac{\Delta\phi}{\Delta t}$ where ∅=BAcosθ is the magnetic flux			
8 HOURS	**<u>Electric circuits</u>**				
4 hours	Ohm's Law	• Determine the relationship between current, voltage and resistance at constant temperature using a simple circuit • State the difference between Ohmic and non-Ohmic conductors, and give an example of each • Solve problems using the mathematical expression of Ohm's Law, R=V/I, for series and parallel circuits	**Recommended experiment for informal assessment** Obtain current and voltage data for a resistor and light bulb and determine which one obeys Ohm's law.	**Materials:** Light bulb, resistor, connecting wires, ammeter and voltmeter	Maximum of four resistors

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 hours	Power, Energy	• Define power as the rate at which electrical energy is converted in an electric circuit and is measured in watts (W) • Know that electrical power dissipated in a device is equal to the product of the potential difference across the device and current flowing through it i.e. P=IV • Know that power can also be given by $P=I^2R$ or $P=V^2/R$ • Solve circuit problems involving the concept of power • Know that the electrical energy is given by E=Pt and is measured in joules (J) • Solve problems involving the concept of electrical energy • Know that the kilowatt hour (kWh) refers to the use of 1 kilowatt of electricity for 1 hour • Calculate the cost of electricity usage given the power specifications of the appliances used as well as the duration if the cost of 1 kWh is given	**Experiment/Demonstration:** Investigate the power dissipated in bulbs connected either in series or parallel or both series and parallel	**Materials:** Bulbs, batteries, conducting wires, crocodile clips, bulb-holders, battery holders, ammeters, voltmeters.	Get learners to estimate the cost saving by consuming less electricity by switching off devices. Maximum of four resistors **Note:** Textbooks use both kWh AND kWhr as abbreviations for kilowatt hour.

GRADE 11 CHEMISTRY *(CHEMICAL CHANGE)* TERM 3

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 HOURS	**Energy and chemical change:**	Energy is exchanged or transformed in all chemical reactions and physical changes of matter. Thermodynamics is the science of heat or energy flow in chemical reactions.			
2 hours	Energy changes in reactions related to bond energy changes;	• Explain the concept of enthalpy and its relationship to heat of reaction • Define exothermic and endothermic reactions • Identify that bond breaking requires energy (endothermic) and that bond formation releases energy (exothermic) • Classify (with reason) the following reactions as exothermic or endothermic: respiration; photosynthesis; combustion of fuels	**Recommended project for formal assessment** (1) Investigate endothermic reactions as for example ammonium nitrate and water, potassium nitrate and water and magnesium sulphate and water, **AND** (2) Investigate exothermic reactions as for example calcium chloride and water, dry copper(II) sulphate and water and lithium and water. (Identify and explain the applications of exothermic and endothermic reactions in everyday life and industry)	**Materials:** Glass beaker, thermometer, water bowl, test tubes, spatula, stirring rod, potassium nitrate, potassium bromide, magnesium sulphate, ammonium nitrate, ammonium hydroxide, barium chloride, citric acid, vinegar, sodium carbonate, sodium hydrogen carbonate, sodium thiosulphate, Cal-C-Vita tablets. **Materials:** Glass beaker, thermometer, water bowl, test tubes, spatula, potassium permanganate, copper(II) sulphate, lithium, magnesium ribbon, magnesium powder, dilute sulphuric acid, calcium chloride, glycerine	Link bond making and bond breaking to potential energy diagram used in bonding previously.
1 hour	Exothermic and endothermic reactions;	• State that $\Delta H > 0$ for endothermic reactions. • State that $\Delta H < 0$ for exothermic reactions • Draw free hand graphs of endothermic reactions and exothermic reactions (without activation energy)			

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Activation energy.	• Define activation energy • Explain a reaction process in terms of energy change and relate this change to bond breaking and formation and to "activated complex" • Draw free hand graphs of endothermic reactions and exothermic reactions (with activation energy)	**Experiment:** (1) Investigate the concept of activation energy by burning magnesium ribbon in air or oxygen and draw a rough energy graph of your results. (Graph of temperature against time)		
12 HOURS	**<u>Types of reaction:</u>**	Interactions between matter generate substances with new physical and chemical properties. Chemicals react in predictable ways and chemical reactions can be classified. Chemical reactions and their applications have significant implications for society and the environment.			

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
6 **hours**	Acid-base	• Use the acid-base theories of, Arrhenius and Bronsted and Lowry to define acids and bases • Define an acid as an H^+ donor and a base as an H^+ acceptor in reaction • Identify conjugate acid/base pairs • Define an ampholyte • List common acids (including hydrochloric acid, nitric acid, sulfuric acid and acetic acid) and common bases (including sodium carbonate, sodium hydrogen carbonate and sodium hydroxide) by name and formula	**Experiment:** (1) Titration (leave until grade 12 or do a simple qualitative titration here and a more practical applied and quantitative titration in grade 12) **<u>Recommended experiment for informal assessment</u>** (2) Discover your own effective natural acid base indicator by using coloured plants. Do experiments using natural indicators (Don't use only red cabbage; investigate with different coloured plants to find new indicators that might be useful and compare their usefulness as acid-base indicator)	**Materials:** 2x burettes or 2x Swift pipettes, silicone tubing, 2x 2 ml syringes, glass beaker, spatula, water bowl, funnel, test tubes, watch glass, volumetric flask, distilled water, 0,5 mol/dm^3 sodium hydroxide solution, phenolphthalein solution, oxalic acid.	Revise all the concepts on acids and bases done from grade 4 to grade 10. Don't do an in-depth study of acids and bases. Summarise all previous knowledge of acids and bases. Revise the macroscopic characteristics of acids and bases.
6 **hours**	Acid-base	• Write the overall equation for simple acid-metal hydroxide, acid- metal oxide and acid -metal carbonate reactions and relate these to what happens at the macroscopic and microscopic level • What is an indicator? Look for some natural indicators • Use acid-base reactions to produce and isolate salts e.g.Na_2SO_4; $CuSO_4$ and $CaCO_3$	(3) Prepare sodium chloride salt by using acid base reactions to produce and isolate salts (4) What is the purpose of using limestone by communities when building blair toilets (pit latrines)? (5) What is the purpose of using ash in the blair toilets by communities?		

ASSESSMENT TERM 3	**<u>TERM 3: Prescribed Formal Assessment</u>** **1. Physics project OR Chemistry project** **2. Control test**

TERM 4 GRADE 11

GRADE 11 CHEMISTRY *(CHEMICAL CHANGE)* TERM 4

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
5 hours	Redox reactions;	• Determine the oxidation number from a chemical formula and electronegativities • Identify a reduction - oxidation reaction and apply the correct terminology to describe all the processes • Describe oxidation reduction reactions as involving electron transfer • Describe oxidation - reduction reactions as always involving changes in oxidation number • Balance redox reaction equations by using oxidation numbers via the ion-electron method	**Recommended experiment for informal assessment** (1) Do redox reactions that include synthesis reactions, decomposition reactions and displacement reactions (for informal assessment do at least ONE synthesis, ONE decomposition and ONE displacement reaction) (2) Investigate the reducing action of hydrogen sulphide and the oxidizing action of potassium permanganate on various substances	**Material:** Depend on the choice of your reactions.	Link redox reactions to oxidation numbers. In this section, care must be taken to emphasise the relationship between the symbolic (chemical reaction equations) and the macroscopic (what you see with your eyes) and sub-microscopic (on molecular level) representations of the reactions.

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Oxidation number of atoms in molecules to explain their relative "richness" in electrons.	• Explain the meaning of 'oxidation number' • Assign oxidation numbers to atoms in various molecules like H_2O, CH_4, CO_2, H_2O_2, $HOC\ell$ by using oxidation number guidelines or rules • Use rules of oxidation to assign oxidation numbers to atoms in a variety of molecules and ions	**Definition of oxidation number:** The oxidation number of an element is a number assigned to each element in a compound in order to keep track of the electrons during a reaction The concept of oxidation states (also called oxidation numbers) provides a way to keep track of electrons in oxidation-reduction reactions, particularly redox reactions involving covalent substances Each atom in a molecule or ion is assigned an oxidation state to show how much it is oxidised or reduced. Two very useful rules about oxidation states are: (1) atoms in elements are in oxidation state zero, (2) in simple ions the oxidation state is the same as the charge on the ion		Give a short list of rules or guidelines for determining oxidation numbers. In determining oxidation numbers use simple compounds. Keep as muchas possible to cations and anions on the given tables in the appendix Forms a basis for electrochemistry in grade 12. Link this to grade 12.

GRADE 11 CHEMISTRY *(CHEMICAL SYSTEMS)* TERM 4

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**<u>Exploiting the lithosphere or earth's crust:</u>**	The lithosphere is the earth's crust and upper mantle. The crust contains non-renewable fossil fuels (created from ancient fossils that were buried and subjected to intense pressure and heat) and minerals, and renewable soil chemicals (nutrients) needed for plant life. **Choose ONE mining activity and develop the mining activity according to the statements given**			Choose only one mining activity The focus here should be the earth and its resources, sustainable energy, our responsibility towards future generations and not the chemistry or chemical reactions. Skills that should be addressed here are analysis, synthesis, giving own opinions, summarising, concluding, and others.
8 hours	Mining and mineral processing: The choices are the following: Gold, iron, phosphate, coal, diamond, copper, platinum, zinc, chrome, asbestos and manganese mining industries	• Give a brief history of humankind across the ages: - Linking their technology and the materials they have used to their tools and their weapons - Referring to evidence of these activities in South Africa - Describe the earth's crust as a source of the materials man uses - What is available? (the abundance of the elements on earth)	**Experiment:** (1) Investigate the process of corrosion of iron **Activity:** (2) Describe the methods for the extraction of metals from their ores, such as the physical method, heating alone and heating with carbon (3) Describe different forms of calcium carbonate in nature **Experiment:** (4) Investigate the actions of heat, water, and acids on calcium carbonate. **Experiment:** (5) Design and perform chemical tests for calcium carbonate	**Materials:** Glass beaker, water bowl, test tubes, spatula, burner, solid, litmus paper, electrodes (Al, Zn, Cu, Pb), sodium chloride, sodium hydroxide, calcium chloride, sodium carbonate, ammonium hydroxide, dilute sulphuric acid, magnesium ribbon or rod, 14 iron nails (25mm), 14 galvanised iron nails (25mm), cotton wool, Vaseline, paint, oil, water, mass meter, tin rod, steel wool.	Chemistry and its influence on society and the environment are important. Link to aspects of chemical reactions - oxidation, factors affecting rates of reactions etc.

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 hours		• Where is it found? (the uneven distribution of elements across the atmosphere, the hydrosphere, the biosphere and the lithosphere) • How is it found? (Seldom as elements, inevitably as minerals) • How are the precious materials recovered? (the need to mine and process the minerals and separating them from their surroundings and processing them to recover the metals or other precious material - use terms like resources, reserves, ore, ore body) • Describe the **recovery of gold** referring to - why it is worth mining? - the location of the major mining activity in South Africa?	**Experiment:** (6) How can we use Oxy-cleaners to produce oxygen? (7) How can we use Oxy-cleaners to get a metal from its ore **Discussion** (8) Participate in decision-making exercises or discussions on issues related to conservation of natural resources **Practical investigation:** Learner could investigate the mining industries not chosen by the teacher Gold; Coal; Copper; Iron; Zinc; Manganese; Chrome; Platinum and Pt group metals (PGM's); Diamonds OR **Practical investigation** Look at the periodic table again and research where all the elements come from and what they are used for with special reference to elements coming from the lithosphere		**Questions to be asked:** Why is this mining industry important in SA? Where do the mining activities take place? How is the mineral mined? E.g. mining method, major steps in the process, refining method. What is the mineral used for? What is the impact of the mining industry on SA, e.g. environment, economic impact, safety, etc?

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 hours		- the major steps in the process: deep level underground mining separation of the ore from other rock - the need to crush the ore bearing rock - separating the finely divided gold metal in the ore by dissolving in a sodium cyanide oxygen mixture (oxidation) - simple reaction equation - the recovery of the gold by precipitation (Zn) (reduction) - simple reaction equation (this method is outdated, mines use activated carbon) smelting • Discuss old mining methods and the impact on the environment of such methods e.g. Mapungubwe. • Give the major steps in the process of mining if you have chosen one of the other mining activities. • Descibe the environmental impact of (1) mining operations and (2) mineral recovery plants • Describe the consequences of the current large scale burning of fossil fuels; and why many scientists and climatologists are predicting global warming			Find out about Mapungubwe on the internet or libraries and from people who know about this place. Let learners discuss the issues about environment and mining possibilities in and around Mapungubwe. Find out weather there are old mines and activities that we know of today and compare the impact on the environment with the current mines.

ASSESSMENT	**<u>TERM 4: Prescribed Formal Assessment</u>**
TERM 4	**1. Final Examinations**

GRADE 12 SKILLS FOR PRACTICAL INVESTIGATIONS IN PHYSICS AND CHEMISTRY TERM 1

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 Hours	Skills needed for practical investigations (observation, precautions, data collection, data handling, tables, general types of graphs, analysis, writing conclusions, writing a hypothesis, identifying variables, for example independent, dependent and control variable.).	• Trace the historical development of a scientific principle or theory • Identify an answerable question and formulate a hypothesis to guide a scientific investigation • Design a simple experiment including appropriate controls • Perform and understand laboratory procedures directed at testing a hypothesis • Select appropriate tools and technology to collect precise and accurate quantitative data • Correctly read a thermometer, a balance, metric ruler, graduated cylinder, pipette, and burette • Record observations and data using the correct scientific units • Export data into the appropriate form of data presentation (e.g. equation, table, graph, or diagram) • Analyze information in a table, graph or diagram (e.g. compute the mean of a series of values or determine the slope of a line) • Determine the accuracy and the precision of experimental results • Analyze experimental results and identify possible sources of bias or experimental error • Recognize, analyze and evaluate alternative explanations for the same set of observations • Design a model based on the correct hypothesis that can be used for further investigation • Define qualitative analysis and give a practical example • Define quantitative analysis and give a practical example	**Activity:** (1) Analyse the components of a properly designed scientific investigation. (2) Choose an experiment and determine appropriate tools to gather precise and accurate data (3) Defend a conclusion based on scientific evidence (4) Determine why a conclusion is free from bias (5) Compare conclusions that offer different, but acceptable explanations for the same set of experimental data (6) Investigate methods of knowing used by people who are not necessarily scientists	Support material that develops these skills should be used	Historical development means the study of all the people that contributed towards for instance the concept of balanced equations or atomic theory. This section should be taught while the learners do an investigation themselves. The skills for practical investigations should also be discussed and practiced as a class at regular intervals throughout the year.

GRADE 12 PHYSICS *(MECHANICS)* TERM 1

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
13 HOURS	**<u>Momentum & Impulse</u>**				
2 hours	Momentum	• Define momentum • Calculate the momentum of a moving object using $p = mv$ • Describe the vector nature of momentum and illustrate with some simple examples • Draw vector diagrams to illustrate the relationship between the initial momentum, the final momentum and the change in momentum in each of the above cases			
2 hours	Newton's second law expressed in terms of momentum	• State Newton's second law in terms of momentum: *The net force acting on an object is equal to the rate of change of momentum* • Express Newton's second law in symbols: $F_{net} = \frac{\Delta p}{\Delta t}$ • Explain the relationship between net force and change in momentum for a variety of motions • Calculate the change in momentum when a resultant force acts on an object and its velocity increases in the direction of motion (e.g.2nd stage rocket engine fires), decreases (e.g. brakes are applied), reverses its direction of motion e.g. a soccer ball kicked back in the direction it came from			This is the general form of Newton's Second Law. The form $F_{net} = ma$ applies only to the special case when the mass is constant, and should be presented as such. Stress that the motion of an object, and therefore its momentum, only changes when a net (resultant) force is applied. Conversely, a net force causes an object's motion, and therefore its momentum, to change.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
5 hours	Conservation of momentum and Elastic and Inelastic collisions.	• Explain what is meant by a system (in physics) • Explain (when working with systems) what is meant by internal and external forces • Explain that an isolated system is one that has no net force (external) acting on it • State the law of conservation of momentum as: *The total linear momentum of an isolated system remains constant* (is conserved) • Distinguish between elastic and inelastic collisions • Know that kinetic energy is only conserved in an elastic collision • Apply the conservation of momentum to collisions of two objects moving in one dimension (along a straight line) with the aid of an appropriate sign convention	**Prescribed Experiment for formal assessment:** Verify the Conservation of Linear Momentum **Recommended demostration for informal assessment** Investigate the Conservation of momentum and energy using Newton's cradle (qualitative)	**Materials for prescribed experiment** Air-track with blower. Two trolleys, pulley, two photo-gates, two retort stands, dual timer, metre-stick, black card, set of equal weights OR Two spring-loaded trolleys, stop-watch, meter-stick, two barriers **Materials for informal assessment:** Newtons Cradle	A system is a small part of the universe that we are considering when solving a particular problem. Everything outside this system is called the environment.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 hours	Impulse	• Define impulse as the product of the net force and the contact time i.e. Impulse= $F_{net}\Delta t$ • Know that impulse is a vector quantity • Know that $F_{net}\Delta t$ is a change in momentum, i.e. $F_{net}\Delta t = \Delta p$. This relationship is referred to as the impulse-momentum theorem • Use the impulse-momentum theorem to calculate the force exerted, time for which the force is applied and change in momentum for a variety of situations involving the motion of an object in one dimension • Apply the concept of impulse to safety considerations in everyday life, e.g. airbags, seatbelts and arrestor beds			A very important application of impulse is improving safety and reducing injuries. In many cases, an object needs to be brought to rest from a certain initial velocity. This means there is a certain specified change in momentum. If the time during which the momentum changes can be increased then the force that must be applied will be less and so it will cause less damage. This is the principle behind arrestor beds for trucks, airbags, and bending your knees when you jump off a chair and land on the ground.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
5 HOURS	**Vertical projectile motion in one dimension (1D)**				
5 hours	Vertical projectile motion * (1D) represented in words, diagrams, equations and graphs * Near the surface of the Earth and in the absence of air friction	• Explain that projectiles fall freely with gravitational acceleration 'g' accelerate downwards with a constant acceleration irrespective of whether the projectile is moving upward or downward or is at maximum height • Know that projectiles take the same time to reach their greatest height from the point of upward launch as the time they take to fall back to the point of launch. This is known as time symmetry • Know that projectiles can have their motion described by a single set of equations for the upward and downward motion • Use equations of motion to determine the position, velocity and displacement of a projectile at any given time • Draw position vs. time (x vs. t), velocity vs. time (v vs. t) and acceleration vs. time (a vs. t) graphs for 1D projectile motion	**Recommended experiment for informal assessment:** Investigate the motion of a falling body Draw a graph of position vs. time and velocity vs. time for a free falling object **AND** Use the data to determine the acceleration due to gravity	**Materials:** Ticker tape apparatus, ticker-timer, mass, platform. You could include automated data logging apparatus as alternative materials	

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Give equations for position versus time and velocity versus time for the graphs of 1D projectile motion • Given x vs. t, v vs. t or a vs. t graphs determine position, displacement, velocity or acceleration at any time t. • Given x vs. t, v vs. t or a vs. t graphs describe the motion of the object e.g. graphs showing a ball, bouncing, thrown vertically upwards, thrown vertically downward, and so on			

GRADE 12 CHEMISTRY *(MATTER & MATERIALS)* TERM 1

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
12 HOURS	**<u>Organic molecules:</u>**	• Define organic molecules as molecules containing carbon atoms. • Describe carbon as the basic building block of organic compounds that recycles through the earth's air, water, soil, and living organisms including human beings.			NO mechanisms of reactions required ONLY reaction equations.
3 hours	Organic molecular structures - functional groups, saturated and unsaturated structures, isomers;	• Discuss the special properties of carbon that makes it possible to form a variety of bonds • Give, condensed structural, structural and molecular formulae for alkanes and compounds containing the following functional groups: double carbon-carbon bonds, triple carbon-carbon bonds, alkyl halides, alcohols, carboxylic acids, esters, aldehydes, and ketones (up to 8 carbon atoms) • Explain the terms functional group, hydrocarbon and homologous series • Explain the terms saturated, unsaturated and isomer • Identify compounds that are saturated, unsaturated and are isomers (up to 8 carbon atoms)	**<u>Recommended experiment for informal assessment</u>** (1) Use the reactions of alkanes and alkenes with bromine water and potassium permanganate to indicate saturated and unsaturated molecules (2) Prepare alkynes and investigate the reactions with bromine water and potassium permanganate **Other Experiments** (3) Compare physical properties of the following compounds: propane, butane, pentane, ethanol, propan-1-ol and butan-1-ol. (Use for identifying physical properties: melting point, boiling point, vapour pressure) (4) Search and present information on the principles and applications of the alcohol breathalyser. (optional application)	Visual aids that can be sourced: simulations and animations of organic molecules and organic reactions **Materials:**	A few core experiments are identified to illustrated specific concepts and the variety of further experiments are available if teachers want to use it. Links to Gr 11 multiple bonds Emphasis should be placed on different representations of organic compounds: macroscopic, sub-microscopic and symbolic representation and the links between them Also illustrate their 3D orientation using models to build them (marbles and prestik or jelly tots and toothpicks), Show reactions taking place with the models Explain the physical properties with the models Molecular formula = $C_5H_{12}O_1$ Structural formula = where ALL the bonds are shown. Condensed structural formula = where SOME of the bonds are shown $CH_3CH_2CH_2CH_2CH_2OH$.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours		• Isomers are restricted to structural isomers: (1) chain isomers (different chain); (2) positional isomers (different position of the same functional group) and (3) functional isomers (different functional group). Remember ALL possible isomers have the SAME molecular formula			
	IUPAC naming and formulae,	• Give the IUPAC name when given the formula • Give the formula when given the IUPAC name • Naming is restricted to compounds with the functional groups alkanes, alkenes, alkynes, alkyl halides, aldehydes, ketones, alcohols, carboxylic acids and esters, up to a maximum of 8 carbon atoms in the parent chain (i.e. the longest chain) • Organic compounds are restricted to one type of functional group per compound and to a maximum of two functional groups of the same type per compound	Practical investigation or experiment into the physical properties of organic molecules **Activity:** (1) Drawing structural formulae and writing systematic names for alkanes, alkenes, alcohols and carboxylic acids (2) Building molecular models of simple alkanes, alkenes, alcohols and carboxylic acids (use atomic model kits) (3) Building molecular models of compounds with different functional groups. (4) Building molecular models of but-2-enes (5) Building molecular models of butan-2-ol or propanoic acid		Link to Intermolecular forces in grade 11 Cycloalkanes, cycloalkenes and dienes are allowed under the same rules that apply to all the other organic molecules. Number longest chain beginning at the end nearest to the functional group with the alkyl substituents on the lowest numbered carbon atoms of the longest chain. Arrange substituents in alphabetical order in the name of the compound. Indicate the number of the carbon atom on which the substituent appears in the compound.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours		• The only substituent chains that are allowed in naming and reactions are: methyl- and ethyl- groups • A maximum of THREE substituent chains (alkyl substituents) are allowed on the parent chain	Practical investigation or		Teach learners the meaning of primary, secondary and tertiary alcohols. For esters there can be 8 carbons in the alkyl group (from the alcohol) and 8 carbons in the carboxylic group (from the carboxylic acid). Both sides of the ester must be unbranched.
1 hour	Structure physical property relationships;	• Recognize and apply to given examples the relationship between: - physical properties and intermolecular forces (ethanol, dimethyl ether, ethanoic acid, ethane, chloro-ethane) - physical properties and number and type of functional groups (ethanol, dimethyl ether, ethanoic acid, ethane, chloro-ethane) - physical properties and chain length (methane, ethane, propane, butane, hexane, octane) - physical properties and branched chains (pentane, 2-methylbutane; 2,2-dimethylpropane)			The physical properties to be considered are melting point, boiling point, and vapour pressure, physical state, density, molecular shape, flammability and smell. The IMF to be considered are hydrogen bonds and Van der Waals forces.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Applications of organic chemistry	• Alkanes are our most important (fossil) fuels. The combustion of alkanes (oxidation) is highly exothermic and carbon dioxide and water are produced: alkane + $O_2 \rightarrow H_2O + CO_2$ with $\Delta H<0$ • An ester is a product of an acid catalyzed condensation between an alcohol and a carboxylic acid • Identify the alcohol and carboxylic acid used to prepare a given ester and vice versa, and write an equation to present this preparation	**Prescribed experiment for formal assessment** (1) Prepare diiferent Esters and identify the Esters by smell	**Material:** Test tubes, water bowl, glass beaker, burner, test tube holder, propette, spatula, methanol, ethanol, pentanol, acetic acid, salicylic acid, concentrated sulphuric acid etc.	Use safety data to learn the properties of organic compounds.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours	Substitution, addition and elimination. (ONLY alkanes, alkenes, alkynes, alcohols, halo-alkanes, carboxylic acids, and esters)	Describe criteria to use to **classify** elimination, substitution or addition reactions according to structural change • **Addition reactions:** Unsaturated compounds (alkenes, cycloalkenes) undergo addition reactions: - Hydrohalogenation: Addition of HX to an alkene e.g. $CH_2 = CH_2 + HC\ell \rightarrow CH_3 - CH_2C\ell$ Reaction conditions: HX (X = Cℓ, Br, I) added to alkene; no water must be present (During addition of HX to unsaturated hydrocarbons, the H atom attaches to the C atom already having the greater number of H atoms. The X atom attaches to the more substituted C atom) - Halogenation: Addition of X_2 (X = Cℓ, Br) to alkenes e.g. $CH_2 = CH_2 + C\ell_2 \rightarrow CH_2C\ell\text{-}CH_2C\ell$ Reaction conditions: X_2 (X = Cℓ, Br) added to alkene	**Experiment:** • Prepare ethanol from ethene • Demonstrate the hydrogenation of vegetable oils to form margarine		Recall some organic compounds that are produced by people in their homes e.g. alcohol from sorghum beer or grapes or malt or rice. Why does over fermentation lead to acid formation? How is sour porridge made? What are the reactants and what are the products? Unsaturated compounds undergo addition reactions to form saturated compounds e.g. $CH_2{=}CH_2 + C\ell_2 \rightarrow CH_2C\ell\text{-}CH_2C\ell$

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours		- Hydration: Addition of H_2O to alkenes e.g. $CH_2 = CH_2 + H_2O \rightarrow CH_3 - CH_2OH$ Reaction conditions: H_2O in excess and a small amount of HX or other strong acid (H_3PO_4) as catalyst (During addition of H_2O to unsaturated hydrocarbons, the H atom attaches to the C atom already having the greater number of H atoms. The OH group attaches to the more substituted C-atom) - Hydrogenation: Addition of H_2 to alkenes e.g. $CH_2 = CH_2 + H_2 \rightarrow CH_3 - CH_3$ Reaction conditions: alkene dissolved in a non polar solvent with the catalyst (Pt, Pd or Ni) in a H_2 atmosphere			

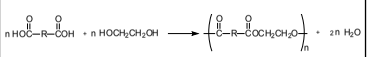
Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours		• **Elimination reactions:** Saturated compounds (haloalkanes, alcohols, alkanes) undergo elimination reactions - Dehydrohalogenation: Elimination of HX from a haloalkane e.g. $CH_2C\ell\text{-}CH_2C\ell \rightarrow CH_2 = CHC\ell + HC\ell$ Reaction conditions: heat under reflux (vapours condense and return to reaction vessel during heating) in a concentrated solution of NaOH or KOH in pure ethanol as the solvent i.e. hot ethanolic NaOH/KOH (If more than one elimination product is possible, the major product is the one where the H atom is removed from the C atom with the least number of H atoms)	Saturated compounds undergo elimination reactions to form unsaturated compounds e.g. $CH_2C\ell\text{-}CH_2C\ell \rightarrow CH_2{=}CHC\ell + HC\ell$		

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours		- Dehydration of alcohols: Elimination of H_2O from an alcohol e.g. $CH_3 - CH_2OH \rightarrow CH_2 = CH_2 + H_2O$ Reaction conditions: Acid catalyzed dehydration - heating of alcohol with an excess of concentrated H_2SO_4 (or H_3PO_4) (If more than one elimination product is possible, the major product is the one where the H atom is removed from the C atom with the least number of H atoms) • Cracking of hydrocarbons: Breaking up large hydrocarbon molecules into smaller and more useful bits Reaction conditions: high pressures and temperatures without a catalyst (thermal cracking), or lower temperatures and pressures in the presence of a catalyst (catalytic cracking)			

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• **Substitution reactions:** - Interconversion between alcohols and haloalkanes: Reactions of HX (X = Cℓ , Br) with alcohols to produce haloalkanes: Reaction conditions: - Tertiary alcohols are converted into haloalkanes using HBr or HCℓ at room temperature e.g. $C(CH_3)_3OH + HBr \rightarrow C(CH_3)_3Br + H_2O$ - The reaction works best with tertiary alcohols. Primary and secondary alchohols react slowly and at high temperatures. *Reactions of bases with haloalkanes (Hydrolysis) to produce alcohols e.g.* $C(CH_3)_3X + KOH \rightarrow C(CH_3)_3OH + KBr$ Reaction conditions: Haloalkane dissolved in ethanol before treatment with aqueous sodium hydroxide and warming th mixture; the same hydrolysis reation occurs more slowly without alkali, i.e. H_2O added to the haloalkane dissolved in ethanol. (Strong based will cause elimination)	Two types of saturated structure can be inter-converted by substitution e.g. • $C(CH_3)_3OH + HBr \rightarrow C(CH_3)_3Br + H_2O$ • $C(CH_3)_3Br + KOH \rightarrow C(CH_3)_3OH + KBr$ • Write equations for simple substitution reactions e.g. Organic reactions: • $CH_4 + C\ell_2 \rightarrow CH_3C\ell + HC\ell$ • $CH_3C\ell + H_2O \rightarrow CH_3OH + HC\ell$		Distinguish between primary, secondary and tertiary carbons. A primary carbon is a carbon atom bonded to ONE other carbon atom. A secondary carbon is a carbon atom bonded to TWO other carbon atoms. A tertiary carbon is a carbon atom bonded to THREE other carbon atoms. For example: $CH_3CH_2CH_3$ carbon 1 and 3 are primary carbons because they are only bonded to one other carbon atom. Carbon 2 is a secondary carbon because it is bonded to two other carbon atoms. In $C(CH_3)_3X$ the central carbon in this compound is a tertiary carbon because it is bonded to three other carbons. A primary alcohol is –OH bonded to a primary carbon ($CH_3CH_2CH_2OH$). A secondary alcohol is a –OH bonded to a secondary carbon ($CH_3CH(OH)CH_3$) and a tertiary alcohol is –OH bonded to a tertiary carbon ($C(CH_3)_3OH$).

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		Reactions of bases with haloalkanes (hydrolysis) to produce alcohols e.g. $C(CH_3)_3X + KOH \rightarrow C(CH_3)_3OH + KBr$ Reaction conditions: Haloalkane dissolved in ethanol before treatment with aqueous sodium hydroxide and warming of the mixture; the same hydrolysis reaction occurs more slowly without alkali, i.e. H_2O added to the haloalkane dissolved in ethanol - Haloalkanes from alkanes. Reaction conditions: X_2 (X = Br, Cℓ) added to alkane in the presence of light or heat	**Experiment:** (1) Alkanes and alkenes react with bromine and potassium permanganate (substitution and addition) Only the reaction of alkenes with **potassium permanganate** in *alkaline solution* should be added as an activity. This will result in the formation of the diol and would be an addition reaction	**Matertials:** Propettes, test tubes, solid stoppers, spatula, hexane, hexene, bromine water, spatula, potassium permanganate, dilute hydrochloric acid, chloroform.	Link to reactions used in industry: Substitution, addition and elimination. SASOL - polymers Include ONLY these three reaction types, and not further specifying reactions
		• Describe **addition reactions** that are important in industry e.g. addition polymerization reactions to produce polyethylene, polypropylene, and PVC			

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 hours	Plastics and polymers (ONLY BASIC POLYMERISATION as application for organic chemistry)	• Describe the term polymer; macromolecule, chain, monomer, functional groups • Illustrate the reaction to produce a polymer by an addition reaction using the polymerization of ONLY ethene to produce polythene [$nCH_2=CH_2 \rightarrow (-CH_2-CH_2-)_n$] • What is the industrial use of polythene? (Make squeeze bottles, plastic bags, films, toys and molded objects, electric insulation. Polythene has the recycling number 4) • Illustrate the reaction to produce a polymer by condensation reaction with the reaction to produce a polyester. Use ONLY the reaction to make the polymer polyethylene	**Experiment** (1) Plastics physical properties and recycling numbers (2) Performing an experiment to prepare an addition polymer **Activities:** (1) Searching for information or reading articles about the discovery of polyethene and the development of addition polymers (2) Building physical or computer models of addition polymers (3) Searching for and presenting information on environmental issues related to the use of plastics (4) Conducting a survey to investigate the quantities and types of solid waste generated at home or school and suggesting methods to reduce these wastes		Make learners aware materials made from polymers. What do you know about Kevlar and Mylar? What are the functions of these materials and what are they used for? Who discovered or invented the materials? Investigate what some windscreens are made of? What are break pads made of? Discuss the different polymers that are used instead of glass. Another example is the following Illustrate the reaction to produce a polymer by condensation reaction with the reaction to produce a polyester.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		Illustrate the reaction to produce a polymer by condensation reaction with the reaction to produce a polyester. Polylactic acid (PLA) is an interesting polymer because the monomer used for this polymer comes from the biological fermentation of plant materials (as opposed to monomers coming from petroleum) and the polymer is biodegradable. This polymer (PLA) is mostly used for packaging material and because it is biodegradable it has the potential to alleviate land-fill disposal problems  • Identify the monomer used to produce a polymer from the structural formula of a section of a chain. Use only the following polymers to identify monomers: Polyvinyl chloride (PVC); polystyrene; polythene, and polyvinyl acetate (PVA). (Limited to identification of monomers) • Identify a polymer as the product of an addition or condensation polymerization reaction, from its structural formula (use only polythene and Polylactic acid)			

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Identify a polymer as the product of an addition or condensation polymerization reaction, from its structural formula	**Experiments** (1) Polymerization - silicone rubber from sodium silicate and ethyl alcohol (2) Polymerization - polymeric sulphur i.e. plastic sulphur **Recommended experiment for informal assessment** (3) Cross-linking polymers - polyvinyl alcohol and sodium borate to make "slime" (4) Cross-linking polymers - white wood glue and borax to make "silly putty"	**Materials:** PVA and sodium borate White wood glue (Alcolin, or Red Devil) and Borax powder, food colouring, empty yogurt containers, glass beaker, stirring rod.	

ASSESSMENT TERM 1	**TERM 1: Prescribed Formal Assessment** **1. Experiment (Chemistry): Preparation of esters** **2. Control Test**

TERM 2: GRADE 12

GRADE 12 PHYSICS *(MECHANICS)* TERM 2

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
10 HOURS	**Work, Energy & Power**				
2 hours	Definition of Work	• Define the work done on an object by a force as: $W=F\Delta x\cos\theta$. • Know that work is a scalar quantity and is measured in joules (J) • Calculate the net work done on an object by applying the definition of work to each force acting on the object while it is being displaced, and then adding up (scalar) each contribution • Positive net work done on a system will increase the energy of the system and negative net work done on the system will decrease the energy of the system **ALTERNATE METHOD FOR DETERMINING** **THE NET WORK.** 1. Draw a force diagram showing only forces that act along the plane. Ignore perpendicular forces			Stress the difference between the everyday use of the word "work" and the physics use. Only the component of the applied force that is parallel to the motion does work on an object. So, for example, a person holding up a heavy book does no work on the book. Forces perpendicular to the objects displacement do no work on the object, since $\theta=90^{o}$ ($\cos\theta=0$) Forces parallel to the objects displacement do positive work on the object, since $\theta=0^{o}$ ($\cos\theta=1$) Forces anti-parallel to the objects displacement (eg friction) do negative work on the object, since $\theta=180^{o}$ ($\cos\theta=-1$)

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		2. Calculate the resultant force (along the plane) 3. Calculate the net work done on an object by taking the product of the resultant force (along the plane) acting on the object and its displacement along the plane			
2 hours	Work -Energy Theorem	• Know that the net work done on an object causes a change in the object's kinetic energy - the *work-energy theorem* - $W_{net} = E_{kf} - E_{ki}$ • Apply the work-energy theorem to objects on horizontal and inclined planes (frictionless and rough)			NOTE: a contact force only does work on an object if it stays in contact with the object. For example, a person pushing a trolley does work on the trolley, but the road does no work on the tyres of a car if they turn without slipping (the force is not applied over any distance because a different piece of tyre touches the road every instant).

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours	Conservation of energy with non-conservative forces present.	• Define conservative forces and give an example • Define non-conservative forces and give examples • Know that when only conservative forces are present, mechanical energy is conserved • Know that when non-conservative forces are present mechanical energy (sum of kinetic and potential) is not conserved, but total energy (of the system) is still conserved • Solve conservation of energy problems (with dissipative forces present) using the equation: $W_{nc} = \Delta E_k + \Delta E_p$ • Use the above relationship to show that in the absence of non-conservative forces, mechanical energy is conserved			A force is a conservative force if the net work done the force in moving an abject around a closed path, starting and ending at the same point is zero. Gravitational force is an example of a conservative force. Examples of non-conservative forces include air resistance, friction, tension and applied forces. W_{nc} represents the work done by the non-conservative forces

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
3 hours	Power	• Define power as the rate at which work is done • Calculate the power involved when work is done • Understand the average power required to keep an object moving at a constant speed along a rough horizontal surface or a rough inclined plane and do calculations using $P_{av}=Fv_{av}$ • Calculate the minimum power required of an electric motor to pump water from a borehole of a particular depth at a particular rate using $W_{nc} = \Delta E_k + \Delta E_p$	**Recommended practical investigation for informal assessment:** Perform simple experiments to determine the work done in walking up (or running up a flight of stairs). By timing the run and walk (same flight of stairs) one can enrich the concept of power	**Materials:** Flight of stairs, stopwatch, measuring tape (5m) or meter stick,	

GRADE 12 PHYSICS *(WAVES, SOUND & LIGHT)* TERM 2

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
6 HOURS 4 hours	**Doppler Effect (relative motion between source observer)** With sound and ultrasound	• State the Doppler Effect for sound and give everyday examples. • Explain (using appropriate illustrations) why a sound increases in pitch when the source of the sound travels towards a listener and decreases in pitch when it travels away • Use the equation $f_L = \frac{v \pm v_L}{v \pm v_S} f_S$ to calculate the frequency of sound detected by a listener (L) when **EITHER** the source or the listener is moving • Describe applications of the Doppler Effect with ultrasound waves in medicine, e.g. to measure the rate of blood flow or the heartbeat of a foetus in the womb	**Practical Demonstration:** Doppler effect	**Materials:** Tuning fork (or small sound source), string	Doppler applications would involve either a moving source (stationary observer) or a moving observer (stationary source)

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 hours	With light - red shifts in the universe (evidence for the expanding universe).	• State that light emitted from many stars is shifted toward the red, or longer wavelength/lower frequency, end of the spectrum due to movement of the source of light • Apply the Doppler Effect to these “red shifts” to conclude that most stars are moving away from Earth and therefore the universe is expanding			No calculations are to be done on red shifts. Electromagnetic Spectrum - the red end of the spectrum corresponds to lower frequency and the blue end to higher frequency light. Matter and Materials - emission spectra and discuss the fact that stars emit light of frequencies that are determined by their composition.

GRADE 12 CHEMISTRY *(CHEMICAL CHANGE)* TERM 2

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 HOURS	**Rate and Extent of Reaction:**				
2 hours	Rates of reaction and factors affecting rate (nature of reacting substances, concentration [pressure for gases], temperature and presence of a catalyst);	• Explain what is meant by reaction rate • List the factors which affect the rate of chemical reactions. (Surface area (solid), concentration (solution), pressure (gas), temperature, and catalyst) • Explain in terms of collision theory how the various factors affect the rate of chemical reactions	**Experiments:** Determine the: (1) Effect of different concentrations of- vinegar and baking soda (2) Effect of temperature - vinegar and baking soda; Alka Seltzer or Cal-C-Vita (3) Effect of temperature and concentration - potassium iodate (0.01 M), soluble starch, $Na_2S_2O_3$ and H_2SO_4 (iodine clock reaction) (4) Effect of catalyst - hydrogen peroxide and manganese dioxide; burning a sugar cube with and without dipping in activated carbon. Also adding a piece of copper to the reaction between zinc and HCl will accelerate the rate	**Materials:**	This section must be done very well; deep understanding of this section gives the foundation for incisive knowledge later. Link chemical systems grade 12 to industrial processes. Very useful PHET simulations of reaction rate are available. Also others like Greenbowe simulations for redox reactions
1 hour	Measuring rates of reaction;	• Suggest suitable experimental techniques for measuring the rate of a given reaction including the measuring of gas volumes, turbidity (e.g. precipitate formation), change of colour and the change of the mass of the reaction vessel	**Experiment** (1) Determine the reaction rate and the influence of all the rate factors in the reaction of Zn and HCl **Recommended experiment for informal assessment** (2) Determine the quantitative reaction rate and drawing graphs in the reaction between $Na_2S_2O_3$ and HCl. Turbidity is seldom quantitatively accurate, but it is useful	**Materials:** Sodium sulphite, dilute hydrochloric acid, 5 test tubes, glass beaker, propette, 2,5 ml syringe, white paper, pencil, stop watch or cell phone with stop watch function, ice, burner, spatula, graph paper.	This is an important section for illustrating and assessing understanding of investigative process, the relationship between theory and experiment, the importance of empirical data and mathematical modelling of relationships. Teaching about practical investigations should form part of this section

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Mechanism of reaction and of catalysis;	• Define activation energy - the minimum energy required for a reaction to take place. Colliding molecules must have, apart from the correct orientation, a kinetic energy equal to or bigger than the activation energy of a reaction before the reaction can take place • Use a graph showing the distribution of molecular energies (number of particles against their kinetic energy) to explain why only some molecules have enough energy to react and hence how adding a catalyst and heating the reactants affects the rate • Explain (in simple terms) how some catalysts function by reacting with the reactants in such a way that the reaction follows an alternative path of lower activation energy	**Activity:** (1) Using appropriate methods, skills, and techniques, such as the micro-scale chemistry technique to study the progress of a reaction	**Materials:**	Activation energy revised. This topic is important and relevant.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**<u>Chemical Equilibrium</u>**				
2 hours	Chemical equilibrium and factors affecting equilibrium;	• Explain what is meant by: - Open and closed systems - A reversible reaction - Dynamic equilibrium • List the factors which influence the **position** of an equilibrium	**<u>Recommended experiment for informal assessment</u>** (1) Investigate equilibrium and the factors influencing equilibrium on the equilibrium of $CoCl_2$ and H_2O (2) Designing and performing an experiment to investigate effects of pH on equilibrium systems such as: $Br_2(aq) + H_2O(l) \rightleftarrows HOBr(aq) + H^+(aq) + Br^-(aq)$ $Cr_2O_7^{2-}(aq) + H_2O(l) \rightleftarrows 2CrO_4^{2-}(aq) +$ $2H^+(aq)$	**Material** 5 test tubes, cobalt chloride, ethanol, silver nitrate, sodium chloride, dilute hydrochloric acid, water, ice, glass beaker, spatula, burner.	Use liquid vapour equilibrium in a closed system to illustrate reversibility.
4 hours	Equilibrium constant;	• List the factors which influence the **value** of the equilibrium constant K_c • Write down an expression for the equilibrium constant having been given the equation for the reaction • Perform calculations based on K_c values • Explain the significance of high and low values of the equilibrium constant	**Activity:** (1) Search for information on issues related to chemical equilibrium (2) Investigating examples of reversible and irreversible reactions (3) Investigating the effect of changes in concentration or temperature on chemical equilibria using a computer simulation		In the calculations of K_c the use of quadratic equations are not allowed

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 hours	Application of equilibrium principles.	• State Le Chatelier's principle. Use Le Chatelier's principle to identify and explain the effects of changes of pressure, temperature, and concentration (common ion effect) on the concentrations and amounts of each substance in an equilibrium mixture. Explain the use of a catalyst and its influence on an equilibrium mixture • Interpret only simple graphs of equilibrium • Apply the rate and equilibrium principles to important industrial applications e.g. Haber process			**Definition:** Le Chatelier's principle states that a change in any of the factors that determine equilibrium conditions of a system will cause the system to change in such a manner as to reduce or counteract the effect of the change.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**Acids and Bases**				
8 hours	Acid-base reactions	• Explain what is meant by acids and bases? • State acid and base models (Arrhenius, Lowry-Brønsted) • Write the reaction equations of aqueous solutions of acids and bases • Give conjugate acid-base pairs for given compounds. • Determine the approximate pH of salts in salt hydrolysis • Give the neutralisation reactions of common laboratory acids and bases. • How do indicators work? What is the range of methyl orange, bromo thymol blue and phenolphthalein indicators? • Do simple acid-base titrations • Do calculations based on titration reactions • Name some common strong and weak acids and bases • Explain the pH scale. • Calculate pH values of strong acids and strong bases • Define the concept of K_w. • Distinguish between strong and concentrated acids	**Activities and experiments** (1) Search for examples of naturally occurring acids and bases, and their chemical composition (2) Investigating the actions of dilute acids on metals, metal carbonates, metal hydrogen carbonates, metal oxides and metal hydroxides.(revision of grade 11) (3) Searching for information about hazardous nature of acids and bases (4) Investigating the action of dilute bases on aqueous metal ions to form metal hydroxide precipitates (5) Performing experiments to investigate the corrosive nature of concentrated acids and bases (drain cleaners, battery acid, swimming pool acid etc) (6) Investigate the temperature change in a neutralisation process **Prescribed experiment for formal assessment** (7) Preparing a standard solution for volumetric analysis	There are useful animations of titrations available to use here (e.g. Greenbowe animations) **Material** 25 ml volumetric flask, mass meter, spatula, oxalic acid, water, watch glass, burette (or two Swift pipettes), test tubes, sodium hydroxide, glass beaker, apparatus stand, phenolphthalein as indicator, funnel.	Acids and bases are introduced in Grade 11 and done in more detail here, including calculations pH meters and data loggers can also be used in titrations if they are available.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Distinguish between concentrated and dilute acids • Explain the auto-ionisation of water • Compare the K_a and K_b values of strong and weak acids and bases. • Compare strong and weak acids by looking at (1) pH (2) conductivity (3) reaction rate • Look at the application of acids and bases in the Chlor-alkali industry (chemical reactions only) • Look at the application of acids and bases in the chemistry of hair. (What is the pH of hair? What is permanent waving lotion and how does it work? What are hair relaxers and how do they work? Discuss different ways of colouring hair)	(8) Performing acid-base titrations using suitable indicators e.g. oxalic acid against sodium hydroxide with phenolphthalein as indicator (9) Using a titration experiment to determine the concentration of acetic acid in vinegar or the concentration of sodium hydroxide in drain cleaner (10) Do acid-base titration experiments to determine presence of acid in a compound (% of ethanoic acid in vinegar etc)		<u>Hair straightening</u> Hair straightening compounds have high pH, sometimes 13. This is usually a strong base, NaOH. If not used properly, it may hurt or burn the scalp. (Look at "The truth about hair relaxers" on the internet.)

ASSESSMENT TERM 2	**<u>TERM 2: Prescribed Formal Assessment</u>** 1. **<u>Experiment (Chemistry)</u>:** How do you use the titration of oxalic acid against sodium hydroxide to determine the concentration of the sodium hydroxide? **OR** **<u>Experiment (Physics)</u>:** Conservation of linear momentum. (This experiment should be conducted when teaching the section on momentum but formally assessed in term 2) 2. **Midyear Examinations**

TERM 3: GRADE 12

GRADE 12 PHYSICS *(ELECTRICITY & MAGNETISM)* TERM 3

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
4 HOURS	**Electric circuits**				
4 hours	Internal resistance and series- and parallel networks	• Solve problems involving current, voltage and resistance for circuits containing arrangements of resistors in series and in parallel • State that a real battery has internal resistance • The sum of the voltages across the external circuit plus the voltage across the internal resistance is equal to the emf: $\varepsilon = V_{load} + V_{internal\ resistance}$ or $\varepsilon = IR_{ext} + Ir$ • Solve circuit problems in which the internal resistance of the battery must be considered. • Solve circuit problems, with internal resistance, involving series-parallel networks of resistors	**Prescribed experiment for formal assessment:** (part 1 and part 2) **Part 1** Determine the internal resistance of a battery **Part 2** Set up a series parallel network with known resistor. Determine the equivalent resistance using an ammeter and a voltmeter and compare with the theoretical value **Recommended Practical Investigation for informal assessment:** Set up a series parallel network with an ammeter in each branch and external circuit and voltmeters across each resistor, branch and battery, position switches in each branch and external circuit. Use this circuit to investigate short circuits and open circuits	**Materials:** Battery, connecting wires resistor, voltmeter, ammeter and switch. **Materials:** Battery, connecting wires, several resistors of different values, voltmeter, ammeter and switch. **Materials:** Battery, connecting wires, several resistors of different values, several voltmeters, several ammeter, switches, a length of low resistance wire.	Some books use the term "lost volts" to refer to the difference between the emf and the terminal voltage. The voltage is not "lost", it is across the internal resistance of the battery, but "lost" for use in the external circuit. The internal resistance of the battery can be treated just like another resistor in series in the circuit. The sum of the voltages across the external circuit plus the voltage across the internal resistance is equal to the emf: $\varepsilon = V_{load} + V_{internal\ resistance}$

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**<u>Electrodynamics</u>**				
4 hours	Electrical machines (generators, motors)	• State that generators convert mechanical energy to electrical energy and motors convert electrical energy to mechanical energy • Use Faraday's Law to explain why a current is induced in a coil that is rotated in a magnetic field. • Use words and pictures to explain the basic principle of an AC generator (alternator) in which a coil is mechanically rotated in a magnetic field • Use words and pictures to explain how a DC generator works and how it differs from an AC generator • Explain why a current-carrying coil placed in a magnetic field (but not parallel to the field) will turn by referring to the force exerted on moving charges by a magnetic field and the torque on the coil • Use words and pictures to explain the basic principle of an electric motor	**Project:** Build a simple electric generator **Project:** Build a simple electric motor	**Materials:** Enamel coated copper wire, 4 large ceramic block magnets, cardboard (packaging), large nail, 1.5 V 25mA light bulb. **Materials:** 2 pieces of thin aluminium strips 3cmx6cm, 1.5 m of enamel coated copper wire, 2 lengths of copper wire, a ring magnet (from an old speaker) a 6cmx15cm block of wood, sandpaper and thumb tacks.	The basic principles of operation for a motor and a generator are the same, except that a motor converts electrical energy into mechanical energy and a generator converts mechanical energy into electrical energy. Both motors and generators can be explained in terms of a coil that rotates in a magnetic field. In a generator the coil is attached to an external circuit and mechanically turned, resulting in a changing flux that induces an emf. In an AC generator the two ends of the coil are attached to a slip ring that makes contact with brushes as it turns. The direction of the current changes with every half turn of the coil. A DC generator is constructed the same way as an AC generator except that the slip ring is split into two pieces, called a commutator, so the current in the external circuit does not change direction. In a motor, a current-carrying coil in a magnetic field experiences a force on both sides of the coil, creating a torque, which makes it turn.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Give examples of the use of AC and DC generators • Give examples of the use of motors			**A note on torque:** Know that the moment of a force, or torque, is the product of the distance from the support (pivot point) and the component of the force perpendicular to the object.
4 hours	Alternating current	• Explain the advantages of alternating current • Write expressions for the current and voltage in an AC circuit • Define the rms (root mean square) values for current and voltage as $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ and $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ respectively, and explain why these values are useful. • Know that the average power is given by: $P_{av} = I_{rms}V_{rms} = \frac{1}{2}I_{max}V_{max}$ (for a purely resistive circuit) • Draw a graph of voltage vs time and current vs time for an AC circuit. • Solve problems using the concepts of I_{rms}, V_{rms}, P_{av}			The main advantage to AC is that the voltage can be changed using transformers (device used to increase or decrease the amplitude of an AC input). That means that the voltage can be stepped up at power stations to a very high voltage so that electrical energy can be transmitted along power lines at low current and therefore experience low energy loss due to heating. The voltage can then be stepped down for use in buildings, street lights, and so forth.

GRADE 12 PHYSICS *(MATTER & MATERIALS)* TERM 3

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
6 HOURS	**Optical phenomena and properties of materials**				
4 hours	Photoelectric effect	• Describe the photoelectric effect as the process that occurs when light shines on a metal and it ejects electrons • Give the significance of the photo-electric effect: it establishes the quantum theory and it illustrates the particle nature of light • Define cut-off frequency, f_o • Define work function and know that the work function is material specific • Know that the cut-off frequency corresponds to a maximum wavelength • Apply the photo-electric equation: $E = W_o + KE_{max}$, where $E = hf$ and $W_o = hf_o$ $KE_{max} = \frac{1}{2} m v_{max}^2$ • Know that the number of electrons ejected per second increases with the intensity of the incident radiation	**Practical Demonstration:** Photoelectric effect	**Materials:** Mercury discharge lamp; photosensitive vacuum tube; set of light filters; circuit to produce retarding voltage across phototube; oscilloscope, ammeter.	Link to the harnessing of solar energy.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Know that if the frequency of the incident radiation is below the cut-off frequency, then increasing the intensity of the radiation has no effect i.e. it does not cause electrons to be ejected • Understand that the photoelectric effect demonstrates the particle nature of light			
2 hours	Emission and absorption spectra	• Explain the source of atomic emission spectra (of discharge tubes) and their unique relationship to each element • Relate the lines on the atomic spectrum to electron transitions between energy levels • Explain the difference between of atomic absorption and emission spectra			Application to astronomy.

GRADE 12 CHEMISTRY *(CHEMICAL CHANGE)* TERM 3

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**Electrochemical reactions**				
2 hours	Electrolytic cells and galvanic cells;	• Define the galvanic cell in terms of: self-sustaining electrode reactions conversion of chemical energy to electrical energy • Define the electrolytic cell in terms of: electrode reactions that are sustained by a supply of electrical energy conversion of electrical energy into chemical energy • Define oxidation and reduction in terms of electron (e^-) transfer • Define oxidising agent and reducing agent in terms of oxidation and reduction. • Define anode and cathode in terms of oxidation and reduction	**Recommended experiment for informal assessment** (1) Investigate the electrolysis of water and sodium iodide. **Recommended experiment for informal assessment** (2) Find the Galvanic cell with the highest potential (3) Investigate the reduction of metal ions and halogens	**Materials:** Water bowl, electrodes for the electrolysis of water, test tubes, conductivity wires, 9 volt battery, current indicator (LED), water and sodium iodide and sodium sulphate. **Materials:** Zinc, lead, aluminium and copper electrodes, zinc sulphate, copper sulphate, lead nitrate, sodium hydroxide, and potassium nitrate.	RECAP the redox reactions studied in grade 11. Link to: Grade 11 Oxidation number and Grade 11 Redox reactions. USE SINGLE ARROWS in redox chemical equations and half reactions, but KNOW that all chemical reactions are by nature reversible (equilibrium reactions).

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
1 hour	Relation of current and potential to rate and equilibrium;	• Give and explain the relationship between current in an electrochemical cell and the rate of the reaction • State that the potential difference of the cell (V_{cell}) is related to the extent to which the spontaneous cell reaction has reached equilibrium • State and use the qualitative relationship between V_{cell} and the concentration of product ions and reactant ions for the spontaneous reaction viz. V_{cell} decreases as the concentration of product ions increase and the concentration of reactant ions decrease until equilibrium is reached at which the $V_{cell} = 0$ (the cell is 'flat'). (Qualitative treatment only. Nernst equation is NOT required)			Illustrate processes sub-microscopically. Le Chatelier's principle can be used to argue the shift in equilibrium.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 hours	Understanding of the processes and redox reactions taking place in cells;	• Describe the movement ions through the solutions the electron flow in the external circuit of the cell the half reactions at the electrodes the function of the salt bridge in galvanic cells • Use cell notation or diagrams to represent a galvanic cell			
	Standard electrode potentials;	• Give the standard conditions under which standard electrode potentials are determined • Describe the standard hydrogen electrode and explain its role as the reference electrode • Explain how standard electrode potentials can be determined using the reference electrode and state the convention regarding positive and negative values • Use the Table of Standard Reduction Potentials to calculate the emf of a standard galvanic cell. • Use a positive value of the standard emf as an indication that the reaction is spontaneous under standard conditions			**Cell notations** can be used to represent galvanic cells. e.g. for the zinc - copper cell the following notation can be used: Zn/Zn^{2+} // Cu^{2+} / Cu at concentrations of 1 mol/dm^3. Oxidation at the anode on the left separated by the salt bridge (//) with reduction at the cathode on the right.

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
2 hours	Writing of equations representing oxidation and reduction half reactions and redox reactions	• Predict the half-cell in which oxidation will take place when connected to another half-cell • Predict the half-cell in which reduction will take place when connected to another half-cell • Write equations for reactions taking place at the anode and cathode. • Deduce the overall cell reaction by combining two half-reactions • Describe, using half equations and the equation for the overall cell reaction, the following electrolytic processes The decomposition of copper chloride A simple example of electroplating (e.g. the refining of copper)			Link to: Oxidation numbers in grade 11. USE SINGLE ARROWS in redox chemical equations and half reactions, but KNOW that all chemical reactions are by nature reversible (equilibrium reactions).
1 hour	Oxidation numbers and application of oxidation numbers	• Revise from grade 11 and extend in grade 12 • Describe, using half equations and the equation for the overall cell reaction, the layout of the particular cell using a schematic diagram and potential risks to the environment of the following electrolytic processes used industrially (i) The production of chlorine (the chemical reactions of the chloroalkali-industry) (ii) The recovery of aluminium metal from bauxite. (South Africa uses bauxite from Australia)			The applications should provide real life examples of where electrochemistry is used in industry. The industry per se need not to be studied, but assessment should be done using the chemical reactions that is used in industry Give the learners the chemical reactions and don't expect the learners to know the reactions by heart.

GRADE 12 CHEMISTRY *(CHEMICAL SYSTEMS)* TERM 3

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
	Chemical industry				
6 hours	The fertilizer industry (N, P, K).	• List, for plants, (a) three non-mineral nutrients, i.e. nutrients that are not obtained from the soil: C, H and O and their sources i.e. the atmosphere (CO_2) and rain (H_2O) (b) three primary nutrients N, P and K and their source i.e. the soil (c) These nutrients are mineral nutrients that dissolve in water in the soil and are absorbed by the roots of plants. Fertilizers are needed because there are not always enough of these nutrients in the soil for healthy growth of plants	**Activity:** **Study the stoichiometry** of production of N, P, K in industry. • The quality of water sources in the country has been on the news a lot in our country. Rivers used to be clean sources of water, do an investigation on the causes of this high pollution of rivers near you • Assess how many people rely on fertilizers for their gardens in your area, assess whether the use of inorganic fertilizers has gone up. Research if this can be related to the quality of water in the river near your village, town, city • Discuss advantages of inorganic fertilizers • Discuss alternatives to inorganic fertilizers (IKS) • Discuss how the public can help to prevent eutrophication		Keep the details in this section limited to applications Link to Gr 11:Lithosphere - mining and mineral processing (especially phosphates and potassium salts) Acid and base reactions - especially neutralisation Gr 12 rate and extent of reactions Chemical systems SASOL the manufacture of fertilizers

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Explain the function of N, P and K in plants • Give the source of N (guano), P (bone meal) and K (German mines) before and after the first world war) • Interpret the N:P:K fertilizer ratio • Describe and explain (rates, yields, neutralization, …), using chemical equations where ever appropriate, these aspects of the industrial manufacture of fertilizers, given diagrams, flow charts and so on N_2 - fractional distillation of air H_2 - at SASOL from coal and steam NH_3 - Haber process; HNO_3 - the Ostwald process; H_2SO_4 - including the contact process; H_3PO_4; Ca $(H_2PO_4)_2$ (super phosphates) NH_4NO_3; $(NH_4)_2SO_4$; H_2NCONH_2 (urea); • Give sources of potash (mined imported potassium salts like KNO_3, K_2SO_4, KNO_3,)			

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		• Evaluate the use of inorganic fertilizers on humans and the environment • Link SASOL to the production of fertilizers i.e. ammonium nitrate (fertilizer and explosive) • Define Eutrophication • Discuss alternatives to inorganic fertilizers as used by some communities			Knowledge of eutrophication is expected.

ASSESSMENT ***TERM 3***	**<u>TERM 3: Prescribed Formal Assessment</u>** **1. Experiment (Physics): Determine internal resistance of a battery.** **2. Trial Examination**

TERM 4: GRADE 12

GRADE 12 PHYSICS

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource material	Guidelines for Teachers
2 hours	Mechanics, Electricity and Magnetism, Waves, Sound and Light	• Consolidate the laws and principles covered in the grade 11syllabus viz. 1. Newton's Laws (Newton 1, 2, 3 and Newton's Law of Universal Gravitation) and Application of Newton's Laws 2. Electrostatics (Coulomb's Law and Electric field) 3. Electric circuits (Ohm's Law, Power and Energy) • Do further integrated problem solving activities			Problem-solving activities integrating any of: energy, momentum, electrostatics and/ or mechanics.
2 hours	Mechanics, Electricity and Magnetism, Waves, Sound and Light	• General revision and consolidation. • Examination tips for example utilization of time, numbering of answers to questions in the exam paper, etc. • Revision of problem solving strategies using relevant problem solving activities			

GRADE 12 CHEMISTRY

Time	Topics Grade 12	Content, Concepts & Skills	Practical Activities	Resource material	Guidelines for Teachers
2 hours	Organic chemistry	• Consolidate the use of IUPAC names, functional groups, organic reactions, isomers, monomers and polymers, addition and condensation reactions of polymers • Do further integrated problem solving activities			
1 hour	Rate and Equilibrium	• Revise the factors that influence rate and equilibrium; how to measure rate; how to calculate the equilibrium constant and use the value of K_c in calculations; effect of Le Chatelier's principle			
1 hour	Acids & Bases and Electrochemistry	• General revision and consolidation • Examination tips for example utilization of time, numbering of answers to questions in the exam paper, etc • Revision of problem solving strategies using relevant problem solving activities			

ASSESSMENT ***TERM 4***	**<u>TERM 4: Prescribed Formal Assessment</u>** **1. Final Examinations**

SECTION 4: ASSESSMENT

4.1 INTRODUCTION

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: generating and collecting evidence of achievement; evaluating this evidence; recording the findings and 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 and skills and the 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.

4.2 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 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. Informal assessment should be used to provide feedback to the learners and to inform planning for teaching, but need not be recorded. It should not be seen as separate from learning activities taking place in the classroom. Learners or teachers can mark these 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. The results of the informal daily assessment tasks are not formally recorded unless the teacher wishes to do so. The results of daily assessment tasks are not taken into account for promotion and certification purposes.

Informal, ongoing assessments should be used to structure the acquisition of knowledge and skills and should be precursor to formal tasks in the Programme of Assessment.

4.3 FORMAL ASSESSMENT

Grades	Formal school-based assessments	End-of-year examinations
R-3	100%	n/a
4-6	75%	25%
7-9	40%	60%
10 and 11	25% including a midyear examination	75%
12	25% including midyear and trial examinations	External examination: 75%

All assessment tasks that make up a 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, performances, etc. Formal assessment tasks form part of a year-long formal Programme of Assessment in each grade and subject.

4.3.1 Control tests & 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 Grades 10-12 could adhere to the weighting of cognitive levels given in Table 1. See **APPENDIX 1** for a detailed description of the cognitive levels.

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 **%**

Table 1: Recommended weighting of cognitive levels for examinations and control tests

4.3.2 Practical investigations & experiments

Practical investigations and experiments should focus on the practical aspects and the process skills required for scientific inquiry and problem solving. Assessment activities should be designed so that learners are assessed on their use of scientific inquiry skills, like 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 contexts.

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.

4.3.3 Projects

A project is an integrated assessment task that focuses on process skills, critical thinking and scientific reasoning as well as strategies to investigate and solve problems in a variety of scientific, technological, environmental and everyday contexts. This requires a learner to follow the scientific method to produce either a device, a model or to conduct a practical investigation

A project will entail only one of the following:

(i) Construction of a device e.g. electric motor

(ii) Building a physical model in order to solve a challenge you have identified using concepts in the FET Physical Sciences curriculum

(iii) Practical investigation

Note:

The learner has the **option** to include a **poster** as part of the presentation of his/her project.

The assessment tools used, specifying the assessment criteria for each task, will be dictated by the nature of the task and the focus of assessment. Assessment tools could be one or a combination of rubrics, checklists, observation schedules and memoranda.

<u>REQUIREMENTS FOR GRADE 10, 11 AND 12 PRACTICAL WORK</u>

In grade 10 and 11 learners will do TWO prescribed experiments for formal assessment (ONE Chemistry and ONE Physics experiment) and ONE project on either Physics or Chemistry. This gives a total of **THREE formal assessments in practical work** in Physical Sciences in each of Grades 10 and 11.

In grades 10 and 11 it is recommended that learners do FOUR experiments for informal assessment (TWO Chemistry and TWO Physics experiments). This gives a total of **FOUR informal assessments in practical work** in Physical Sciences in each of Grades 10 and 11.

In grade 12 learners will do THREE prescribed experiments for formal assessment (ONE or TWO Chemistry and ONE or TWO Physics). This gives a total of **THREE formal assessments in practical work** in Physical Sciences in Grade 12.

In grade 12 it is recommended that learners do THREE experiments for informal assessment (TWO Chemistry and ONE Physics experiment OR ONE Chemistry and TWO Physics experiments). This gives a total of **THREE informal assessments in practical work** in Physical Sciences in Grade 12.

Grade 10

Table 2: Practical work for grade 10

Practical work	Chemistry	Physics
Prescribed experiments (formal assessment)	1	1
Project (formal assessment)	ONE either Physics or Chemistry	
Experiments (informal assessment)	2	2
TOTAL	**7 practical activities**	

Grade 11

Table 3: Practical work for grade 11

Practical work	Chemistry	Physics
Prescribed experiments (formal assessment)	1	1
Project (formal assessment)	ONE either Physics or Chemistry	
Experiments (informal assessment)	2	2
TOTAL	**7 practical activities**	

Grade 12

Table 4: Practical work for grade 12

Practical work	Chemistry	Physics
Prescribed experiments (formal assessment)	1	2
OR Prescribed experiments (formal assessment)	2	1
Project (formal assessment)	NONE	
Experiments (informal assessment)	1	2
OR Experiments (informal assessment)	2	1
TOTAL	**6 practical activities = 3 Chemistry & 3 Physics**	

The forms of assessment used should be age - and developmental level appropriate. 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.

4.4 PROGRAMME OF ASSESSMENT

The Programme of Assessment is designed to spread formal assessment tasks in all subjects in a school throughout a term

4.4.1 Programme of formal assessment for grades 10 and 11

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 in Grades 10 and 11. In Grades 10 and 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. These marks will be used to determine the promotion of learners in Grades 10 and 11. Table 3 illustrates an assessment plan and weighting of tasks in the programme of assessment for Physical Sciences grades 10 &11.

PROGRAMME OF ASSESSMENT FOR GRADES 10						
ASSESSMENT TASKS (25%)						**END-OF-YEAR ASSESSMENT (75%)**
TERM 1		**TERM 2**		**TERM 3**		**TERM 4**
Type	Mark	Type	Mark	Type	Mark	
Experiment	20	**Experiment**	20	**Project:** **ANY ONE OF:** **Construction of device/building a model/practical investigation**	20	**Final Examination** (**2 x 150 marks giving a total of 300 marks for papers 1 and 2)**
Control Test	10	**Mid-Year Examination**	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%						

Table 5: Assessment plan and weighting of tasks in the programme of assessment for Grades 10

PROGRAMME OF ASSESSMENT FOR GRADES 11						
ASSESSMENT TASKS (25%)						**END-OF-YEAR ASSESSMENT (75%)**
TERM 1		**TERM 2**		**TERM 3**		**TERM 4**
Type	Mark	Type	Mark	Type	Mark	
Experiment	20	**Experiment**	20	**Project:** **ANY ONE OF:** **Construction of device/building a model/practical investigation**	20	**Final Examination** (**2 x 150 marks giving a total of 300 marks for papers 1 and 2)**
Control Test	10	**Mid-Year Examination**	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%						

Table 6: Assessment plan and weighting of tasks in the programme of assessment for Grades 11

4.4.2 Programmme of formal assessment for grade 12

Assessment consists of two components: a Programme of Assessment which makes up 25% of the total mark for Physical Sciences and an external examination which makes up the remaining 75%. The Programme of Assessment for Physical Sciences comprises six tasks that are internally assessed. Together the Programme of Assessment and external assessment make up the annual assessment plan for Grade 12. Table 7 illustrates the assessment plan and weighting of tasks in the programme of assessment for Physical Sciences Grade 12.

The Programme of Assessment is the School Based Assessment (SBA)

PROGRAMME OF ASSESSMENT FOR GRADE 12 (SBA)						**EXTERNAL ASSESSMENT**
ASSESSMENT TASKS (25%)						**END-OF-YEAR ASSESSMENT (75%)**
TERM 1		TERM 2		TERM 3		TERM 4
Type	Mark	Type	Mark	Type	Mark	**Final Examination (2 x 150 marks giving a total of 300 marks for papers 1 and 2)**
Experiment	15	**Experiment**	15	**Experiment**	15	
Control Test	10	**Mid-Year Examination**	20	**Trial Examination**	25	
Total: 25 marks		Total: 35 marks		Total: 40 marks		Total: 300 marks
Total = 400 marks						
FINAL MARK = 25% (ASSESSMENT TASKS) +75% (FINAL EXAM)=100%						

Table 7: Assessment plan and weighting of tasks in the programme of assessment for grade 12

4.4.3 END-OF-YEAR EXAMINATIONS

4.4.3.1 Grades 10 and 11 (internal assessment)

The end-of-year examination papers for Grades 10 and 11 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.

Tables 5 and 6 below respectively show the weighting of questions across cognitive levels and the specification and suggested weighting of the content for the Grades 10 and 11 end-of-year examinations (across the two papers).

GRADE 10								
Paper	**Content**	**Marks**	**Total Marks/ Paper**	**Duration (Hours)**	**Weighting of Questions Across Cognitive Levels**			
					Level 1	**Level 2**	**Level 3**	**Level 4**
PAPER1: ***PHYSICS FOCUS***	Mechanics	75	150	2	15 %	35 %	40 %	10 %
	Waves, Sound & Light	40						
	Electricity & Magnetism	35						
PAPER 2: ***CHEMISTRY FOCUS***	Chemical Change	60	150	2	15 %	40 %	35 %	10 %
	Chemical Systems	20						
	Matter & Materials	70						

Table 8: Weighting of questions across cognitive levels, the specification and suggested weighting of the content for the Grade 10 end-of-year examination

GRADE 11								
Paper	Content	Marks	Total Marks/ Paper	Duration (Hours)	Weighting of Questions Across Cognitive Levels			
					Level 1	Level 2	Level 3	Level 4
PAPER1: ***PHYSICS FOCUS***	Mechanics	68	150	3	15 %	35 %	40 %	10 %
	Waves, Sound & Light	32						
	Electricity & Magnetism	50						
PAPER 2: ***CHEMISTRY FOCUS***	Chemical Change	70	150	3	15 %	40 %	35 %	10 %
	Chemical Systems	20						
	Matter & Materials	60						

Table 9: Weighting of questions across cognitive levels, the specification and suggested weighting of the content for the Grade 11 end-of-year examination

4.4.3.2 Grade 12 (external assessment)

The external examinations are set externally, administered at schools under conditions specified in the *National policy on the conduct, administration and management of the National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF)* and marked externally.

The core content outlined in the Physical Sciences Curriculum and Assessment Policy (CAPS) document is compulsory and will be examined through Papers 1 and 2. Note that all the topics in the grade 12 curriculum are examinable in the end of year examination plus selected topics from grades 10 and 11. Below is a list of selected content, outlined for Grade 10 and 11 in the CAPS document that is also examinable in the Grade 12 final examination.

Selected Examinable Grades 10 & 11 Topics	
Physics from grade 11	**Chemistry from grades 10 and 11**
1. Newton's Laws (Newton 1, 2, 3 and Newton's Law of Universal Gravitation) and Application of Newton's Laws. 2. Electrostatics (Coulomb's Law and Electric field) 3. Electric circuits (Ohm's Law, Power and Energy)	1. Representing chemical change (grade 10) 2. Intermolecular forces (grade 11) 3. Stoichiometry (grade 11) 4. Energy and Change (grade 11)

Table 10: Examinable topics from grade 10 and 11

Multiple-choice questions could be set in examination papers. However, such questions should have a maximum weighting of 10%. The examination paper may also consist of conceptual type questions.

The final end-of-year examination is nationally set, marked and moderated.

The nationally set, marked and moderated examination will consist of two papers:

- Paper 1: Physics focus (3 hours, 150 marks)
- Paper 2: Chemistry focus (3 hours, 150 marks)
- All of the questions will focus on content as stated in the National Curriculum Statement.
- Questions will reflect the different levels of the Physical Sciences Assessment Taxonomy (APPENDIX 1) appropriate to the paper.

Table 11 shows the weighting of questions across cognitive levels and the specification and suggested weighting of the content for the Grade 12 end-of-year examinations (across the two papers).

GRADE 12								
Paper	**Content**	**Marks**	**Total Marks/ Paper**	**Duration (Hours)**	**Weighting of Questions Across Cognitive Levels**			
					Level 1	**Level 2**	**Level 3**	**Level 4**
PAPER1: ***PHYSICS FOCUS***	Mechanics	63	150	3	15 %	35 %	40 %	10 %
	Waves, Sound & Light	17						
	Electricity & Magnetism	55						
	Matter & Materials	15						
PAPER 2: ***CHEMISTRY FOCUS***	Chemical Change	84	150	3	15 %	40 %	35 %	10 %
	Chemical Systems	18						
	Matter & Materials	48						

Table 11: Weighting of questions across cognitive levels, the specification and suggested weighting of the content for the Grade 12 end-of-year examination

4.5 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 learner's conceptual progression within a grade and her / his 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 against the subject. The various achievement levels and their corresponding percentage bands are as shown in the table below.

Note: The seven point scale should have clear descriptions that give detailed information for each level. Teachers will record actual marks against the task by using a record sheet; and report percentages against the subject on the learners' 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

Table 12: Codes and percentages for reporting in Grades R-12

4.5.1 Recording and reporting in the first, second and third terms

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. Schools should use the following weighting for **reporting purposes only** and only in the **first, second and third** terms of Grades 10, 11 and 12:

	Practical Work	Control test/mid-year exam/trial exam
Weighting	25%	75%

4.5.2 Recording and reporting on the Assessment Tasks and SBA in the Programme of Assessment

Schools are also required to provide quarterly feedback to parents and learners of the marks obtained by learners in the assessment tasks as given in tables 5 and 6 and on the SBA as given in table 7. This report should adhere strictly to the weighting given in tables 5, 6 and 7 and should use a formal reporting tool.

4.5.3 Recording and reporting at the end of the academic year

The **weighting** of tasks in the **Programme of Assessment** must be strictly adhered to when calculating the **FINAL MARK** of the learner for promotion purposes in each of Grades 10, 11 and 12, at the end of the academic year.

4.6 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 and 11 tasks are internally moderated. The subject head or head of department for Physical Sciences at the school will generally manage this process.

All Grade 12 tasks should be externally moderated. The subject head or head of department for Physical Sciences at the school will generally manage this process.

4.7 GENERAL

This document should be read in conjunction with:

4.7.1 *National policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R-12*; and

4.7.2 The policy document, *National Protocol for Assessment Grades R-12.*

APPENDIX 1: PHYSICAL SCIENCES ASSESSMENT TAXONOMY

The following table provides a possible hierarchy of cognitive levels that can be used 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 fifth column below 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
CREATING	**4**	The learner creates new ideas and information using the knowledge previously learned or at hand. At the extended abstract level, the learner makes connections not only within the given subject area but also beyond it and generalises and transfers the principles and ideas underlying the specific instance. The learner works with relationships and abstract ideas.	• Generating • Planning • Producing • Designing • Inventing • Devising • Making	Devise, predict, invent, propose, construct, generate, make, develop, formulate, improve, plan, design, produce, forecast, compile, originate, imagine
EVALUATING		The learner makes decisions based on in-depth reflection, criticism and assessment. The learner works at the extended abstract level.	• Checking • Hypothesising • Critiquing • Experimenting • Judging • Testing • Detecting • Monitoring	Combine, integrate, modify, rearrange, substitute, compare, prepare, generalise, rewrite, categorise, combine, compile, reconstruct, organise, justify, argue, prioritise, judge, rate, validate, reject, appraise, judge, rank, decide, criticise

DESCRIPTION OF COGNITIVE	LEVEL	EXPLANATION	SKILLS DEMONSTRATED	ACTION VERBS
ANALYSING	**3**	The learner appreciates the significance of the parts in relation to the whole. Various aspects of the knowledge become integrated, the learner shows a deeper understanding and the ability to break down a whole into its component parts. Elements embedded in a whole are identified and the relations among the elements are recognised.	• Organising • Comparing • Deconstructing • Attributing • Outlining • Finding • Structuring • Integrating	Analyse, separate, order, explain, connect, classify, arrange, divide, compare, select, infer, break down, contrast, distinguish, draw, illustrate, identify, outline, point out, relate, question, appraise, argue, defend, debate, criticise, probe, examine, investigate, experiment
APPLYING		The learner has the ability to use (or apply) knowledge and skills in other familiar situations and new situations.	• Implementing • Carrying out • Using • Executing	apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover, construct, manipulate, prepare, produce, draw, make, compile, compute, sequence, interpret
UNDERSTANDING	**2**	The learner grasps the meaning of information by interpreting and translating what has been learned.	• Interpreting • Exemplifying • Comparing • Explaining • Inferring • Classifying	summarise, describe, interpret, contrast, associate, distinguish, estimate, differentiate, discuss, extend, comprehend, convert, explain, give example, rewrite, infer, review, observe, give main idea
REMEMBERING	**1**	The learner is able to recall, remember and restate facts and other learned information.	• Recognising • Listing • Describing • Identifying • Retrieving • Recalling • Naming	list, define, tell, describe, identify, show, know, label, collect, select, reproduce, match, recognise, examine, quote, name

APPENDIX 2

It is recommended that these skills be incorporated in lessons in grade 10 appropriately in order to sharpen the skills that are necessary for successful teaching and learning.

GRADE 10: INTRODUCTION TO PHYSICAL SCIENCES					
SKILLS FOR PHYSICAL SCIENCES LEARNERS					
Time	**Topics Grade 10**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
Prior or in context	**Skills for Physical Science**	Science applies mathematics to investigate questions, solve problems, and communicate findings. Science process skills will provide the students with background and curiosity to investigate important issues in the world around them.		**PRIOR MATHEMATICAL KNOWLEDGE and SCIENTIFIC SKILLS**	This section is meant as an introduction of definitions and a **summary of mathematical and other skills needed by learners**. It is meant to be a reference to use when skills are taught in context.
	Scientific notation.	• Scientific notation is a way of presenting very large or very small numbers in a compact and consistent form that simplifies calculations. • In scientific notations a number is expressed as a product of two numbers: $Nx10^n$ N is the digit term where N is between 1 and 9,999….. 10^n is the exponential term and is some integer power of 10. • A large number has a positive exponential term: e.g. 10^6 • A small number has a negative exponential term: e.g. 10^{-5} • Adding and subtracting, multiplication and division with scientific notation • Powers of numbers expressed in scientific notation and roots of numbers expressed in scientific notation.	Activities: (1) Give learners TEN numbers and ask them to write the numbers in the correct scientific notation. (2) Let learners do calculations with numbers in scientific notation. (3) When working with pocket calculators, check the scientific notation buttons on the calculators. Different calculators work differently and learners sometimes have difficulty going backwards and forwards from numbers to scientific notation on the calculator.	Science equipment; any relevant equipment from the home. Textbooks, library books, newspaper articles, any other resource materials including the internet.	This topic should include Chemistry and Physics applications. It might not be examined *per se* but integrated in other questions throughout the rest of the syllabus CHEMISTRY and PHYSICS should share the time spent on this topic. Teachers should indicate the relationship between scientific notation in Mathematics and scientific notation in Physical Sciences.

GRADE 10: INTRODUCTION TO PHYSICAL SCIENCES					
SKILLS FOR PHYSICAL SCIENCES LEARNERS					
Time	**Topics Grade 10**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
	Conversion of units.	• A conversion factor expresses the equivalence of a measurement in two different units (1 cm = 10 mm) • List the seven base units (length, mass, time, temperature, electric current, luminous intensity, amount of substance) and their respective SI units. • Identify common conversion factors in mass, length, volume, temperature and pressure. • Recognize and convert various scales of measurement: temperature (Celsius and Kelvin), length, (km, m, cm, mm) mass (kg, g), pressure (kPa, atm). • Using conversion factors and doing calculations • Using conversion factors in dimensional analysis. • Translate data into the correct units and dimensions using conversion factors and scientific notation.	**Activities:** (1) Do conversions with the following selected prefixes used in the metric system: giga-, mega-, kilo-, deci-, centi-, milli-, micro-, nano-, pico-, femto-.		Learners are notoriously careless with units in the answers of calculations. Exercise dimensional analysis in moderation with learners to prove homogeneity of equations. Dimensional analysis stresses the importance and meaning of the correct use of units. Be strict about answers of calculations with the correct units. Take note of derived units and defined units.
	Changing the subject of the formula.	• Identify the correct formula for the problem at hand. • Identify what is given in a problem and what is asked. • Change the subject of a given formula to any other variable or constant present in the formula..	**Activities:** (1) Consider the formula for density done in grade 9: D = m/V. If you have the density and the volume, how are you going to calculate the mass?		

GRADE 10: INTRODUCTION TO PHYSICAL SCIENCES					
SKILLS FOR PHYSICAL SCIENCES LEARNERS					
Time	**Topics Grade 10**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
	What is rate? Applications in Physics (e.g. power) and Chemistry (e.g. reaction rates).	• The rate at which something happens is the number of times it happens over a period of time. • Rate is change per second, whether it is change in mass, or change in velocity or change in concentration, or change in energy. For example: - Power is the amount of energy delivered per unit time (Joule per second = Watt) - Reaction rate is the change in concentration of a reagent per unit time.	**Experiment:** (1) Vinegar and baking powder have carbon dioxide as one of the products. Determine the rate of the reaction by means of the volume gas produced against time. (2) Temperature can also be used as a variable in the reaction between vinegar and baking powder		The examples provided are not the only ones available; please add your own examples where possible.
	Direct and inverse proportions.	• Proportion or variation is way of describing certain relationships between two variables: y is directly proportional to x or y is inversely proportional to x. • Organize observations in a data table , analyze the data for trends or patterns, and interpret the trends or patterns, using scientific concepts • Interpret a graph constructed from experimentally obtained data to identify relationships: direct or inverse. • Select appropriate units, scales, and measurement tools for problem situations involving proportional reasoning and dimensional analysis.	**Activity:** (1) Draw the graph of the data collected from the reaction between vinegar and baking powder. The shape of the graph tells you something about the relationship between the volume and time or volume and temperature. (2) Recognise the shape of the graph for direct proportions and the shape of the graph for inverse proportions. (3) A density graph will give a better proportionality between the mass and the volume for a fixed substance.		**Just a general comment**: Conceptually this might be difficult to teach at this stage, depending on where the learner's maths content knowledge is. They essentially have Grade 9 Maths. These are important skills, but choose very simple examples carefully. Only simple examples should be taught initially and more complex ones later. Application can be dealt with when the content is taught, e.g. Newton, or gas laws. **Note:** Just the initial rate of the vinegar/ baking powder reaction will be (volume gas produced against time) directly proportional. As the reagents' concentrations decrease the reaction slows down.

GRADE 10: INTRODUCTION TO PHYSICAL SCIENCES					
SKILLS FOR PHYSICAL SCIENCES LEARNERS					
Time	**Topics Grade 10**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
	Fractions and ratios	• Fractions are numbers, or algebraic expressions, which is the quotient of two integers or algebraic expressions. A fraction is written a/b where a is called the numerator and b the denominator. • Ratio is the quotient of two quantities written as a:b or a/b so as to highlight their relative sizes.	**Activity:** (1) Use any regular object and divide the object into any number of equal parts. Take for example an A4 page, a cake, a 30 cm ruler, a stick. Divide an A4 paper into 5 equal parts. If you take two parts of paper and give your friend the rest of the pieces, how much of the page do you have? (You have two pieces out of five possible pieces.) Let the class come up with a solution to the problem before you teach them the rules of fractions. (2) Use a block or a dice to demonstrate the division of a cube.		
	The use and meaning of constants in equations, e.g. changing from a proportion to an equation.	• A constant is a quantity which, in a given context, takes a fixed value. • Proportion or variation is a way of describing certain relationships between two variables. y is directly proportional to x means y = kx for some constant k and y is inversely proportional to x means y = k/x (or xy = k) for some constant k. • Examples are Newton's law of gravitation, and the ideal gas law.	**Activity:** (1) Can you determine a constant from the graph of the data collected from the reaction between vinegar and baking powder? The shape of the graph tells you something about the relationship between the volume and time or volume and temperature. What about the gradient of the graph?		**Note:** Just the initial rate of the vinegar/ baking powder reaction will be (volume gas produced against time) directly proportional. As the reagents' concentrations decrease the reaction slows down. The gradient changes. **Therefore:** A density graph will give a better proportionality between the mass and the volume for a fixed substance. The density value will be your constant.
Skills for practical investigations in Physics and Chemistry					

GRADE 10: INTRODUCTION TO PHYSICAL SCIENCES					
SKILLS FOR PHYSICAL SCIENCES LEARNERS					
Time	**Topics Grade 10**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
	Skills needed for practical investigations (observation, precautions, data collection, data handling, tables, general types of graphs, analysis, writing conclusions, writing a hypothesis, identifying variables, for example independent, dependent and control variable.).	• Trace the historical development of a scientific principle or theory • Identify an answerable question and formulate a hypothesis to guide a scientific investigation. • Design a simple experiment including appropriate controls. • Perform and understand laboratory procedures directed at testing a hypothesis. • Select appropriate tools and technology to collect precise and accurate quantitative data. • Correctly read a thermometer, a balance, metric ruler, graduated cylinder, pipette, and burette. • Record observations and data using the correct scientific units. • Export data into the appropriate form of data presentation (e.g. equation, table, graph, or diagram). • Analyze information in a table, graph or diagram (e.g. compute the mean of a series of values or determine the slope of a line). • Determine the accuracy and the precision of experimental results. • Analyze experimental results and identify possible sources of bias or experimental error. • Recognize, analyze and evaluate alternative explanations for the same set of observations. • Design a model based on the correct hypothesis that can be used for further investigation. • Define qualitative analysis and give a practical example. • Define quantitative analysis and give a practical example.	**Activity:** (1) Analyse the components of a properly designed scientific investigation. (2) Choose an experiment and determine appropriate tools to gather precise and accurate data. (3) Defend a conclusion based on scientific evidence (4) Determine why a conclusion is free from bias. (5) Compare conclusions that offer different, but acceptable explanations for the same set of experimental data. (6) Investigate methods of knowing used by people who are not necessarily scientists.	Support material that develops these skills should be used	Historical development means the study of all the people that contributed towards for instance the concept of balanced equations or atomic theory. This section should be taught while the learners do an investigation themselves, for example: The skills for practical investigations should also be discussed and practiced as a class at regular intervals throughout the year.

GRADE 10: INTRODUCTION TO PHYSICAL SCIENCES					
SKILLS FOR PHYSICAL SCIENCES LEARNERS					
Time	**Topics Grade 10**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
	Models in science	• Understand what the purpose of models is. • Recognise models used in science • Recognize how models change with the discovery of new information	**Activity:** The purpose of models is to explain and or simplify a difficult chemical concept. Name all the models in chemistry that you know of e.g. • How did the atomic model change through the years? • Who contributed towards the periodic table (this is also just a model of representing chemical information), • Models for chemical bonding etc.		To make models tangible, one would have to include concrete examples. A lot of knowledge is transferred through models. We used a model as an explanation of a concept until a better explanation and or model is formulated based on newly discovered information and constructed knowledge.
	Safety data	• Know the explanations for the hazard symbols. • Know how to interpret and apply the safety data of the chemicals. • Know the laboratory safety rules.			Use Merck's safety data information or the safety data regulations of the Internal Labour Organization (ILO).
	Basic trigonometry skills	• Define the sin, cos and tan of an angle • Do simple applications and calculations with the values (e.g. in calculating force components).			Trigonometry is necessary to solve certain Physics problems.

PERIODIC TABLE OF THE ELEMENTS
PERIODIEKE INDELING VAN DIE ELEMENTE

IA (1)	IIA (2)	IIIB (3)		IVB (4)	VB (5)	VIB (6)	VIIB (7)	VIII (8)	VIII (9)	VIII (10)	IB (11)	IIB (12)	IIIA (13)	IVA (14)	VA (15)	VIA (16)	VIIA (17)	0 (18)
1 **H** 1,01																		2 **He** 4,00
3 **Li** 6,94	4 **Be** 9,01												13 **Al** 27,0					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** 35,45	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** 95,9	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** 226,0	89 **Ac** 227,0	#	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)									

atomic number / atoomgetal
symbol / simbool
atomic mass / atoommassa

lanthanides* / lantaniede	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# / aktiniede	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** (260)

APPENDIX 4 Cation and Anion table

TABLE 1

TABLE OF CATIONS/TABEL VAN KATIONE

hydrogen (waterstof)	H^+	beryllium (berillium)	Be^{2+}	aluminium (aluminium)	Al^{3+}	chromium (VI) [chroom (VI)]	Cr^{6+}
lithium (litium)	Li^+	magnesium (magnesium)	Mg^{2+}	[chromium (III) [chroom (III)]	Cr^{3+}	manganese (VII) [mangaan (VII)]	Mn^{7+}
sodium (natrium)	Na^+	calcium (kalsium)	Ca^{2+}	iron (III) [yster (III)]	Fe^{3+}		
potassium (kalium)	K^+	barium (barium)	Ba^{2+}	cobalt (III) [kobalt (III)]	Co^{3+}		
silver (silwer)	Ag^+	tin (II) [tin (II)]	Sn^{2+}				
mercury (I) [kwik (I)]	Hg^+	lead (II) [lood (II)]	Pb^{2+}				
copper (I) [koper (I)]	Cu^+	chromium (II) [chroom (II)]	Cr^{2+}				
ammonium	NH_4^+	manganese (II) [mangaan (II)]	Mn^{2+}				
		iron (II) [yster (II)]	Fe^{2+}				
		cobalt (II) [kobalt (II)]	Co^{2+}				
		nickel (nikkel)	Ni^{2+}				
		copper (II) [koper (II)]	Cu^{2+}				
		zinc (sink)	Zn^{2+}				

TABLE 2

TABLE OF ANIONS/TABEL VAN ANIONE

fluoride (fluoried)	F^-	oxide (oksied)	O^{2-}
chloride (chloried)	Cl^-	peroxide (peroksied)	O_2^{2-}
bromide bromied	Br^-	carbonate (karbonaat)	CO_3^{2-}
iodide (jodied)	I^-	sulphide (sulfied)	S^{2-}
hydroxide (hidroksied)	OH^-	sulphite (sulfiet)	SO_3^{2-}
nitrite (nitriet)	NO_2^-	sulphate (sulfaat)	SO_4^{2-}
nitrate (nitraat)	NO_3^-	thiosulphate (tiosulfaat)	$S_2O_3^{2-}$
hydrogen carbonate (waterstofkarbonaat)	HCO_3^-	chromate (chromaat)	CrO_4^{2-}
hydrogen sulphite (waterstofsulfiet)	HSO_3^-	dichromate (dichromaat)	$Cr_2O_7^{2-}$
hydrogen sulphate (waterstofsulfaat)	HSO_4^-	manganate (manganaat)	MnO_4^{2-}
dihydrogen phosphate (diwaterstoffosfaat)	$H_2PO_4^-$	oxalate (oksalaat)	$(COO)_2^{2-}/C_2O_4^{2-}$
hypochlorite (hipochloriet)	ClO^-	hydrogen phosphate (waterstoffosfaat)	HPO_4^{2-}
chlorate (chloraat)	ClO_3^-	nitride (nitried)	N^{3-}
permanganate (permanganaat)	MnO_4^-	phosphate (fosfaat)	PO_4^{3-}
acetate /ethanoate (asetaat)	CH_3COO^-	phosphide (fosfied)	P^{3-}

APPENDIX 5 Solubility table

Solubility Table

Soluble compounds		Exceptions
Almost all salts of Na^+, K^+ and NH_4^+		
All salts of Cl^-, Br^- and I^-	⇔	Halides of Ag^+, Hg_2^{2+} and Pb^{2+}
Compounds containing F^-	⇔	Fluorides of Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+} and Pb^{2+}
Salts of nitrate, NO_3^- chlorate, ClO_3^- perchlorate, ClO_4^- acetate, CH_3COO^-		$KClO_4$
Salts of sulphate, SO_4^{2-}	⇔	Sulphates of Sr^{2+}, Ba^{2+} and Pb^{2+}

Insoluble compounds		Exceptions
All salts of carbonate, CO_3^{2-} phosphate, PO_4^{3-} oxalate, $C_2O_4^{2-}$ chromate, CrO_4^{2-} sulphide, S^{2-} Most metal hydroxides OH^- and oxides, O^{2-}	⇔	Salts of NH_4^+ and alkali metal cations