# 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 | |
|---|---|---|
| | All Chemical System topics are to be used as contexts and examples throughout the teaching and learning | |
| Chemical Systems **(Not examinable)** | 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 recommended practical activities. It is recommended that at least two informal experiments should be done to enhance conceptual development. From the list choose two experiments for formal assessment (ONE in Physics and ONE in Chemistry) across grades 10 to 12.

| Grade | Term | Recommended Practical Activities for Physics | Recommended Practical Activities for Chemistry |
|---|---|---|---|
| 10 | Term1 | • Measurement of average/instantaneous velocity with position/time, velocity/time or acceleration/time graphs (trolley with ticker tape)<br>• 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/ velocity vs time graph and hence determine the acceleration | Heating curve of water/wax. |
| | Term 2 | None | None |
| | Term 3 | • Use a ripple tank to demonstrate constructive and destructive interference of two pulses<br>• Electric circuits with resistors in series and parallel - measuring potential difference and current.<br>• Pattern and direction of the magnetic field around a bar magnet | • Test for halides, sulphates, carbonates, etc.<br>• Simple redox/precipitation/displacement reactions |
| | Term 4 | None | None |
| 11 | Term1 | • Determine the unknown mass of an object using force board (closed vector diagram)..<br>• Experiment on friction: relationship between N and maximum static friction and kinetic friction; different surfaces on static friction;<br>• Verify the effect of different surfaces on maximum static friction by keeping the object the same.<br>• Determine the coefficient of friction with the aid of an incline<br>• Verify the relationship between force and acceleration | • The effects of intermolecular forces on boiling point, melting point and solubility<br>• |
| | Term 2 | None | |
| | Term 3 | • Determine the critical angle of a rectangular glass (clear) block.<br>• Snell's Law<br>• Obtain current and voltage data for a resistor and a light bulb and determine which one obeys Ohm's law.<br>• Ohm's law | • Exothermic and endothermic reactions (examples and applications)<br>• Boyle's law (or any gas law)<br>• Preparation of a standard solution |
| | Term 4 | None | None |

| Grade | Term | Recommended Practical Activities for Physics | Recommended Practical Activities for Chemistry |
|---|---|---|---|
| 12 | Term1 | Conservation of linear momentum. | Preparation of esters |
| | Term 2 | Investigation (Physics) | |
| | Term 3 | • Determine the internal resistance of a battery.<br>• 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. | • Use the titration of oxalic acid against sodium hydroxide to determine the concentration of the sodium hydroxide. (Use any acid or base)<br>• Determine the rate of a reaction<br>• Set up a galvanic cell and determine the Emf |
| | Term 4 | | |

## 2.6 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 to 12TWO experiments are done per year, ONE Physics experiment and ONE Chemistry experiment as formal assessment (one experiment per term for term 1 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. In all grades June examinations must have two papers covering term1 and term 2 content.

ONLY in grade 10 and grade 11 ONE project is done per year as INFORMAL 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 in grade 12 NO project is done.

## 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.

# SECTION 3

## 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** | **Revise Matter & classification (from grade 9)** | Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.<br>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.<br>1. Strength<br>2. Thermal and electrical conductivity<br>3. Brittle, malleable or ductile<br>4. Magnetic or non-magnetic<br>5. Density (lead / aluminium)<br>6. Melting points and boiling points | **Activity:**<br>**What materials are products made of?**<br>If you have a sand dune, the material out of which the dune is made is sand.<br>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**<br><br>Learners are encouraged to look at food additives and preservatives. This should be contrasted with indigenous ways of food preservation |

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| | Mixtures: heterogeneous and homogeneous. | • Revise the properties of a mixture<br>• Revise the properties of a heterogeneous mixture.<br>• Revise the properties of a | **Which mixtures are heterogeneous and which mixtures are homogeneous?**<br>• Make mixtures of sand and water, potassium | | |

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| 0.25 hour | | homogeneous mixture<br>• Give examples of heterogeneous and homogeneous mixtures | dichromate and water, iodine and ethanol, iodine and water. Which mixtures are heterogeneous and which mixtures are homogeneous?<br>• 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<br>• Revise the definition of an element<br>• Revise the definition of a compound<br>• Revise the definition of pure substances<br>• Revise the classification of substances as pure, as compounds or as elements<br>• 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<br>• Use molecular models to build pure substances, elements and compounds<br>**Activity:**<br>• 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.<br><br>Test tubes, glass beaker, filter paper and water soluble ink- pens. | |

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| | Names and formulae of substances. | • Revise the names of compounds using the names of the elements from which they are made | **Activity:**<br>• Why do we have scientific names?<br>• Identify the elements | | Indicate the relationship between names and chemical formulae and chemical bonding to learners.<br>**Use cation and anion tables** |

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| 0.25 hour | | • Revise the cation and anion table<br>• Revise the writing of names when given the formulae.<br>• Revise the writing of formulae when given the names<br>• Revise the meaning of the name endings like -ide, -ite and -ate<br>• Understand the meaning of prefixes di-, tri- etc | that make up a compound on the food labels collected by the learners<br>• Compare the scientific names with traditional names for compounds known by learners | | **in appendix 4**<br>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<br>• Identify the metals, their position on the periodic table and their number in comparison to the number of non-metals<br>• Revise the classification of non-metals using their properties<br>• Identify the non-metals and their position on the periodic table<br>• Describe metalloids as having mainly non-metallic properties | • Identify the metals, non- metals and metalloids on the periodic table.<br>• 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. |

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| | | • Revise the classification of | | | |

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| | | metalloids by their characteristic property of increasing conductivity with increasing temperature (the reverse of metals) e.g. silicon and graphite.<br>• 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<br>• Give examples of electrical conductors, semiconductors and insulators<br>• 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<br>• 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 | | |

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| | Magnetic and nonmagnetic materials. | • Revise how to test and classify materials as magnetic and non-magnetic | • Test the following substance to classify them as magnetic, or | | |

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| 0.25 hours | | • Give examples of materials that are magnetic and non-magnetic<br>• Give examples of the use we make of magnets in daily life (in speakers, in telephones, electric motors, as compasses) | nonmagnetic: glass, wood, graphite, copper, zinc, aluminium, iron nail and materials of your own choice | | |
| **2 HOURS** | **<u>States of Matter and the kinetic Molecular Theory</u>** | 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<br>• List and characterize the three states of matter<br>• Define freezing point, melting point and boiling point<br>• Identify the physical state of a substance at a specific temperature, given the melting point and the boiling point of the substance<br>• Define melting, evaporation, freezing, sublimation and condensation as changes in state<br>• Demonstrate these changes of state | **<u>Prescribed experiment for formal assessment</u>**<br>• 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:**<br>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.<br>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>** | 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 | | | Visualization is very important in Chemistry to demystify the subject and make it easier |

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| | **(Atomic structure)** | 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 | | | 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<br>• Identify five major contributions to the current atomic model used today.<br>• What is the purpose of a model of the atomic structure? | **Activity:**<br>(1) Make a list of key discoveries about atomic structure<br>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<br>State the key discovery in ONE sentence and match the discovery to the influence on the description of the atom<br>(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.<br>This topic could also be used as a cooperative learning activity.<br>You don't need information on all the names mentioned: you can choose the names of the scientists you want information on.<br>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 |
|---|---|---|---|---|---|
| | Atomic mass and diameter. | • Give a rough estimate of | **Activity:** | | Simulate the α-particle scattering experiment with |

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| 0.5 hour | | the mass and diameter of an atom<br>• 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)<br>• Describe and use the concept of relative atomic mass | (1) Note the correct use of scientific notation and the meaning of the values obtained when giving atomic mass or atomic radius<br>(2) Use analogies to show how small the nucleus is compared to the atom | | 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;<br>- Define the atomic number of an element and give its value<br>- Give the number of protons present in an atom of an element<br>- Give the number of electrons present in a neutral atom<br>- Show that by removing electrons from an atom the neutrality of the atom is changed<br>- Determine charge after removing/adding electrons from the atom.<br>- Calculate the number of neutrons present<br>- Calculate the mass number for an isotope of an element | **Activities:**<br>(1) Use the PT to make a Science puzzle to clarify and strengthen concepts<br>(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:**<br>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 |
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| 1 hour | Isotope | • Explain the term isotope<br>• 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.<br>• Represent atoms (nuclides) using the notation $^{Z}_{A}E$ | **Activities:**<br>(1) Identify isotopes among elements with relevant information<br>(2) Perform calculations related to isotopic masses and relative atomic masses | | Do simple calculations to improve learners understanding of the concept isotopes.<br>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)<br>• Describe atomic orbitals and the shapes of the s-orbitals and the p-orbitals<br>• Sate Hund's rule and Pauli's Exclusion Principle | **Activities:**<br>(1) Understand and deduce the electronic arrangement of atoms<br>(2) Represent the electronic arrangements of atoms using electron diagrams<br>**<u>Recommended experiment</u>**<br>**for informal assessment**<br>(3) Do flame tests to identify some metal cations and metals | **Materials**<br>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.<br>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.<br>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 |
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| 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<br>• Appreciate the PT as a systematic way to arrange elements<br>• Define the group number and the period number of an element in the PT<br>• Relate the position of an element in the PT to its electronic structure and vice versa<br>• 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.<br>• What is the influence of periodicity on electron-affinity and electronegativity?<br>• Define atomic radius, ionization energy, electron-affinity and electronegativity | **Activities:**<br>(1) Use the PT to make a Science puzzle to clarify and strengthen concepts<br>(2) Searching for an d presenting information on elements and the development of the PT<br>(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:**<br>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.<br>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!!<br>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 |
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| | Similarities in chemical properties | • Relate the electronic | • | | |

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| 2 hours | among elements in Groups 1, 2, 17 and 18 | arrangements to the chemical properties of group 1, 2, 17 and 18 elements<br>• Describe the differences in reactivity of group 1, 2 and 17 elements,<br>• Predict chemical properties of unfamiliar elements in groups 1, 2, 17 and 18 of the PT<br>• Indicate where metals are to be found on the periodic table<br>• Indicate where nonmetals are to be found on the periodic table<br>• Indicate where transition metals are to be found on the periodic table | | | |

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| **4 HOURS** | **<u>Chemical bonding</u>** | Interactions between matter generate substances with new | | | |

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

**GRADE 10 PHYSICS *(MECHANICS)* TERM** 1

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| **4 HOURS** | **<u>Vectors and scalars</u>** | | | | |
| 4 hours | Introduction to vectors & scalars. | • List physical quantities for example time, mass, weight, force, charge etc.<br>• Define a vector and a scalar quantity<br>• Differentiate between vector and scalar quantities<br>• Understand that $\vec{F}$ represents the force factor, whereas F represents the magnitude of the force factor<br>• Graphical representation of vector quantities.<br>• 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 <u>one dimension only</u>.<br>• Define resultant vector<br>• 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 |
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| **8 HOURS** | **Motion in one dimension:** | | | | |
| 3 hours | Reference frame, position, displacement and distance. | • Describe the concept of a frame of reference<br>• Explain that a frame of reference has an origin and a set of directions e.g. East and West or up and down<br>• Define one dimensional motion<br>• Define position relative to a reference point and understand that position can be positive or negative<br>• Define distance and know that distance is a scalar quantity<br>• Define displacement as a change in position<br>• Know that displacement is a vector quantity that points from initial to final position<br>• Know and illustrate the difference between displacement and distance<br>• Calculate distance and displacement for one dimensional motion | **Practical Demonstration**:<br>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:**<br>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 $\Delta$x (or $\Delta$y) for displacement to emphasise that displacement is a change in position.<br><br>Use D for distance.<br><br>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 |
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| 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<br>• 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<br>• Calculate average speed and average velocity for one dimensional motion.<br>• Convert between different units of speed and velocity, e.g. $m{\cdot}s^{-1}$, $km{\cdot}h^{-1}$<br>• Define average acceleration as the change in velocity divided by the time taken<br>• Differentiate between positive acceleration, negative acceleration and deceleration<br>• Understand that acceleration provides no information about the direction of motion; it only indicates how the motion (velocity) changes | **Experiment**:<br>Measurement of velocity | **Materials:**<br>Ticker timer and tape, power supply, trolley, inclined plane, retort stand, ruler.<br>**Materials:**<br>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.<br>Mathematically velocity is defined as<br>For uniformly accelerated motion in one dimension, average acceleration and instantaneous acceleration are one and the same and will be referred to as "acceleration"<br>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.<br>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 |
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| **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<br>• Know that instantaneous velocity is a vector quantity<br>• 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<br>• Describe the motion of an object given its position *vs* time, velocity *vs* time and acceleration *vs* time graph<br>• Determine the velocity of an object from the gradient of the position *vs* time graph<br>• 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**<br>Acceleration:<br>E.g. You could use the following example or any other topic on acceleration:<br>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.<br>The following variations could be added to the investigation:<br>i. Vary the angle of inclination and determine how the inclination impacts on the acceleration<br>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:**<br>Trolley, ticker tape apparatus, tape, ticker-timer, graph paper, ruler | The emphasis should be on concept formation and testing understanding.<br>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.<br>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 |
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| | | • Determine the acceleration of an object from the gradient of the velocity vs time graph<br>• Determine the displacement of an object by finding the area under a velocity *vs* time graph<br>• Use the kinematics equations to solve problems involving motion in one dimension (horizontal only)<br>$v_f = v_i + a\Delta t$<br>$\Delta x = v_i\Delta t + \frac{1}{2}a(\Delta t)^2$<br>$v_f^2 = v_i^2 + 2a\Delta x$<br>$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$<br>• 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).<br>Note: The following kinematic equations are also acceptable.<br>$v = u + at$<br>$s = ut + \frac{1}{2}at^2$<br>$v^2 = u^2 + 2as$<br>$s = \left(\frac{v+u}{2}\right)t$<br>u = initial velocity<br>v = final velocity<br>a = acceleration<br>s = displacement<br>t = time interval<br>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 |

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| ***ASSESSMENT***<br>***TERM 1*** | **<u>TERM 1: Prescribed Formal Assessment</u>**<br>**1. Physics experiment OR Chemistry experiment**<br>**2. Control test** |

| TERM 2 GRADE 10 | | | | | |
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| **GRADE 10 PHYSICS *(MECHANICS)* TERM 2** | | | | | |
| **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<br>• 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).<br>Inform learners that g = 9,8m·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<br>• 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.<br>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<br>Use equation: $E_M = E_K + E_P$ | | | |

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| 4 hours | Conservation of mechanical energy (in the absence of dissipative forces). | • State the law of the conservation of energy<br>• State that in the absence of air resistance, the mechanical energy of an object moving in the earth's gravitational field is constant (conserved)<br>• 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<br>Use equation:<br>$E_{K1}+E_{P1}=E_{K2}+E_{P2}$ | **Practical Demonstration:**<br>Conversion of Energy (qualitative) | **Materials:**<br>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. |

| TERM 1 GRADE 10 | | | | | |
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| **GRADE 10 CHEMISTRY *(MATTER & 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.<br>• Molecules (molecular substances) are due to covalent bonding.<br>• Ionic substances are due to ionic bonding.<br>(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<br>• State that the only substances found in atomic form are the noble gases at ambient conditions<br>• 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<br>• 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:**<br>(1) Identify elements and compounds in chemical reactions. Elements and compounds are investigated by doing experiments<br>(2) Determine the products of the electrolysis of water (sodium sulphate added). Identify the elements and the compounds<br>**Demonstration:**<br>(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,<br>(2) Demonstrate chemical bonding. Use atomic model kits to demonstrate chemical bonding in elements and compounds<br>Visual representations, preferably 3D, is important here to ensure conceptual | **Materials:**<br>(For exp.1)<br>Cal-C-Vita tablets, water, glass beaker, candle, limewater, zinc metal and hydrochloric acid, blue copper (II) sulphate, test tubes and burner.<br><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!<br>Both molecules and ionic substances are COMPOUNDS, respectively due to DIFFERENT chemical bonding!<br>**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.<br>Description of molecules and ionic substances make it important to do this section after the concept of chemical bonding.<br>The terms simple molecules and giant molecules are confusing (sugar being anything but a simple molecule if water is seen as a simple molecule!) |

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| | | | understanding of the formation of the different types of compounds | | |
| **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)<br>• 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<br>• Give **examples of molecules** based on the above description e.g.<br>• <u>Covalent molecular structures</u> consist of separate molecules: oxygen, water, petrol, $CO_2$, $S_8$, $C_{60}$ (buckminsterfullerene or buckyballs)<br>• <u>Covalent network structures</u> consist of giant repeating lattices of covalently bonded | | | The terms **covalent molecular structures** and **covalent network structures** can be used instead. |

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| | | atoms: diamond, graphite, $SiO_2$, some boron compounds | | | |

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| | | • Give **examples of ionic substances** (solids, salts, ionic compounds) based on the above description e.g.<br>• A sodium chloride crystal, potassium permanganate crystal, …<br>• Give **examples of metals** based on the above description e.g.<br>• a metal crystal like a piece of copper, or zinc, or iron,<br>• Recognize molecules from models (space filling, ball and stick, …)<br>• Draw diagrams to represent molecules using circles to represent atoms<br>• Represent molecules using<br>• Molecular formula for covalent molecular structures, e.g. $O_2$, $H_2O$, $C_8H_{18}$, $C_{12}H_{22}O_{11}$,<br>• Empirical formulae for covalent network structures, e.g. C as diamond, graphite and $SiO_2$ as quartz, glass or sand<br>• 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 |
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| **4 HOURS** | **<u>Physical and Chemical Change</u>** | The properties of matter determine how matter interacts with energy. | | | A <u>chemical change</u> 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)<br>• Describe that the rearrangement of molecules occurs during **physical changes** e.g.<br>- molecules as separated when water evaporates to form water vapour<br>- disordering of water molecules when ice melts due to breaking of intermolecular forces<br>- energy change (as small) in relation to chemical changes<br>• mass, numbers of atoms and molecules as being conserved during these physical changes<br>• Define a chemical change as a change in which the chemical nature of the substances involved changes (new chemical substances are formed)<br>- | **Practical Demonstration:**<br>(1) Show macroscopically what happens when ice is heated in a glass beaker to liquid and further to gas<br>(2) Show with small plastic pellets or marbles the arrangement of the particles in ice, in water and in water vapour<br>(3) Separation reactions like distillation, filtration and paper-chromatography can be used to indicate physical change<br>(4) Mix iron and sulphur and separate with a magnet<br>(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:**<br>Burner, glass beaker, ice.<br>Marbles of plastic pellets<br><br>**Materials:**<br>$MnO_2$, 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.<br><br>The use of models to demonstrate is crucial in this section. This helps learners to 'see' into the submicroscopic world of matter.<br><br>Explain the energy transformations carefully. |

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| | | • Describe examples of | **Practical experiments:** | | |

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| | | a **chemical change** that could include<br>- the decomposition of hydrogen peroxide to form water and oxygen; and<br>- the synthesis reaction that occurs when hydrogen burns in oxygen to form water. (Why do we consider these reactions to be chemical changes?)<br>• Describe<br>- 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<br>- mass and atoms are conserved during these chemical changes but the number of molecules is not. Show this with diagrams of the particles | (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)<br>(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) | <u>**Recommended experiment for informal assessment**</u><br>(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:**<br>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.<br>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 |
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| | | • Draw diagrams representing molecules at a sub- microscopic level to show how particles rearrange<br>• in chemical reactions and atoms are conserved | | | |
| | Law of constant composition | • State the law of constant proportions<br>• Explain that **the ratio** in a particular compound **is fixed** as represented by its chemical formula | **Experiment:**<br>(1) Investigate the ratio in which the following elements combine: $AgNO_2$ and NaCl; Pb $(NO_3)_2$ and NaI; and $FeCl_2$ and NaOH to form products | **Materials:**<br>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)<br>• Balance reaction equations by<br>- 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:**<br>(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:**<br>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. |
| **Time** | **Topics Grade 10** | **Content, Concepts & Skills** | **Practical Activities** | **Resource Material** | **Guidelines for Teachers** |

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| | | - representing molecules at a sub-microscopic level using coloured circles and simply rearranging the pictures to form the product molecules while conserving atoms'.<br>- by inspection using reaction equations<br>• Interpret balanced reaction equations in terms of<br>- conservation of atoms<br>- conservation of mass (use relative atomic masses) | | | |

| GRADE 10 PHYSICS *(ELECTRICITY & MAGNETISM)* TERM 2 | | | | | |
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| **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)<br>• 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<br>• 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:**<br>Determine the pattern and direction of the magnetic field around a bar magnet | **Materials:**<br>Sheet of A4 paper, a bar magnet, iron filings<br>**Materials:**<br>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.<br>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 |
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| | | • 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<br>• Compare the magnetic field of the Earth to the magnetic field of a bar magnet using words and diagrams<br>• Explain the difference between the geographical North pole and the magnetic North pole of the Earth<br>• Give examples of phenomena that are affected by Earth's magnetic field e.g. Aurora Borealis (Northern Lights), magnetic storms<br>• 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 |
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| **4 HOURS** | **Electrostatics** | | | | |
| 0.5 hour | Two kinds of charge | • Know that all materials contain positive charges (protons) and negative charges (electrons)<br>• Know that an object that has an equal number of electrons and protons is neutral (no net charge)<br>• Know that positively charged objects are electron deficient and negatively charged objects have an excess of electrons<br>• 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).<br>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 |
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| **Time** | **Topics Grade 10** | **Content, Concepts & Skills** | | | |
| 1 hour | Charge conservation | • Know that the SI unit for electric charge is the coulomb<br>• 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.<br>• Apply the principle of conservation of charge<br>• Know that when two identical conducting objects having charges $Q_1$ and [1] $Q_2$ on insulating stands touch, that each has the same final charge on seperation. final charge: after separation $Q = \frac{Q_1 + Q_2}{2}$<br>**NOTE:** This equation is only true of identically sized conductors on insulated stands | | | |
| 1 hour | Charge quantization | • State the principle of charge quantization<br>• Apply the principle of charge quantization | | | Every charge in the universe consists of integer multiples of the electron charge.<br>$Q=nq_e$, 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 |
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| 0.5 hour | Force exerted by charges on each other (descriptive)<br><br>Attraction between charged and uncharged objects (polarisation) | • Recall that like charges repel and opposite charges attract<br>• Explain how charged objects can attract uncharged insulators because of the polarization of molecules inside insulators | **Practical Demonstration:**<br>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)<br>2. Demonstrate everyday examples of the effect of electrostatics | **Materials:**<br><br>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. |

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| ***ASSESSMENT***<br><br>***TERM 2*** | **<u>TERM 2: Prescribed Formal Assessment</u>**<br><br>1. Midyear Examinations |

| TERM 1 GRADE 10 | | | | | |
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| **GRADE 10 PHYSICS *(ELECTRICITY & MAGNETISM)* TERM 3** | | | | | |
| **Time** | **Topics Grade 10** | **Content, Concepts & Skills** | **Practical Activities** | **Resource Material** | **Guidelines for Teachers** |
| **8 HOURS** | **Electric circuits** | | | | |
| 1 hour | emf, Terminal Potential Difference (terminal pd) | • Define potential difference in terms of work done and charge. V = W/Q<br>• Know that the voltage measured across the terminals of a battery when no current is flowing through the battery is called the emf<br>• 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).<br>• Know that emf and pd are measured in volts (V)<br>• 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 |
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| 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<br>• Calculate the current flowing using the equation<br>• 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.<br>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<br>• 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 |
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| 1 hour | Resistance | • Define resistance<br>• Explain that resistance is the opposition to the flow of electric current<br>• Define the unit of resistance; one ohm (Ω) is one volt per ampere.<br>• 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.<br>• State and explain factors that affect the resistance of a substance<br>• 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.<br>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.<br>• 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.<br>• Calculate the equivalent (total) resistance of resistors connected in series using:<br>$R_s = R_1 + R_2 + ...$ | **Prescribed experiment:**<br>(Part 1 and part 2)<br><br>**Part 1**<br>Set up a circuit to show that series circuits are voltage dividers, while current remains constant | **Materials:**<br>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 |
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| 2 hours | Resistors in parallel | • Know that voltage is constant across resistors connected in parallel<br>• 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<br>• Calculate the equivalent (total) resistance of resistors connected in parallel using:<br>$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$ | **Prescribed experiment: Part 2**<br>Set up a circuit to show that parallel circuits are current dividers, while potential difference remains constant, | **Materials:**<br>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,<br>the total resistance can be calculated using:<br>$R_p = \frac{product}{sum} = \frac{R_1R_2}{R_1 + R_2}$ | | | |
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**TERM 3 GRADE 10**

| GRADE 10 CHEMISTRY *(CHEMICAL CHANGE)* TERM | | | | | |
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| **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<br>• Represent the dissolution process using balanced reaction equations using the abbreviations (s) and (aq) appropriately<br>e.g. when salt is dissolved in water ions form according to the equation:<br>$NaCl(s) \rightarrow Na^{+}(aq) + Cl^{-}(aq)$<br>• Define the process of dissolving (solid ionic crystals breaking up into ions in water) | **Practical work:**<br>• 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<br>• Investigate different types of reactions in aqueous medium and write balanced ionic equations for the different reaction types<br>**Activity:**<br>(1) Explain what is meant by ion exchange reactions and use an experiment to illustrate the concept of ion-exchange reactions | **Materials:** | **Note:**<br>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)<br>• 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).<br>• 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 |
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| 1 hour | Electrolytes and extent of ionization as measured by conductivity | • Describe a simple circuit to measure conductivity of solutions<br>• Relate conductivity to<br>- the **concentration of ions** in solution and this in turn to the **solubility** of particular substances, however<br>- 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:**<br>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<br>**Experiment:**<br>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.<br>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.<br>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.<br>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 |
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| 3 hours | Precipitation reactions. | • Write balanced reaction equations to describe precipitation of insoluble salts<br>• Explain how to test for the presence of the following anions in solution:<br>- Chloride - using silver nitrate and nitric acid<br>- Bromide- using silver nitrate and nitric acid<br>- Iodide -using silver nitrate and nitric acid<br>- Sulphate - using barium nitrate and nitric acid<br>- Carbonate -using barium nitrate and acid (precipitate dissolves in nitric acid)<br>• Identify an ion or ions in a solution from a description of the reactants mixed and the observations of the products | **Experiment:**<br>1. Do some qualitative analysis tests of cations and anions (e.g. chlorides, bromides, iodides, sulphates, carbonates)<br>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 |
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| 2 hours | Other chemical reaction types. In water solution | • Ion exchange reactions<br>- Precipitation reactions<br>- Gas forming reaction<br>- Acid-base reactions<br>• 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 | **<u>Recommended experiment for informal assessment</u>**<br>(1) Identify CHEMICAL REACTION TYPES experimentally:<br>- precipitation<br>- gas forming reactions<br>- acid-base reactions<br>- redox reactions<br>(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)<br>(3) Identify each reaction type in a group of miscellaneous chemical reactions | **Materials:**<br>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.<br>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.<br>Reaction types are done **to create awareness of the types** of reactions and to make it easier for learners to write balanced chemical equations.<br>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.<br>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.<br>“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). |

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| **8 HOURS** | **Quantitative aspects of chemical change:** | 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<br>• Relate amount of substance to relative atomic mass<br>• Describe the relationship between mole and Avogadro's number<br>• Conceptualize the magnitude of Avogadro's number using appropriate analogies<br>• Write out Avogadro's number with all the zeros to get a better concept of the amount<br>• Define molar mass<br>• Describe the relationship between molar mass and relative molecular mass and relative formula mass<br>• Calculate the molar mass of a substance given its formula | | | Refer back to atomic mass earlier in grade 10<br>Do the mole concept thoroughly.<br><u>Note to the teacher</u>: The term atomic *mass* should be used and not atomic *weight*.<br>Avogadro's number =<br>602 200 000 000 000 000 000 000<br>1 dozen = 12 eggs(e.g.)<br>1 gross = 144 eggs<br>1 million = 1000 000 eggs<br>1 mole = Avogadro's number = $6{,}022 \times 10^{23}$ eggs<br>Molar mass is the mass of one mole of any substance under discussion.<br>Relative molecular mass is the mass of ONE MOLECULE (e.g. water $H_2O$) relative to the mass of carbon -12.<br>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 |
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| 2 hours | Molecular and formula masses; | • Reason qualitatively and proportionally the relationship between number of moles, mass and molar mass<br>• Calculate mass, molar mass and number of moles according to the relationship n= m/M<br>• Determine the **empirical formula** for a given substance from percentage composition<br>• Determine the number of moles of **water of crystallization** in salts like $AlCl_3.nH_2O$ | **Experiment:**<br>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<br>• Define and determine concentration as moles per volume | • Describe practical quantitative methods for determining chemical composition<br>• Determine the percentage composition from the chemical formula of the substance | **Materials:**<br>Glass beaker spatula, propette, water bowl, filter paper, mass meter, sodium hydrogen carbonate, dilute sulphuric acid.<br>**Materials**<br>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<br>• Definition of molar volume is stated as: 1 mole of gas occupies 22.4 $dm^3$ at $0^0C$ (273K) and 1 atmosphere (101.3 kPa)<br>• 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 |
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| 2 hours | Basic stoichiometric calculations | • Do calculations based on concentration, mass, moles, molar mass and volume<br>• 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 *(WAVES, SOUND & LIGHT)* TERM 3

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| **4 HOURS** | **<u>Transverse pulses on a string or spring</u>** | • | • | | |
| 2 hours | Pulse, amplitude | • Define a pulse<br>• Define a transverse pulse<br>• Amplitude<br>• Define amplitude as maximum disturbance of a particle from its rest (equilibrium) position<br>• 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:<br>Let learners observe the motion of a single pulse travelling along a long, soft spring or a heavy rope | **Materials:**<br>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<br>• Define constructive interference<br>• Define destructive interference<br>• 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<br>• Apply the principle of superposition to pulses | **<u>Recommended experiment for informal assessment:</u>**<br>Use a ripple tank to demonstrate constructive and destructive interference of two pulses | **Materials:**<br>Ripple tank apparatus. | |

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| **2 HOURS** | **Transverse waves** | | | | |
| 2 hours | Wavelength, frequency, amplitude, period, wave speed; | • Define a transverse wave as a succession of transverse pulses<br>• Define wavelength, frequency, period, crest and trough of a wave<br>• Explain the wave concepts: in phase and out of phase<br>• Identify the wavelength, amplitude, crests, troughs, points in phase and points out of phase on a drawing of a transverse wave<br>• Know the relationship between frequency and period, i.e. $f = 1/T$ and $T = 1/f$<br>• Define wave speed as the product of the frequency and wavelength of a wave: $v = f\lambda$<br>• 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** | **Longitudinal waves:** | | | | |
| 1 hour | On a spring | • Generate a longitudinal wave in a spring<br>• 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:**<br><br>Generate a longitudinal wave in a spring | **Materials:**<br><br>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<br>• Define compression and rarefaction<br>• Differentiate between longitudinal and transverse waves<br>• Define the period and frequency of a longitudinal wave and the relationship between the two quantities. $f = \frac{1}{T}$<br><br>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<br>• Describe a sound wave as a longitudinal wave<br>• Explain the relationship between wave speed and the properties of the medium in which the wave travels (gas, liquid or solid)<br>• Understand that sound waves undergo reflection.<br>• Understand what are echoes<br>• 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**<br>**Practical Demonstration:**<br>How to make sound using a vuvuzela, string, tuning-fork, loud-speaker, drum-head<br><br>**Practical Activity (Project):**<br>Making a string (or wire) telephone<br><br>**Practical Activity:**<br>Determine the speed of sound in air. You could repeat this on different days in order to vary the temperature | **Materials:**<br>Vuvuzela, string, tuning-fork, loud-speaker, drum-head<br><br>**Materials:**<br>Two 340ml drink cans, 2 nails, string or copper wire (not too thick)<br><br>**Materials:**<br>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 |
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| | Pitch, loudness, quality (tone) | • Relate the pitch of a sound to the frequency of a sound wave<br>• Relate the loudness of a sound to both the amplitude of a sound wave and the sensitivity of the human ear | **Practical Activity:**<br>1. Compare the sounds made by blowing on different vuvuzelas of different sizes | **For 1 and 2:**<br>Vuvuzelas of different sizes, flutes<br>Or Tuning forks Or Vuvuzelas, flutes, microphone, oscilloscope, loudspeaker, 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 | | | • Compare the sounds made by blowing on a vuvuzela versus the sounds produced by a flute<br>• 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 3:**<br>Oscilloscope, function generator, loud- speaker, cables | |
| 1 hour | Ultrasound | • Describe sound with frequencies higher than 20 kHz as ultrasound, up to about 100 kHz<br>• 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<br>• 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. |

| ***ASSESSMENT TERM 3*** | **<u>TERM 3: Prescribed Formal Assessment</u>**<br>**1. Physics OR Chemistry experiment**<br>2. **Control Test** |
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| TERM 4 GRADE 10 |
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## GRADE 10 PHYSICS *(WAVES, SOUND & LIGHT)* TERM 4

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| **3.5 HOURS** | **Electromagnetic Radiation** | | | | |
| 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. |
| 1 hour | Nature of EM radiation | • Describe the source of electromagnetic waves as an accelerating charge<br>• 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<br>• State that these mutually regenerating fields travel through space at a constant speed of $3 \times 10^8$ 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<br>• Given the wavelength of EM waves, calculate the frequency and vice versa, using the equation: | | | Show learners a diagram with the different types of EM radiation.<br>Make the link between EM radiation and everyday life |

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| | | • 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<br>• Indicate the penetrating ability of the different kinds of EM radiation and relate it to energy of the radiation<br>• Describe the dangers of gamma rays, X-rays and the damaging effect of ultra-violet radiation on skin<br>• Discuss radiation from cell-phones | | | |
| 1 hour | Nature of EM as particle - energy of a photon related to frequency and<br>Wavelength | • Define a photon<br>• Calculate the energy of a photon using<br>$E = hf = \frac{hc}{\lambda}$<br>Where h = 6.63 x$10^{-34}$ J.s is<br>Planck's constant, c=3x$10^{8}$ m.$s^{-1}$ is the speed of light in a vacuum and $\lambda$ 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. |

## GRADE 10 CHEMISTRY *(CHEMICAL SYSTEMS)* TERM

| Time | Topics Grade 10 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| **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<br>• Explain how the building of dams affect the lives of the people and the ecology in the region | **Activity:**<br>Study the ecology of the dams built to provide water for communities<br>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<br>• Study the ecology of rivers in your area<br>• Study the ecology of the dams built to provide water for communities<br>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<br>**Recommended experiment for informal assessment**<br>Test water samples for carbonates, chlorides, nitrates, nitrites, pH and look at water samples under the microscope<br>**Recommended project for informal assessment.**<br>The purification and quality of water | **Materials**<br>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.<br>The emphasise should be on the CHEMISTRY of the hydrosphere.<br>This topic can be given as a **project** to save teaching time. |

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| ***ASSESSMENT***<br>***TERM 4*** | **TERM 4: Prescribed Formal Assessment**<br>**1. Final Examinations** |

GRADE 11 PHYSICS (MECHANICS) TERM 1

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| **4 HOURS** | **Vectors in two dimensions** | | | | |
| 2 hours | Resultant of perpendicular vectors | • On a Cartesian plane, draw a sketch of the vertical (y-axis) and horizontal (x-axis)<br>• Add co-linear vertical vectors and co-linear horizontal vectors to obtain the net vertical vector ($R_y$) and net horizontal vector ($R_x$)<br>• Sketch $R_x$ and $R_y$ on a Cartesian plane<br>• Sketch the resultant (R) using either the tail-to-head or tail-to-tail method.<br>• Determine the magnitude of the resultant using the theorem of Pythagoras.<br>• 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<br>• Understand what is a closed vector diagram<br>• Determine the direction of the resultant using simple trigonometric ratios | **Practical activity**<br>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.<br>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<br>• Use $R_x= R\cos(\theta)$ for the resultant x-component<br>• Use $R_y = R\sin(\theta)$ for the resultant y-component | | | Use examples involving force and displacement vectors. |
| **23 HOURS** | **<u>Newton's Laws and Application of Newton's Laws.</u>** | | | | |
| | Different kinds of forces: weight, | • Define normal force, N, as the | **<u>Practical activity</u>** | **Materials:** | The force of static friction |

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| 5 hours | normal force, frictional force, applied (push, pull), tension (strings or cables) | force exerted by a surface on an object in contact with it<br>• Know that the normal force acts perpendicular to the surface irrespective of whether the plane is horizontal or inclined<br>• 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<br>• Distinguish between static and kinetic friction forces<br>• Explain what is meant by the maximum static friction, $f_s^{\max}$<br>• Calculate the value of the maximum static frictional force for objects at rest on horizontal and inclined planes using: $f_s^{\max} = \mu_s N$<br>• Know that static friction $f_s < \mu_s N$ | 1 Investigate the relationship between normal force and maximum static friction<br>2 Investigate the effect of different surfaces on maximum static friction by keeping the object the same.<br>and/or<br>3. Investigate the relationship between normal force and force of dynamic friction | 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. | can have a range of values from zero up to a maximum value, $\mu_s$ N. The force of dynamic friction on an object is constant for a given surface and equals $\mu_k$N.<br>Friction forces can be explained in terms of the interlocking of the irregularities in surfaces, which impedes motion.<br>**<u>Indigenous knowledge Systems</u>**<br>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: $f_k = \mu_k N$ | | | |
| | 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<br>• 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 | | | |

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| 3 hours | | from the dot<br>• 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<br>• The resultant or net force in the x-direction is a vector sum of all the components in the x- direction.<br>• The resultant or net force in the y-direction is a vector sum of all the components in the y-direction. | | | |
| 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.*<br>• Discuss why it is important to wear seatbelts using Newton's first law<br>• 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*<br>$\vec{F}_{net} = m\vec{a}$<br>• Draw force diagrams for objects that are in equilibrium (at rest or moving with constant velocity) and accelerating (non-equilibrium)<br>• Draw free body diagrams for objects that are in equilibrium (at rest or moving with constant velocity) and accelerating (non-equilibrium) | **<u>Practical Activity</u>**<br>Investigate the relationship between force and acceleration (Verification of Newton's second law) | **Materials:**<br>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.<br>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.<br>**NOTE**: Sum of forces perpendicular to the plane of the motion will always add up to zero. |
| | | • 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 | | | |

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| | | motion (lifts, rockets etc.) and also two-body systems such as two masses joined by a light (negligible mass) string<br>• Understand apparent weight<br>• 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*<br>• Identify action-reaction pairs e.g. donkey pulling a cart, a book on a table<br>• List the properties of action-reaction pairs | | | |
| 4 hours | Newton's Law of Universal Gravitation | • State Newton's Law of Universal Gravitation<br>• Use the equation for Newton's Law of Universal Gravitation to calculate the force two masses exert on each other<br>$F = G\frac{m_1 m_2}{d^2}$<br>• Describe weight as the gravitational force the Earth exerts on any object on or near its surface<br>• Calculate the acceleration due to gravity on Earth using the equation:<br>$g_{Earth} = G\frac{M_{Earth}}{d^2_{Earth}}$<br>*N.B. This formula can be used to calculate g on any planet using the appropriate planetary data*<br>• Calculate weight using the expression W= mg, where g is the acceleration due to gravity. Near the earth the value | **Practical activity**<br>Verify the value for g | Ticker timer apparatus, ticker tape (preferably self - carbonating tape), stop watch<br>You could include automated data logging apparatus as alternative materials | |

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| | | is approximately 9.8 $m{\cdot}s^{-2}$<br>• Calculate the weight of an object on other planets with different values of gravitational acceleration<br>• Distinguish between mass and weight. Know that the unit of weight is the newton (N) and that of mass is the kilogram (kg)<br>• Understand weightlessness | | | |

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

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| **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. | | | |
| | 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 | **Activity:**<br>Draw Lewis structures of the elements and determine the number of bonds the element can make. | 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.<br>Bonding is introduced in grade 10.<br>The atom, the arrangement of electrons into core and valence electrons. |

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| 2 hours | | • Deduce the number of valence electrons in an atom of an element<br>• Represent atoms using Lewis diagrams<br>• Explain, referring to diagrams showing electrostatic forces between protons and electrons, and in terms of energy considerations, why<br>- two H atoms form an $H_2$ molecule, but<br>- He does not form $He_2$<br>• Draw a Lewis diagram for the hydrogen molecule<br>• Describe a covalent chemical bond as a shared pair of electrons | **Activity:**<br>(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. | | ******************************* NB!!!**<br>**Increased stability due to lower potential energy (and higher entropy) to be used as the main reason for bonding.**<br>*********************************<br>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. |
| | | • Describe and apply simple rules to deduce bond formation, viz.<br>- different atoms, each with an unpaired valence electron can share these electrons to form a chemical bond<br>- different atoms with paired valence electrons called lone pairs of electrons, cannot share these four electrons and cannot form a chemical bond<br>- different atoms, with unpaired valence electrons can share these | | | 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.<br>The "two electrons" per bond is just as untrue as the "octet" rule. Both are just USEFUL MODELS to explain chemical bonding.<br>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 |

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| | | electrons and form a chemical bond for each electron pair shared (multiple bond formation)<br>- 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. $NH_4^+$, $H_3O^+$)<br>• Draw Lewis diagrams, given the formula and using electron configurations, for<br>• simple molecules (e.g. $F_2$, $H_2O$, $NH_3$, HF, $OF_2$, HOCℓ)<br>• molecules with multiple bonds e.g. $O_2$, $N_2$, HCN | | | Co-ordinate covalent or dative covalent bonds must NOT<br>be done in detail, ONLY the definition and an example of the concept is required |
| | Molecular shape as predicted using the Valence Shell Electron Pair Repulsion (VSEPR) theory. | • State the major principles used in the VSEPR<br>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<br>- Linear shape $AX_2$, (e.g. $CO_2$, $BeCl_2$)<br>- trigonal planar shape $AX_3$ (e.g. $BF_3$ )<br>- tetrahedral shape | **Activity:**<br>(1) Build the five ideal molecular shapes with Atomic Model kits or with Jelly Tots and tooth picks<br>(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 | **NOTE:** | Determine what learners know about VSEPR and what do they need to know.<br>Definition<br>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.<br>Structural electron pairs are bond pairs plus lone pairs.<br>OR<br>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. |

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| 2 hours | | $AX_4$ (e.g. $CH_4$)<br>- trigonal bipyramidal shape $AX_5$ (e.g. $PCl_5$)<br>- 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<br>• Deduce the shape of<br>- molecules like $CH_4$, $NH_3$, $H_2O$, $BeF_2$, and $BF_3$<br>- molecules with more than four bonds like $PCl_5$ and $SF_6$ and<br>- molecules with multiple bonds like $CO_2$ and $SO_2$ and $C_2H_2$ from their Lewis diagrams using VSEPR theory | 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) | 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. | Note: You only need Lewis diagrams of the molecule to be able to decide the shape of the molecules according to<br>VSEPR. (Hybridization is NOT needed.) |
| | Electronegativity of atoms to explain the polarity of bonds. | • Explain the concepts<br>- Electronegativity<br>- Non-polar bond with examples, e.g. H-H<br>- Polar bond with examples e.g. H-Cℓ<br>• Show polarity of bonds using partial charges δ+ H - Cl δ-<br>• Compare the polarity of chemical bonds using a | **Activity:**<br>(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<br>(2) Look at ideal molecular shapes (build with atomic model kits) **with** | | Link back to intermolecular forces.<br>**NOTE:**<br>The indications about electronegativity differences are given NOT as exact scientific knowledge but as a guideline for learners to work with in deciding polarity of a molecule.<br>(For teachers: All bonds have covalent and ionic character.) |

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| 1 hour | | table of electronegativities<br>• With an electronegativity difference $\Delta EN > 2.1$ electron transfer will take place and the bond would be ionic<br>• With an electronegativity difference $\Delta EN > 1$ the bond will be covalent and polar<br>• With an electronegativity difference $\Delta EN < 1$ the bond will be covalent and very weakly polar<br>• With an electronegativity difference $\Delta EN = 0$ the bond will be covalent and nonpolar<br>• Show how polar bonds do not always lead to polar molecules | **DIFFERENT end atoms** (look at electronegativity)<br>and the bond polarity and molecular polarity | | |
| 1 hour | Bond energy and length | • Give a definition of bond energy<br>• Give a definition of bond length<br>• Explain what is the relationship between bond energy and bond length<br>• Explain the relationship between the strength of a bond between two chemically bonded atoms and<br>- the length of the bond between them<br>- the size of the bonded | | | Link to potential energy diagram used to explain bonding above and point out the bond energy and bond length on the diagram.<br>BEWARE!!<br>That you don't elevate the Lewis presentations as physical truths in chemical bonding. There are NO PHYSICAL BONDS; the<br>chemical bond just represents an area of high electron density and low potential energy. |

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| | | atoms<br>- the number of bonds (single, double, triple) between the atoms | | | |
| 10 HOURS | **Intermolecular forces** | 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 |
| 6 hours | Intermolecular and interatomic forces (chemical bonds).<br><br>Physical state and density explained in terms of these forces.<br><br>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<br>• Explain hydrogen bonds (dipole-dipole)<br>• Revise the concept of a <u>covalent molecule</u><br>• Describe the difference between intermolecular forces and interatomic forces<br>- using a diagram of a group of small molecules; and in words<br>• Represent a common substance, made of small molecules, like water, using diagrams of | **<u>Practical activity</u>**<br>(1) Investigate and explain intermolecular forces and the effects of intermolecular forces on evaporation, surface tension, solubility, boiling points, and capillarity<br><br>**Activity:**<br>(1) Read the labels of different machine oils and motor oils: 15W 40 multi grade SAE 30 mono grade<br>What does the 15W40 stand for? What is the difference between mono grade and multi grade oil?<br>(2) Look at the liquid level in a measuring cylinder (water, oil, mercury…). What | **Materials:**<br>**Evaporation** of ethanol, water, nail polish remover and methylated spirits.<br>**Surface tension** of water, oil, glycerine, nail polish remover and methylated spirits<br>**Solubility** of sodium chloride, iodine, potassium permanganate in water, ethanol and chloroform.<br>**Boiling points** of water, oil, glycerine, nail polish remover and methylated spirits<br>**Capillarity** of water, oil, glycerine, nail polish remover and methylated spirits<br><br><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.<br>The 3 most common types of intermolecular forces should be described in this section:<br>**Hydrogen bonding** (10-40 kJ mol$^{-1}$) - hydrogen bonding occurs when hydrogen is bonded to an atom which has significantly greater electronegativity eg. Oxygen.<br>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.<br>**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. |

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| | | the molecules, to show microscopic representations of ice $H_2O$(s), water liquid $H_2O$ (l) and water vapour $H_2O$ (g). | do you observe about the meniscus? Explain<br><br>**Activity:**<br>Consider copper and graphite and explain how heat conductivity works in both cases | | |
| | | • Illustrate the proposition that intermolecular forces increase with increasing molecular size with examples e.g. He, O, $C_8H_{18}$ (petrol), $C_{23}H_{48}$ (wax). (only for van der Waals forces)<br>• Explain density of material in terms of the number of molecules in a unit volume, e.g. compare gases, liquids and solids<br>• Explain the relationship between the strength of intermolecular forces and melting points and boiling points of substances composed of small molecules<br>• Contrast the melting points of substances composed of small molecules with those of large molecules where bonds must be broken for substances to melt | | | 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 $Cl_2$<br>**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 e.g. $CH_4$<br>The larger the molecule the greater the dispersion force. Dispersion forces are only significant in the absence of any other interaction.<br>Also note that molecular size is only a significant factor in dispersion forces. |

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| | | • 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<br>• Explain the differences between thermal conductivity in non-metals and metals | | | |
| 4 hours | The chemistry of water<br><br>(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<br>• Water's unique features are due to the hydrogen bonding in solid, liquid and gaseous water<br>• Indicate the number of $H_2O$ molecules in 1 litre of water<br>• The hydrogen bonds require a lot of energy to break; therefore, water can absorb a lot of energy before the water temperature rises<br>• 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<br>• Explain that because | **Activity:**<br>(1) Build a water molecule with marbles and prestik or with Jelly Tots and tooth picks. Or with atomic model kits<br>(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?<br>(3) Measure the boiling point and melting point of water and determine the heating curve and cooling curve of water<br><br>**<u>Practical activity</u>**<br><br>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.<br>Fits in well after concepts of polarity and IMF.<br>Use the water molecule to summarise bonding, polarity, link between physical properties and chemical properties, IMF, etc.<br>The properties of water play an important role in the use of the following traditional apparatus:<br>(a) Water bag on the outside of your car or camel.<br>(b) Clay pots and carafes to keep food or water.<br>(c) "Safe" or "cool room" to keep food cool and prevent decay.<br>Explain how the properties of water influence the function of the apparatus. |

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| | | 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<br>A decrease in density when the water freezes helps water moderate the temperature of the earth and its climate | | | |
| | | • 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*** | **TERM 1: Prescribed Formal Assessment**<br>• **Experiment**<br>• **Controlled test** | | | | |

**TERM 2 GRADE 11**

**GRADE 11 PHYSICS *(ELECTRICITY & MAGNETISM)* TERM 2**

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| **6 HOURS** | **Electrostatics** | | | | |
| | Coulomb's Law | • State Coulomb's Law, which | | | Here is another |

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| 3 hours | | 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). | | | 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.<br><br>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.<br><br>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.<br><br>Make a link with Grade 11 Mechanics, Newton's Law of Universal Gravitation i.e. |

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| | | | | | 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.<br>NOTE:<br>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<br>• Draw electric field lines for various configurations of charges<br>• Define the magnitude of the electric field at a point as the force per unit charge<br>$E = F/q$<br>$\vec{E}$ 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 |

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| | | | | | 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<br>• Calculate the electric field at a point due to a number of point charges, using the equation $F = \frac{KQ}{r^2}$ 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. |
| **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<br>• 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<br>• Draw the magnetic field lines around (i) a straight | **Practical Demonstration:**<br>Get learners to observe the magnetic field around a current carrying wire<br>**Project:**<br>Make an electromagnet | **Materials:**<br>Power supply, wire, retort stand, cardboard, several compasses.<br>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 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| | | current carrying wire, (ii) a current carrying loop (single) of wire and (iii) a solenoid<br>Discuss qualitatively the environmental impact of overhead electrical cables | | | |
| 3 hours | Faraday's Law. | • State Faraday's Law.<br>• 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<br>• 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<br>• 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: $Ø = BA\cos\theta$, where θ is the angle between the magnetic field B and the normal to the loop of area A<br>• Know that the induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux<br>• Calculate the induced emf and induced current for situations involving a changing magnetic field using the equation for Faraday's Law: | **Practical Demonstration:**<br>Faraday's law | **Materials:**<br>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. |

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| | | $$\varepsilon = -N\frac{\Delta\phi}{\Delta t}$$ where ∅=BAcosθ is the magnetic flux | | | 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. |
| **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<br>• State the difference between Ohmic and non- Ohmic conductors, and give an example of each<br>• Solve problems using the mathematical expression of Ohm's Law, R=V/I, for series and parallel circuits | **Practical activity**<br>Obtain current and voltage data for a resistor and light bulb and determine which one obeys Ohm's law. | **Materials:**<br>Light bulb, resistor, connecting wires, ammeter and voltmeter | Maximum of four resistors |
| | Power, Energy | • Define power as the rate at which electrical energy is converted in an electric circuit and is measured in watts (W)<br>• Know that electrical power dissipated in a device is equal to the product of the | **Experiment/Demonstration:**<br>Investigate the power dissipated in bulbs connected either in series or parallel or both series and parallel | **Materials:**<br>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.<br>Maximum of four resistors |

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| 4 hours | | potential difference across the device and current flowing through it i.e. P=IV<br>• Know that power can also be given by $P=I^2R$ or $P=V^2/R$<br>• Solve circuit problems involving the concept of power<br>• Know that the electrical energy is given by E=Pt and is measured in joules (J)<br>• Solve problems involving the concept of electrical energy<br>• Know that the kilowatt hour (kWh) refers to the use of 1 kilowatt of electricity for 1 hour<br>• 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 | | | **Note:**<br>Textbooks use both kWh AND kWhr as abbreviations for kilowatt hour. |

**GRADE 11 CHEMISTRY *(CHEMICAL CHANGE) TERM 2***

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
| --- | --- | --- | --- | --- | --- |
| **12 HOURS** | **Quantitative aspects of chemical change** | 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)** |
| | 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)<br>• Interpret balanced reaction equations in terms of volume relationships for gases under | **Experiment:**<br>(1) Make standard solutions of ordinary salts<br>**Activity:**<br>(2) Do titration calculations | | Make a flow diagram of all the stoichiometry calculations.<br>Link back to gas laws. Express as SI units |

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| 3 hours | | the same conditions of temperature and pressure (volume of gases is directly proportional to the number of particles of the gases)<br>• Calculate molar concentration of a solution | Precipitation calculations: calculate the mass of the precipitate | | |
| 6 hours | More complex Stoichiometric calculations | • Perform stoichiometric calculations using balanced equations that may include limiting reagents<br>• Do stoichiometric calculation to determine the percent yield of a chemical reaction<br>• Do calculations to determine empirical formula and molecular formula of compounds (revise empirical formula calculations done in grade 10)<br>• Determine the percent $CaCO_3$ in an impure sample of sea shells (purity or percentage composition) | **Practical activity**<br>(1) Determine the mass of $PbO_2$ prepared from a certain mass of $Pb(NO_3)_2$ | **Materials:**<br>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.<br>**Remember!**<br>Mass meter experiments can also be done without mass meters!!<br>Electronic pocket scale (0,1g to 500g). |
| 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.<br>• $2NH_4NO_3 \rightarrow 2N_2(g) + 4H_2O(g) + O_2(g)$<br>$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$<br>Give the reactions and use it in stoichiometric calculations<br>• Do as application the functioning | | | The thermal decomposition of ammonium nitrate.<br>$2NH_4NO_3 \rightarrow 2N_2(g) + 4H_2O(g) + O_2(g)$<br>Reaction must be given when used in calculations. |

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| | | of airbags. Sodium azide reaction:<br>$2NaN (s) \rightarrow 2Na(s) + N_2(g)$<br>Reaction must be given when used in calculations | | | |
| ***ASSESSMENT TERM 2*** | | <u>**TERM 2: Formal Assessment**</u><br>**Midyear Examinations** | | | |

## TERM 3 GRADE 11

### GRADE 11 CHEMISTRY *(CHEMICAL CHANGE)* TERM 3

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| **4 HOURS** | <u>**Energy and chemical change:**</u> | 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<br>• Define exothermic and endothermic reactions<br>• Identify that bond breaking requires energy (endothermic) and that bond formation releases energy (exothermic)<br>Classify (with reason) the following reactions as exothermic or endothermic: respiration; photosynthesis; combustion of fuels | <u>**Practical activity**</u><br>(1) Investigate endothermic reactions as for example ammonium nitrate and water, potassium nitrate and water and magnesium sulphate and water, **AND**<br>Investigate exothermic reactions as for example calcium chloride and water, dry copper(II) sulphate and water and lithium and water. (Identify and | **Materials:**<br>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.<br>**Materials:**<br>Glass beaker, | Link bond making and bond breaking to potential energy diagram used in bonding previously. |

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| | | | explain the applications of exothermic and endothermic reactions in everyday life and industry) | thermometer, water bowl, test tubes, spatula, potassium permanganate, copper(II) sulphate, lithium, magnesium ribbon, magnesium powder, dilute sulphuric acid, calcium chloride, glycerine | |
| 1 hour | Exothermic and endothermic reactions; | • State that $\Delta H > 0$ for endothermic reactions.<br>• State that $\Delta H<0$ for exothermic reactions<br>• Draw free hand graphs of endothermic reactions and exothermic reactions<br>(without activation energy) | | | |
| 1 hour | Activation energy. | • Define activation energy<br>• Explain a reaction process in terms of energy change and relate this change to bond breaking and formation and to "activated complex"<br>• Draw free hand graphs of endothermic reactions and exothermic reactions (with activation energy) | **Experiment:**<br>(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 | Contents, 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<br>• Define an acid as an $H^+$ donor and a base as an $H^+$ acceptor in reaction<br>• Identify conjugate acid/base pairs<br>• Define an ampholyte<br>• List common acids (including hydrochloric acid, nitric<br>• acid, sulfuric acid and acetic acid) and common bases (including sodium carbonate, sodium hydrogen carbonate and sodium hydroxide) by name and formula | **Experiment:**<br>(1) Titration (leave until grade 12 or do a simple qualitative titration here and a more practical applied and quantitative titration in grade 12)<br>**Practical Activity**<br>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:**<br>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.<br>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<br>• What is an indicator? Look for some natural indicators<br>• Use acid-base reactions to produce and isolate salts | (3) Prepare sodium chloride salt by using acid base reactions to produce and isolate salts<br>(4) What is the purpose of using limestone by communities when building blair toilets (pit latrines)?<br>What is the purpose of | | |

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| | | e.g. $Na_2SO_4$, $CuSO_4$ and $CaCO_3$. | using ash in the blair toilets by communities? | | |

## GRADE 11 CHEMISTRY *(MATTER & MATERIALS)* TERM 3

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| **8 HOURS** | **Ideal gases and thermal properties:** | 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.<br>- collisions with each other and the walls of the container<br>- molecules in a sample of gas move at different speeds<br>• Explain the idea of 'average speeds' in the context of molecules of a gas<br>• Describe an ideal gas in terms of the motion of molecules<br>• Explain how a real gas differs from an ideal gas<br>• State the conditions under which a real gas approaches ideal gas behavior<br>• Use kinetic theory to explain the gas laws | | | Integrate the teaching of this section into the treatment of the ideal gas laws that follows<br>Link this section to KMT from grade 10 |
| | Ideal gas law | • Describe the relationship between volume and pressure for a fixed amount of a gas at constant temperature (Boyle's | **Practical Task**<br>(1) Verify Boyle's law<br>**Experiment:** | **Materials:**<br>Pressure gauge. 10 ml syringe, 3 cm | This section is an excellent opportunity to show the relationship between |

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| 6 hours | | Law)<br>• Describe the relationship between volume and temperature for a fixed amount of a gas at constant pressure (Charles' Law) and<br>• Describe the relationship between pressure and temperature for a fixed amount of a gas at constant volume (Gay Lussac)<br>- practically using an example<br>- by interpreting a typical table of results<br>- using relevant graphs (introducing the Kelvin scale of temperature where appropriate)<br>- using symbols ('∝') and the words 'directly proportional' and 'inversely proportional' as applicable<br>- writing a relevant equation<br>• Combine the three gas laws into the ideal gas law, PV = nRT<br>• Use the gas laws to solve problems, $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ | Verify Charles' law (exp2) | silicone tubing to attach syringe to pressure gauge, water bowl.<br>**Materials:**<br>Burner, glass beaker, 10 ml syringe, stopper for syringe, thermometer ($-10^0$ - $100^0C$), water bowl, ice. | macro and micro, e.g. explain the pressure volume relationship in terms of particle motions.<br>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.<br>Link to skills topic in grade 10 |
| | | • Give the conditions under which the ideal gas law does not apply to a real gas and explain why<br>Convert Celsius to Kelvin for use in ideal gas law | | | |
| | Temperature and heating, pressure; | • Explain the temperature of a gas in terms of the average kinetic energy of the | | | |

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| 1 hour | | molecules of the gas<br>• Explain the pressure exerted by a gas in terms of the collision of the molecules with the walls of the container | | | |

**GRADE 11 PHYSICS *(WAVES, SOUND & LIGHT)* TERM 3**

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

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| | | show the path of a light ray through different media | | | |
| 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)<br>$n_1 \sin\theta_1 = n_2 \sin\theta_2$<br>• Apply Snell's Law to problems involving light rays passing from one medium into another<br>• Draw ray diagrams showing the path of light when it travels from a medium<br>• with higher refractive index to one of lower refractive index and vice versa | **Recommended practical activity:**<br>Verifying Snell's Laws and determine the refractive index of an unknown solid transparent material using Snell's law | **Materials:**<br>Glass block, Ray box, 0-360$^0$ protractor, A4 paper<br>**Materials:**<br>Glass block, Ray box, 0-360$^0$<br>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<br>• List the conditions required for total internal reflection<br>• Use Snell's Law to calculate the critical angle at the surface between a given pair of media<br>• Explain the use of optical fibers in endoscopes and telecommunications | **<u>Practical task:</u>**<br>Determine the critical angle of a rectangular glass (clear) block | **Materials:**<br>Glass block, Ray box | |
| **ASSESSMENT TERM 3** | | **TERM 3: Prescribed Formal Assessment**<br>**1. Experiment 2**<br>**2. Controlled test** | | | |

**TERM 4 GRADE 11**

**GRADE 11 PHYSICS *(WAVES, SOUND & LIGHT)* TERM 4**

| Time | Topics Grade 11 | Contents, 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)<br>• State Huygen's principle.<br>• 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<br>• 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<br>• Sketch the diffraction pattern for a single slit<br>• Understand that degree of diffraction $\propto \frac{\lambda}{w}$ where w = slit width<br>Understand that diffraction of light demonstrates the wave nature of light | **Experiment / Demonstration**<br>Demonstrate diffraction using a single slit | **Materials:**<br>Single slit (learners can make this using a small plane mirror or using a small rectangular plane sheet of glass that is painted black on one side)<br>Straight filament bulb, colour filters | It is very helpful to use water waves in a ripple tank to demonstrate diffraction. |

**GRADE 11 CHEMISTRY *(CHEMICAL SYSTEMS)* TERM 4**

| Time | Topics Grade 11 | Contents, 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.<br>**Choose ONE mining activity and develop the mining activity according to the statements given** | | | Choose only one mining activity<br>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:<br>Gold, iron, phosphate, coal, diamond, copper, platinum, zinc, chrome, asbestos and manganese mining industries | • Give a brief history of humankind across the ages:<br>- Linking their technology and the materials they have used to their tools and their weapons<br>- Referring to evidence of these activities in South Africa<br>- Describe the earth's crust as a source of the materials man uses<br>• What is available? (the abundance of the elements on earth) | **Experiment:**<br>(1) Investigate the process of corrosion of iron<br>**Activity:**<br>(2) Describe the methods for the extraction of metals from their ores, such as the physical method, heating alone and heating with carbon<br>(3) Describe different forms of calcium carbonate in nature<br>**Experiment: (4)**<br>Investigate the actions of heat, water, and acids on calcium carbonate.<br>**Experiment: (5)**<br>Design and perform chemical tests for calcium carbonate | **Materials:**<br>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.<br>Link to aspects of chemical reactions - oxidation, factors affecting rates of reactions etc. |
| | | • Where is it found? (the uneven distribution of elements across the | **Experiment:** | | **Questions to be asked:** |

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| 8 hours | | atmosphere, the hydrosphere, the biosphere and the lithosphere)<br>• How is it found? (Seldom as elements, inevitably as minerals)<br>• 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)<br>• Describe the **recovery of gold** referring to<br>- why it is worth mining?<br>• the location of the major mining activity in South Africa? | (6) How can we use Oxy-cleaners to produce oxygen?<br>(7) How can we use Oxy-cleaners to get a metal from its ore?<br>**Discussion**<br>(8) Participate in decision-making exercises or discussions on issues related to conservation of natural resources<br>**Practical task:**<br>Learner could investigate the mining industries not chosen by the teacher<br>Gold; Coal; Copper; Iron; Zinc; Manganese; Chrome; Platinum and Pt group metals (PGM's); Diamonds<br>OR<br>**Practical task:**<br>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 | | Why is this mining industry important in SA?<br>Where do the mining activities take place?<br>How is the mineral mined? E.g. mining method, major steps in the process, refining method.<br>What is the mineral used for?<br>What is the impact of the mining industry on SA, e.g. environment, economic impact, safety, etc? |
| | | - the major steps in the process: deep level underground mining separation of the ore from other rock<br>- the need to crush the ore bearing rock<br>- separating the finely divided gold metal in the ore by dissolving in a sodium cyanide | | | 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 |

| Time | Topics Grade 11 | Contents, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| 8 hours | | oxygen mixture (oxidation) - simple reaction equation<br>- the recovery of the gold by precipitation (Zn) (reduction) - simple reaction equation (this method is outdated, mines use activated carbon) smelting<br>• Discuss old mining methods and the impact on the environment of such methods e.g. Mapungubwe.<br>• Give the major steps in the process of mining if you have chosen one of the other mining activities.<br>• Describe the environmental impact of (1) mining operations and (2) mineral recovery plants<br>• Describe the consequences of the current large scale burning of fossil fuels; and why many scientists and climatologists are predicting global warming | | | Mapungubwe.<br>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 TERM 4** | | **<u>TERM 4: Prescribed Formal Assessment</u>**<br>**1. Final Examinations** | | | |

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

| Time | Topics Grade 12 | Content, Concepts and Skills | Practical activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| 4 hrs | 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<br>• Identify an answerable question and formulate a hypothesis to guide a scientific investigation<br>• Design a simple experiment including appropriate controls<br>• Perform and understand laboratory procedures directed at testing a hypothesis<br>• Select appropriate tools and technology to collect precise and accurate quantitative data<br>• Correctly read a thermometer, a balance, metric ruler, graduated cylinder, pipette, and burette<br>• Record observations and data using the correct scientific units<br>• Export data into the appropriate form of data presentation (e.g. equation, table, graph, or diagram)<br>• 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)<br>• Determine the accuracy and the precision of experimental results<br>• Analyze experimental results and identify possible sources of bias or experimental error<br>• Recognize, analyze and evaluate alternative explanations for the same set of observations<br>• Design a model based on the correct hypothesis that can be used for further investigation<br>• Define qualitative analysis and give a practical example<br>• Define quantitative analysis and give a practical example | Activity:<br>(1) Analyse the components of a properly designed scientific investigation.<br>(2) Choose an experiment and determine appropriate tools to gather precise and accurate data<br>(3) Defend a conclusion based on scientific evidence<br>(4) Determine why a conclusion is free from bias<br>(5) Compare conclusions that offer different, but acceptable explanations for the same set of experimental data<br>(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.<br>This section should be taught while the learners do an investigation themselves.<br>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<br>• Calculate the momentum of a moving object using $p = mv$<br>• Describe the vector nature of momentum and illustrate with some simple examples<br>• 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*<br>• Express Newton's second law in symbols: $F_{net} = \frac{\Delta p}{\Delta t}$<br>• Explain the relationship between net force and change in momentum for a variety of motions<br>• 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 | | | 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.<br>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 |
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| 5 hours | Conservation of momentum and Elastic and Inelastic collisions. | • Explain what is meant by a system (in physics)<br>• Explain (when working with systems) what is meant by internal and external forces<br>• Explain that an isolated system is one that has no net force (external) acting on it<br>• State the law of conservation of momentum as: *The total linear momentum of an isolated system remains constant* (is conserved)<br>• Distinguish between elastic and inelastic collisions<br>• Know that kinetic energy is only conserved in an elastic collision<br>• 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. | **<u>Experiment</u>:**<br><br>Verify the Conservation of Linear Momentum<br><br>**<u>Demonstration</u> for informal assessment**<br><br>Investigate the Conservation of momentum and energy using Newton's cradle (qualitative) | **Materials for prescribed experiment**<br><br>Air-track with blower. Two trolleys, pulley, two photo-gates, two retort stands, dual timer, metre-stick, black card, set of equal weights<br><br>OR<br><br>Two spring-loaded trolleys, stop-watch, meter-stick, two barriers<br><br>**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 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| 4 hours | Impulse | • Define impulse as the product of the net force and the contact time i.e. Impulse= $F_{net}\Delta t$<br>• Know that impulse is a vector quantity<br>• 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<br>• 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<br>• 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 |
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| **5 HOURS** | **Vertical projectile motion in one dimension (1D)** | | | | |
| 5 hours | Vertical projectile motion * (1D) represented in words, diagrams, equations and graphs<br><br>* 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<br>• 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<br>• Know that projectiles can have their motion described by a single set of equations for the upward and downward motion<br>• Use equations of motion to determine the position, velocity and displacement of a projectile at any given time<br>• 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:**<br><br>Investigate the motion of a falling body<br><br>Draw a graph of position vs. time and velocity vs. time for a free falling object **AND**<br><br>Use the data to determine the acceleration due to gravity | **Materials:**<br><br>Ticker tape apparatus, ticker-timer, mass, platform.<br><br>You could include automated data logging apparatus as alternative materials | |

| Time | Topics Grade 12 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| | | • Give equations for position versus time and velocity versus time for the graphs of 1D projectile motion<br>• Given x vs. t, v vs. t or a vs. t graphs determine position, displacement, velocity or acceleration at any time t.<br>• 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 |
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| **16 HOURS** | **Organic molecules:** | • Define organic molecules as molecules containing carbon atoms.<br>• 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<br>• 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)<br>• Explain the terms functional group, hydrocarbon and homologous series<br>• Explain the terms saturated, unsaturated and isomer<br>• Identify compounds that are saturated, unsaturated and are isomers (up to 8 carbon atoms) | **<u>Recommended experiment</u>**<br>**for informal assessment**<br>(1) Use the reactions of alkanes and alkenes with bromine water and potassium permanganate to indicate saturated and unsaturated molecules<br>(2) Prepare alkynes and investigate the reactions with bromine water and potassium permanganate<br>**Other Experiments**<br>(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)<br>(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<br><br>**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.<br>Links to Gr 11 multiple bonds<br>Emphasis should be placed on different representations of organic compounds: macroscopic, sub-microscopic and symbolic representation and the links between them<br>Also illustrate their 3D orientation using models to build them (marbles and prestik or jelly tots and toothpicks),<br>Show reactions taking place with the models<br>Explain the physical properties with the models<br>Molecular formula = $C_5H_{12}O$<br>Structural formula = where ALL the bonds are shown.<br>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 |
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| | | • 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 | | | |
| 3 hours | IUPAC naming and formulae, | • Give the IUPAC name when given the formula<br>• Give the formula when given the IUPAC name<br>• 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)<br>• 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<br>**Activity:**<br>(1) Drawing structural formulae and writing systematic names for alkanes, alkenes, alcohols and carboxylic acids<br>(2) Building molecular models of simple alkanes, alkenes, alcohols and carboxylic acids (use atomic model kits)<br>(3) Building molecular models of compounds with different functional groups.<br>(4) Building molecular models of but-2-enes<br>(5) Building molecular models of butan-2-ol or propanoic acid | | Link to Intermolecular forces in grade 11<br>Cycloalkanes, cycloalkenes and dienes are allowed under the same rules that apply to all the other organic molecules.<br>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. |

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| | | • The only substituent chains that are allowed in naming and reactions are: methyl- and ethyl- groups<br>• 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.<br>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:<br>- physical properties and intermolecular forces (ethanol, dimethyl ether, ethanoic acid, ethane, chloro-ethane)<br>- physical properties and number and type of functional groups (ethanol, dimethyl ether, ethanoic acid, ethane, chloro-ethane)<br>- physical properties and chain length (methane, ethane, propane, butane, hexane, octane)<br>- physical properties and branched chains (pentane, 2-methylbutane;<br>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.<br>The IMF to be considered are hydrogen bonds and Van der Waals forces. |

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| 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:<br>alkane + $O_2$ $\rightarrow$ $H_2O$ + $CO_2$<br><br>with $\Delta H<0$<br><br>• An ester is a product of an acid catalyzed condensation between an alcohol and a carboxylic acid<br><br>• Identify the alcohol and carboxylic acid used to prepare a given ester and vice versa, and write an equation to present this preparation | **<u>EXPERIMENT</u>**<br><br>(1) Prepare different Esters and identify the Esters by smell | **Material:**<br><br>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 |
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| 4 hours | Substitution, addition and elimination.<br><br>(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<br><br>• **Addition reactions:**<br><br>Unsaturated compounds (alkenes, cycloalkenes) undergo addition reactions:<br><br>- Hydrohalogenation:<br><br>Addition of HX to an alkene e.g.<br><br>$CH_2{=}CH_2 + HC\ell \rightarrow CH_3 - CH_2C\ell$<br><br>Reaction conditions:<br><br>HX (X = Cℓ, Br, I) added to alkene; no water must be present<br><br>(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)<br><br>- Halogenation:<br><br>Addition of $X_2$ (X = Cℓ, Br) to<br><br>alkenes e.g.<br><br>$CH_2{=}CH_2 + C\ell_2 \rightarrow CH_2C\ell\text{-}CH_2C\ell$<br><br>Reaction conditions:<br><br>$X_2$ (X = Cℓ, Br) added to alkene | **Experiment:**<br><br>• Prepare ethanol from ethene<br><br>• Demonstrate the hydrogenation of vegetable oils to form margarine<br><br>• | | Recall some organic compounds that are produced by people in their homes e.g. alcohol from sorghum beer or grapes or malt or rice.<br><br>Why does over fermentation lead to acid formation?<br><br>How is sour porridge made? What are the reactants and what are the products?<br><br>Unsaturated compounds undergo addition reactions to form saturated compounds e.g.<br><br>$CH_2{=}CH_2 + C\ell_2 \rightarrow CH_2C\ell\text{-}CH_2C\ell$ |

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| | | - Hydration:<br>Addition of $H_2O$ to alkenes e.g.<br>$CH_2 = CH_2 + H_2O \rightarrow CH_3\text{-}CH_2OH$<br>Reaction conditions: $H_2O$ in excess and a small amount of HX or other strong acid ($H_3PO_4$) as catalyst<br>(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)<br>- Hydrogenation:<br>Addition of $H_2$ to alkenes e.g.<br>$CH_2 = CH_2 + H_2 \rightarrow CH_3 - CH_3$<br>Reaction conditions: alkene dissolved in a non-polar solvent with the catalyst (Pt, Pd or Ni) in a $H_2$ atmosphere | | | |

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| | | • **Elimination reactions:**<br>Saturated compounds (haloalkanes, alcohols, alkanes) undergo elimination reactions<br>- Dehydrohalogenation:<br>Elimination of HX from a haloalkane e.g.<br>$CH_2C\ell\text{-}CH_2C\ell \rightarrow CH_2\text{=}CHC\ell + HC\ell$<br>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 ethanoic NaOH/KOH<br>(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.<br>$CH_2C\ell\text{-}CH_2C\ell \rightarrow CH_2\text{=}CHC\ell + HC\ell$ | | |

| Time | Topics Grade 12 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| | | - Dehydration of alcohols:<br>Elimination of $H_2O$ from an alcohol e.g.<br>$CH_3 - CH_3OH \rightarrow CH_2{=}CH_2 + H_2O$<br>Reaction conditions: Acid catalysed dehydration - heating of alcohol with an excess of concentrated $H_2SO_4$ (or $H_3PO_4$)<br>(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)<br>• Cracking of hydrocarbons:<br>Breaking up large hydrocarbon molecules into smaller and more useful bits<br>Reaction conditions: high pressures and temperatures without a catalyst (thermal cracking), or lower temperatures and pressures in the presence of a catalyst (catalytic cracking) | | | |

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| | | - **Substitution reactions:**<br>- Interconversion between alcohols and haloalkanes:<br>Reations of<br>HX (X = Cℓ, Br) with alcohols<br>to produce haloalkanes:<br>Reaction conditions:<br>- Tertiary alcohols are converted into haloalkanes using HBr or HCℓ at room temperature e.g.<br>- $C(CH_3)_3\ OH + HBr \rightarrow C(CH_3)_3\ Br + H_2O$<br>- The reaction works best with tertiary alcohols. Primary and secondary alcohols react slowly and at high temperatures.<br>*Reactions of bases with haloalkanes (Hydrolysis) to produce alcohols e.g.*<br>• $C(CH_3)_3\ Br + KOH \rightarrow C(CH_3)_3\ OH + KBr$<br>Reaction conditions: Haloalkane dissolved in ethanol before treatment with aqueous sodium hydroxide and warming th mixture; the same hydrolysis reaction 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.<br>• $C(CH_3)_3\ OH + HBr \rightarrow C(CH_3)_3\ Br + H_2O$<br>• $C(CH_3)_3\ Br + KOH \rightarrow C(CH_3)_3\ OH + KBr$<br>• Write equations for simple substitution reactions e.g. Organic reactions:<br>• $CH_4 + C\ell_2 \rightarrow CH_3C\ell + HC\ell$<br>• $CH_2\ C\ell + H_2O \rightarrow CH_3OH + HC\ell$ | | Distinguish between primary, secondary and tertiary carbons. A primary carbon<br>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.<br>For example:<br>$CH_3CH_2CH_3$ carbon 1 and 3 are<br>primary carbons because they<br>are only bonded to one other carbon atom.<br>Carbon 2 is a secondary carbon because it is bonded to two other carbon atoms. In $C(CH_3)_3X$ the central carbon<br>in this compound is a tertiary<br>carbon because it is bonded to three other carbons.<br>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 –<br>OH bonded to a tertiary carbon ($C(CH_3)_3OH$). |

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| | | Reactions of bases with haloalkanes (hydrolysis) to produce alcohols e.g.<br>$C(CH_3)_3X + KOH \rightarrow C(CH_3)_3OH + KBr$<br>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<br>- Haloalkanes from alkanes.<br>Reaction conditions: $X_2$ (X = Br, Cℓ) added to alkane in the presence of light or heat | **Experiment:**<br>(1) Alkanes and alkenes react with bromine and potassium permanganate (substitution and addition)<br>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 | **Materials:**<br>Propettes, test tubes, solid stoppers, spatula, hexane, hexene, bromine water, spatula, potassium permanganate, dilute hydrochloric acid, chloroform. | Link to reactions used in industry:<br>Substitution, addition and elimination.<br>SASOL - polymers<br>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 |
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| 4 hours | Plastics and polymers<br><br>**(**ONLY BASIC POLYMERISATION as<br><br>application for organic chemistry) | • Describe the term polymer; macromolecule, chain, monomer, functional groups<br>• Illustrate the reaction to produce a polymer by an addition reaction using the polymerization of ONLY ethene to produce polythene<br>$[nCH_2 = CH_2 \rightarrow (-CH_2 - CH_2 -)_n]$<br>• 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)<br>• Illustrate the reaction to produce a polymer by <u>condensation reaction</u> with the reaction to produce a polyester. Use ONLY the reaction to make the polymer polyethylene | **Experiment**<br>(1) Plastics physical properties and recycling numbers<br>(2) Performing an experiment to prepare an addition polymer<br>**Activities:**<br>(1) Searching for information or reading articles about the discovery of polyethene and the development of addition polymers<br>(2) Building physical or computer models of addition polymers<br>(3) Searching for and presenting information on environmental issues related to the use of plastics<br>(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.<br><br>What do you know about Kevlar and Mylar?<br><br>What are the functions of these materials and what are they used for? Who discovered or invented the materials?<br><br>Investigate what some windscreens are made of?<br><br>What are break pads made of?<br><br>Discuss the different polymers that are used instead of glass.<br><br>Another example is the following<br><br>Illustrate the reaction to produce a polymer by <u>condensation reaction</u> with the reaction to produce a polyester. |

| Time | Topics Grade 12 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| | | Illustrate the reaction to produce a polymer by condensation reaction with the reaction to produce a polyester. Polylactic acid<br><br>(PLA) is an interesting polymer because the monomer used for this polymer comes from the biological fermentation of plant materials (as opposed<br><br>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<br><br>O O O O<br><br>n HOC R COH + n $HOCH_2CH_2OH$ C R $COCH_2CH_2O$ + 2 n $H_2O$<br><br>• 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)<br><br>• Identify a polymer as the product of an addition or condensation polymerization reaction | | | |

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

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| ***ASSESSMENT***<br>***TERM 1*** | **<u>TERM 1: Prescribed Formal Assessment</u>**<br>**1. Experiment**<br>**2. Control Test** |

| TERM 2: GRADE 12 |
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## GRADE 12 PHYSICS *(MECHANICS)* TERM 2

| Time | Topics Grade 12 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| **10 HOURS** | **Work, Energy & Power** | | | | |
| 2 hours | Definition of Work | • Define the work done on an object by a force as: $W = F\Delta x \cos\theta$.<br>• Know that work is a scalar quantity and is measured in joules (J)<br>• 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<br>• 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<br>**ALTERNATE METHOD FOR DETERMINING**<br>**THE NET WORk.**<br>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.<br>Forces perpendicular to the objects displacement do no work on the object, since $\theta=90^{\circ}$ ($\cos\theta=0$)<br>Forces parallel to the objects displacement do positive work on the object, since $\theta=0^{\circ}$ ($\cos\theta=1$)<br>Forces anti-parallel to the objects displacement (eg friction) do negative work on the object, since $\theta=180^{\circ}$ ($\cos\theta=-1$) |

| Time | Topics Grade 12 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| | | 2. Calculate the resultant force (along the plane)<br>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<br>Theorem | • Know that the net work done on an object causes a change in the object's kinetic energy - the *work-energy theorem* -<br>$W_{net} = E_{kf} - E_{ki}$<br>• 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 |
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| 3 hours | Conservation of energy with non-conservative forces present. | • Define conservative forces and give an example<br>• Define non-conservative forces and give examples<br>• Know that when only conservative forces are present, mechanical energy is conserved<br>• 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<br>• Solve conservation of energy problems (with dissipative forces present) using the equation:<br>$W_{nc} = \Delta E_k + \Delta E_p$<br>• 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<br><br>a closed path, starting and ending at the same point is zero. Gravitational force is an example of a conservative force.<br><br>Examples of non-conservative forces include air resistance, friction, tension and applied forces.<br><br>$W_{nc}$ represents the work done by the non-conservative forces |

| Time | Topics Grade 12 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| 3 hours | Power | • Define power as the rate at which work is done<br>• Calculate the power involved when work is done<br>• 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<br>$P_{av} = Fv_{av}$<br>• Calculate the minimum power required of an electric motor to pump water from a borehole of a particular depth at a particular rate using<br>$W_{nc} = \Delta E_k + \Delta E_p$<br>• Calculate and understand minimum and maximum power. | **Recommended practical investigation for informal assessment:**<br><br>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:**<br><br>Flight of stairs, stopwatch, measuring tape (5m) or meter stick, | |

**GRADE 12 CHEMISTRY *(CHEMICAL CHANGE)* TERM 2**

| Time | Topics Grade 12 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
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| **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<br>• List the factors which affect the rate of chemical reactions. (Surface area (solid), concentration (solution), pressure (gas), temperature, and catalyst)<br>• Explain in terms of collision theory how the various factors affect the rate of chemical reactions | **Experiments:**<br>Determine the:<br>(1) Effect of different concentrations of-vinegar and baking soda<br>(2) Effect of temperature - vinegar and baking soda; Alka Seltzer or Cal-C-Vita<br>(3) Effect of temperature and concentration - potassium iodate (0.01 M), soluble starch, $Na_2S_2O_3$ and $H_2SO_4$ (iodine clock reaction) | **Materials:** | This section must be done very well; deep understanding of this section gives the foundation for incisive knowledge later.<br>Link chemical systems grade 12 to industrial processes.<br>Very useful PHET simulations of reaction rate are available. Also others like Greenbowe simulations for redox reactions |

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| | | • | (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 | | |

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| 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**<br>(1) Determine the reaction rate and the influence of all the rate factors in the reaction of Zn and HCl<br>**<u>Recommended experiment for informal assessment</u>**<br>(2) Determine the quantitative reaction rate and drawing graphs in the reaction between $Na_2S_2O_3$ and HCl.<br>Turbidity is seldom quantitatively accurate, but it is useful | **Materials:**<br>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 |

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| 1 hour | Mechanism of reaction and of catalysis; | • Define activation energy - the minimum energy required for a reaction to take place. Colliding<br><br>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<br><br>• 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<br><br>• 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:**<br><br>(1) Using appropriate methods, skills, and techniques,<br><br>such as the micro-scale chemistry technique to study the progress of a reaction | **Materials:** | Activation energy revised.<br><br>This topic is important and relevant. |

| Time | Topics Grade 12 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| **8 HOURS** | **Chemical Equilibrium** | | | | |
| 2 hours | Chemical equilibrium and factors affecting equilibrium; | • Explain what is meant by:<br>- Open and closed systems<br>- A reversible reaction<br>- Dynamic equilibrium<br>• List the factors which influence the **position** of an equilibrium | **Recommended experiment for informal assessment**<br>(1) Investigate equilibrium and the factors influencing equilibrium on the equilibrium of $CoCl_2$ and $H_2O$<br>(2) Designing and performing an experiment to investigate effects of pH on equilibrium systems such as:<br>$Br_2(aq) + H_2O(l) \rightleftarrows$<br>$HOBr(aq) + H^+(aq) + Br^-_{(aq)}$<br>$Cr_2O_7^{2-}(aq) + H_2O(l) \rightleftarrows$<br>$2CrO_4^{2-}(aq) + 2H^+(aq)$ | **Material**<br>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. |

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| 4 hours | Equilibrium constant; | • List the factors which influence the **value** of the equilibrium constant $K_c$<br>• Write down an expression for the equilibrium constant having been given the equation for the reaction<br>• Perform calculations based on $K_c$ values<br>• Explain the significance of high and low values of the equilibrium constant | **Activity:**<br>(1) Search for information on issues related to chemical equilibrium<br>(2) Investigating examples of reversible and irreversible reactions<br>(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<br>• Interpret only simple graphs of equilibrium<br>• Apply the rate and equilibrium principles to important industrial applications e.g. Haber process | | | **Definition:**<br>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** | **<u>Acids and Bases</u>** | | | | |
| 8 hours | Acid-base reactions | • Explain what is meant by acids and bases?<br>• State acid and base models (Arrhenius, Lowry-Brønsted)<br>• Write the reaction equations of aqueous solutions of acids and bases<br>• Give conjugate acid-base pairs for given compounds.<br>• Determine the approximate pH of salts in salt hydrolysis<br>• Give the neutralisation reactions of common laboratory acids and bases.<br>• How do indicators work? What is the range of methyl orange, bromo thymol blue and phenolphthalein indicators?<br>• Do simple acid-base titrations<br>• Do calculations based on titration reactions<br>• Name some common strong and weak acids and bases<br>• Explain the pH scale.<br>• Calculate pH values of strong acids and strong bases<br>• Define the concept of $K_w$.<br>• Distinguish between strong and concentrated acids | **Activities and experiments**<br>(1) Search for examples of naturally occurring acids and bases, and their chemical composition<br>(2) Investigating the actions of dilute acids on metals, metal carbonates, metal hydrogen carbonates, metal oxides and metal hydroxides.(revision of grade 11)<br>(3) Searching for information about hazardous nature of acids and bases<br>(4) Investigating the action of dilute bases on aqueous metal ions to form metal hydroxide precipitates<br>(5) Performing experiments to investigate the corrosive nature of concentrated acids and bases (drain cleaners, battery acid, swimming pool acid etc)<br>(6) Investigate the temperature change in a neutralisation process<br>**<u>Experiment</u>**<br>Preparing a standard solution for volumetric analysis | There are useful animations of titrations available to use here (e.g. Greenbowe animations)<br>**Material**<br>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<br>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<br>• Explain the auto-ionisation of water<br>• Compare the $K_a$ and $K_b$ values of strong and weak acids and bases.<br>• Compare strong and weak acids by looking at (1) pH (2) conductivity (3) reaction rate<br>• Look at the application of acids and bases in the Chlor-alkali industry (chemical reactions only)<br>• 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?<br>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<br>(9) Using a titration experiment to determine the concentration of acetic acid in vinegar or the concentration of sodium hydroxide in drain cleaner<br>(10) Do acid-base titration experiments to determine presence of acid in a compound (% of ethanoic acid in vinegar etc) | | Hair straightening<br>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.<br>(Look at “The truth about hair relaxers” on the internet.) |

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| ***ASSESSMENT***<br>***TERM 2*** | **TERM 2: Formal Assessment**<br>**MIDYEAR EXAMINATIONS** |

| TERM 3: GRADE 12 |
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## 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<br>• State that a real battery has internal resistance<br>• The sum of the voltages across the external circuit plus the voltage across the internal resistance is equal to the emf:<br>$\mathcal{E} = V_{load} + V_{internal\ resistance}$ or<br>$\mathcal{E} = IR_{ext} + Ir$<br>• Solve circuit problems in which the internal resistance of the battery must be considered.<br>• Solve circuit problems, with internal resistance, involving series-parallel networks of resistors | **Experiment:**<br>(part 1 and part 2)<br>**Part 1**<br>Determine the internal resistance of a battery<br>**Part 2**<br>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<br>**Practical Investigation**<br>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:**<br>Battery, connecting wires<br>resistor, voltmeter, ammeter and switch.<br>**Materials:**<br>Battery, connecting wires, several resistors of different values, voltmeter, ammeter and switch.<br>**Materials:**<br>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.<br>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:<br>$\mathcal{E} = V_{load} + V_{internal\ resistance}$ |

| 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<br>• Use Faraday's Law to explain why a current is induced in a coil that is rotated in a magnetic field.<br>• 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<br>• Use words and pictures to explain how a DC generator works and how it differs from an AC generator<br>• 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<br>• Use words and pictures to explain the basic principle of an electric motor | | **Materials:**<br>Enamel coated copper wire, 4 large ceramic block magnets, cardboard (packaging), large nail,<br>1.5 V 25mA light bulb.<br>**Materials:**<br>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<br>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<br>the two ends of the coil are attached to a slip ring that makes contact with brushes as it turns. The direction of the<br>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<br>• Give examples of the use of motors | | | **<u>A note on torque:</u>**<br>Know that the moment<br>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. |

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| 4 hours | Alternating current | • Explain the advantages of alternating current<br>• Write expressions for the current and voltage in an AC circuit<br>• Define the rms (root mean square) values for current and voltage as<br>$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ and $V_{rms} = \frac{V_{max}}{\sqrt{2}}$<br>respectively, and explain why these values are useful.<br>• Know that the average power is given by:<br>$P_{av} = I_{rms} V_{rms} = \frac{1}{2} I_{max} V_{max}$<br>(for a purely resistive circuit)<br>• Draw a graph of voltage vs time and current vs time for an AC circuit.<br>• 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<br><br>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<br><br>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<br>• Give the significance of the photo-electric effect: it establishes the quantum theory and it illustrates the particle nature of light<br>• Define cut-off frequency, $f_o$<br>• Define work function and know that the work function is material specific<br>• Know that the cut-off frequency corresponds to a maximum wavelength<br>• Apply the photo-electric equation:<br>$E = W_o + KE_{max}$ where<br>$E = hf$ and $W_o = hf_0$<br>$KE_{max} = \frac{1}{2}mv^2_{max}$<br>• Know that the number of electrons ejected per second increases with the intensity of the incident radiation | **Practical Demonstration:**<br>Photoelectric effect | **Materials:**<br>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<br>• 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<br>• Relate the lines on the atomic spectrum to electron transitions between energy levels<br>• 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<br>• 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<br>• Define oxidation and reduction in terms of electron ($e^-$) transfer<br>• Define oxidising agent and reducing agent in terms of oxidation and reduction.<br>• Define anode and cathode in terms of oxidation and reduction | **Recommended experiment**<br>**for informal assessment**<br>(1) Investigate the electrolysis of water and sodium iodide.<br>**Recommended experiment**<br>**for informal assessment**<br>(2) Find the Galvanic cell with the highest potential<br>(3) Investigate the reduction of metal ions and halogens | **Materials:**<br>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.<br>**Materials:**<br>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.<br>Link to:<br>Grade 11 Oxidation number and Grade 11 Redox reactions.<br>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<br>• State that the potential difference of the cell ($V_{cell}$) is related to the extent to which the spontaneous cell reaction has reached equilibrium<br>• State and use the qualitative relationship between $V_{cell}$ and the concentration of product ions and reactant ions for the spontaneous reaction viz.<br>$V_{cell}$ 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.<br>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<br>• Use cell notation or diagrams to represent a galvanic cell | | | |
| | Standard electrode potentials; | • Give the standard conditions under which standard electrode potentials are determined<br>• Describe the standard hydrogen electrode and explain its role as the reference electrode<br>• Explain how standard electrode potentials can be determined using the reference electrode and state the convention regarding positive and negative values<br>• Use the Table of Standard Reduction Potentials to calculate the emf of a standard galvanic cell.<br>• 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.<br>e.g. for the zinc - copper cell the following notation can be used:<br>$Zn/Zn^{2+}$ // $Cu^{2+}$ / Cu<br>at concentrations of 1 $mol/dm^3$.<br>Oxidation at the anode on the left separated by the salt<br>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<br>• Predict the half-cell in which reduction will take place when connected to another half-cell<br>• Write equations for reactions taking place at the anode and cathode.<br>• Deduce the overall cell reaction by combining two half-reactions<br>• Describe, using half equations and the equation for the overall cell reaction, the following electrolytic processes<br>The decomposition of copper chloride A simple example of electroplating (e.g. the refining of copper) | | | Link to:<br>Oxidation numbers in grade 11.<br>USE SINGLE ARROWS in<br>redox chemical equations and half reactions, but KNOW that all chemical reactions are by nature reversible (equilibrium reactions). |

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| 1 hour | Oxidation numbers and application of oxidation numbers | • Revise from grade 11 and extend in grade 12<br>• 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<br>(i) The production of chlorine (the chemical reactions of the chloroalkali-industry)<br>(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<br>se need not to be studied, but assessment should be done using the chemical reactions that is used in industry<br>Give the learners the chemical reactions and don't expect the learners to know the reactions by heart. |

**GRADE 12 PHYSICS *(WAVES, SOUND & LIGHT)* TERM 3**

| Time | Topics Grade 12 | Content, Concepts & Skills | Practical Activities | Resource Material | Guidelines for Teachers |
|---|---|---|---|---|---|
| **6 HOURS** | **<u>Doppler Effect (relative motion between source observer)</u>** | | | | |
| 4 hours | With sound and ultrasound | • State the Doppler Effect for sound and give everyday examples.<br>• 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<br>• Use the equation<br>$F_L = \frac{v \pm v_L}{v \pm v_S} F_s$<br>to calculate the frequency of sound detected by a listener (L) when **EITHER** the source or the listener is moving<br>• 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:**<br>Doppler effect | **Materials:**<br>Tuning fork (or small sound source), string | Doppler applications would involve<br>either a moving source (stationary<br>observer) or a moving observer<br>(stationary source) |

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| 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<br>• 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.<br>Electromagnetic Spectrum - the red end of the spectrum corresponds to lower frequency and the blue end to higher frequency light.<br>Matter and Materials - emission spectra and discuss the fact that stars emit light of frequencies that are determined by their composition. |

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| ***ASSESSMENT***<br>***TERM 3*** | **TERM 3:**<br>**1 Recommended Formal Assessment**<br>**2 Prelim Examinations** |

## TERM 4

### Revision

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| ***ASSESSMENT***<br>***TERM 4*** | **TERM 4:**<br>**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% |

**Table 1 containing weightings for SBA and final examinations**

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 | Remembering | 15 % | 15 % |
| 2 | Understanding | 35 % | 40 % |
| 3 | Applying, Analysing | 40 % | 35 % |
| 4 | Evaluating, Creating | 10 % | 10 % |

**Table 2: 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 to 12 learners will do TWO experiments for formal assessment (ONE Chemistry and ONE Physics experiment). One experiment must be done in term 1 and another one in term 3.. This gives a total of **THREE formal assessments in practical work** in Physical Sciences in each of Grades 10 and 11.

It is recommended that all learners (from Grade 10 to Grade 12) do TWO experiments for informal assessment (ONE Chemistry and ONE Physics experiment).

**Table 3: Practical work for grades 10 - 12**

| **Practical work** | **Grade 10** | **Grade 11** | **Grade 12** |
|---|---|---|---|
| Experiments for formal assessment | 1 Physics and 1 Chemistry | 1 Physics and 1 Chemistry | 1 Physics and 1 Chemistry |
| Project (informal assessment) | 1 (Physics or Chemistry) | 1 (Physics or Chemistry) | NONE |
| Experiments (informal assessment) | 1 Physics and 1 Chemistry | 1 Physics and 1 Chemistry | 1 Physics and 1 Chemistry |
| **TOTAL** | **5** | **5** | **4** |

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.

## 4.1 PROGRAMME OF ASSESSMENT

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

### 4.1.1 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 | Weighting and duration | Type | Weighting and duration | Type | Weighting and duration | **Final Examination** (**2 x 150 marks giving a total of 300 marks for papers 1 and 2)** |
| **Experiment** | 10% (Minimum 50 marks and minimum duration 2hours) | **Mid-Year Examination** | 30% (2 x 75 marks) 1,5 hrs each | **Experiment** | 10% (Minimum 50 marks) 2 hrs | |
| **Control Test** | 25% (1 x 75 marks) 1,5 hrs | | | **Control Test** | 25% (1 x 75 marks) 1,5 hrs | |
| Total Weighting: 35% | | Total Weighting: 30% | | Total Weighting: 35% | | |
| | | | | | | |
| **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 | Weighting and duration | Type | Weighting and duration | Type | Weighting and duration | **Final Examination** (**2 x 150 marks giving a total of 300 marks for papers 1 and 2)** |
| **Experiment** | 10% (Minimum 50 marks) 2 hrs | **Mid-Year Examination** | 30% (2 x 100 marks) 2 hrs each | **Experiment** | 10% (Minimum 50 marks) 2 hrs | |
| **Control Test** | 25% (2 x 50 marks) 1 hr each | | | **Control Test** | 25% (2 x 50 marks) 1 hr each | |
| Total Weighting: 35% | | Total Weighting: 30% | | Total Weighting: 35% | | |
| | | | | | | |
| **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**

#### 4.1.2 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 GRADES 12** | | | | | | |
|---|---|---|---|---|---|---|
| **ASSESSMENT TASKS (25%)** | | | | | | **END-OF-YEAR ASSESSMENT (75%)** |
| **TERM 1** | | **TERM 2** | | **TERM 3** | | **TERM 4** |
| Type | Weighting and duration | Type | Weighting and duration | Type | Weighting and duration | **Final Examination**<br>(**2 x 150 marks giving a total of 300 marks for papers 1 and 2)** |
| **Experiment** | 10%<br>(Minimum 50 marks)<br>2 hrs | **Mid-Year Examination** | 2 x 150 marks (25%)<br><br>3 hrs each | **Experiment** | 10%<br>(Minimum 50 marks)<br>2 hrs | |
| **Control Test** | 20%<br>(2 x 50 marks)<br>1 hr each | | | **Preliminary Examination** | 35%<br>(2 x 150 marks)<br>3 hrs each | |
| Total Weighting: 30% | | Total Weighting: 25% | | Total Weighting: 45% | | |
| | | | | | | |
| **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**

#### 4.1.3 END-OF-YEAR EXAMINATIONS

##### 4.1.3.1 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 | 3 | 15 % | 35 % | 40 % | 10 % |
| | Waves, Sound & Light | 40 | | | | | | |
| | Electricity & Magnetism | 35 | | | | | | |
| PAPER 2: ***CHEMISTRY FOCUS*** | Chemical Change | 70 | 150 | 3 | 15 % | 40 % | 35 % | 10 % |
| | | | | | | | | |
| | Matter & Materials | 80 | | | | | | |

**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 | 80 | 150 | 3 | 15 % | 40 % | 35 % | 10 % |
| | | | | | | | | |
| | Matter & Materials | 70 | | | | | | |

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

#### 4.1.3.2 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.<br>2. Electrostatics (Coulomb's Law and Electric field)<br>3. Electric circuits (Ohm's Law, Power and Energy) | 1. Representing chemical change (grade 10)<br>2. Intermolecular forces (grade 11)<br>3. Stoichiometry (grade 11)<br>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 | 92 | 150 | 3 | 15 % | 40 % | 35 % | 10 % |
| | | | | | | | | |
| | Matter & Materials | 58 | | | | | | |

**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 sevenpoint 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. They can also be externally moderated on request.

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.

A 10% sample of learners' portfolios will be used for schools that have more than 50 learners in the grade. If the number of learners is less than 50 a sample of 5 portfolios will be used.

### 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<br>• Planning<br>• Producing<br>• Designing<br>• Inventing<br>• Devising<br>• 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<br>• Hypothesising<br>• Critiquing<br>• Experimenting<br>• Judging<br>• Testing<br>• Detecting<br>• 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<br>• Comparing<br>• Deconstructing<br>• Attributing<br>• Outlining<br>• Finding<br>• Structuring<br>• 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,<br>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<br>• Carrying out<br>• Using<br>• 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<br>• Exemplifying<br>• Comparing<br>• Explaining<br>• Inferring<br>• 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<br>• Listing<br>• Describing<br>• Identifying<br>• Retrieving<br>• Recalling<br>• Naming | list, define, tell, describe, identify, show,<br>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.<br>• In scientific notations a number is expressed as a product of two numbers: $Nx10^n$<br>N is the digit term where N is between 1 and 9,999…..<br>$10^n$ is the exponential term and is some integer power of 10.<br>• A large number has a positive exponential term: e.g. $10^6$<br>• A small number has a negative exponential term: e.g. $10^{-5}$<br>• Adding and subtracting, multiplication and division with scientific notation<br>• Powers of numbers expressed in scientific notation and roots of numbers expressed in scientific notation. | Activities:<br>(1) Give learners TEN numbers and ask them to write the numbers in the correct scientific notation.<br>(2) Let learners do calculations with numbers in scientific notation.<br>(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<br>CHEMISTRY and PHYSICS should share the time spent on this topic.<br>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)<br>• List the seven base units (length, mass, time, temperature, electric current, luminous intensity, amount of substance) and their respective SI units.<br>• Identify common conversion factors in mass, length, volume, temperature and pressure.<br>• Recognize and convert various scales of measurement: temperature (Celsius and Kelvin), length, (km, m, cm, mm) mass (kg, g), pressure (kPa, atm).<br>• Using conversion factors and doing calculations<br>• Using conversion factors in dimensional analysis.<br>• Translate data into the correct units and dimensions using conversion factors and scientific notation. | **Activities:**<br>(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.<br>Exercise dimensional analysis in moderation with learners to prove homogeneity of equations.<br>Dimensional analysis stresses the importance and meaning of the correct use of units.<br>Be strict about answers of calculations with the correct units.<br>Take note of derived units and defined units. |
| | Changing the subject of the formula. | • Identify the correct formula for the problem at hand.<br>• Identify what is given in a problem and what is asked.<br>• Change the subject of a given formula to any other variable or constant present in the formula.. | **Activities:**<br>(1) Consider the formula for density done in grade 9: D = m/V. If you have the density and the volume | | |

| 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.<br>• Rate is change per second, whether it is change in mass, or change in velocity or change in concentration, or change in energy.<br>For example:<br>- Power is the amount of energy delivered per unit time (Joule per second = Watt)<br>- Reaction rate is the change in concentration of a reagent per unit time. | **Experiment:**<br>(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.<br>(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.<br>• Organize observations in a data table , analyze the data for trends or patterns, and interpret the trends or patterns, using scientific concepts<br>• Interpret a graph constructed from experimentally obtained data to identify relationships: direct or inverse.<br>• Select appropriate units, scales, and measurement tools for problem situations involving proportional reasoning and dimensional analysis. | **Activity:**<br>(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.<br>(2) Recognise the shape of the graph for direct proportions and the shape of the graph for inverse proportions.<br>(3) A density graph will give a better proportionality between the mass and the volume for a fixed | | **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.<br>**Note:**<br>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.<br>• Ratio is the quotient of two quantities written as a:b or a/b so as to highlight their relative sizes. | **Activity:**<br>(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.<br>(2) Use a block or a dice to demonstrate the | | |
| | 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.<br>• 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.<br>• Examples are Newton's law of gravitation, and the ideal gas law. | **Activity:**<br>(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 | | **Note:**<br>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.<br>**Therefore:**<br>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<br><br>(observation, precautions, data collection, data handling, tables, general types of graphs, analysis, writing<br><br>conclusions, writing a hypothesis, identifying variables,<br><br>for example independent, dependent and control variable.). | • Trace the historical development of a scientific principle or theory<br>• Identify an answerable question and formulate a hypothesis to guide a scientific investigation.<br>• Design a simple experiment including appropriate controls.<br>• Perform and understand laboratory procedures directed at testing a hypothesis.<br>• Select appropriate tools and technology to collect precise and accurate quantitative data.<br>• Correctly read a thermometer, a balance, metric ruler, graduated cylinder, pipette, and burette.<br>• Record observations and data using the correct scientific units.<br>• Export data into the appropriate form of data presentation (e.g. equation, table, graph, or diagram).<br>• 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).<br>• Determine the accuracy and the precision of experimental results.<br>• Analyze experimental results and identify possible sources of bias or experimental error.<br>• Recognize, analyze and evaluate alternative explanations for the same set of observations.<br>• Design a model based on the correct hypothesis that can be used for further investigation.<br>• Define qualitative analysis and give a practical example.<br>• Define quantitative analysis and give a | **Activity:**<br><br>(1) Analyse the components of a properly designed scientific investigation.<br>(2) Choose an experiment and determine appropriate tools to gather precise and accurate data.<br>(3) Defend a conclusion based on scientific evidence<br>(4) Determine why a conclusion is free from bias.<br>(5) Compare conclusions that offer different, but acceptable explanations for the same set of experimental data.<br><br>(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.<br><br>This section should be taught while the learners do an investigation themselves, for example:<br><br>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.<br>• Recognise models used in science<br>• Recognize how models change with the discovery of new information | **Activity:**<br>The purpose of models is to explain and or simplify a difficult chemical concept. Name all the models in chemistry that you know<br>of e.g.<br>• How did the atomic model change through the years?<br>• Who contributed towards the periodic table (this is also just a model of representing chemical information),<br>• Models for chemical | | To make models tangible, one would have to include concrete examples.<br>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.<br>• Know how to interpret and apply the safety data of the chemicals.<br>• 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<br>• 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

[Kl atomic number / atoomgetal

symbol / simbool

atomic mass / atoommassa

| IA (1 | IIA (2) | IIIB (3) | IVB (4) | VB (5) | VIB (6) | VIIB (7) | (8) | Vill (9) | (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 | | | | | | | | | | | 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 | 88 | 89 # | 104 | 105 | 106 | 107 | 108 | 109 | | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fr | Ra | Ac | Rf | Db | Sg | Bh | Hs | Mt |
| (223) | 226,0 | 227,0 | (261) | (262) | (263) | (262) | (265) | (266) |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 |
| lanthani es / lantaniede | Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu |
| | 140,1 | 140,9 | 144,2 | (145) | 150,4 | 152,0 | 157,3 | 158,9 | 162,5 | 164,9 | 167,3 | 168,9 | 173,0 | 175,0 |
| | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 |
| actinrdes / aktiniede | Th | Pa | u | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr |
| | 232 0 | 231,0 | 238,0 | 237,0 | (244) | (234) | (247) | (247) | (251) | (252) | (257) | (258) | (258) | (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<br>nitrate, $NO_3^-$<br>chlorate, $ClO_3^-$<br>perchlorate, $ClO_4^-$<br>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<br>carbonate, $CO_3^{2-}$<br>phosphate, $PO_4^{3-}$<br>oxalate, $C_2O_4^{2-}$<br>chromate, $CrO^{2-}$ | ⇔ | Salts of $NH_4^+$ and alkali metal cations |