GRADE 11 PHYSICS *(MECHANICS)* TERM 1					
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
4HOURS	**<u>Vectors in two dimensions</u>**				
2 HOURS	Resultant of perpendicular vectors	• Draw a sketch of the vectors (parallel and perpendicular) on the Cartesian plane. • Add co-linear vectors along the parallel and perpendicular direction to obtain the net parallel component (R_x) and a net perpendicular component (R_y). • Sketch R_x and R_y • Sketch the resultant (R) using either the tail-to-head or tail-to-tail method. • Determine the magnitude of the resultant using the theorem of Pythagoras • Determine the direction of the resultant using simple trig ratios.		**textbook**	Use examples involving force vectors.
2 HOURS	Resolution of a vector into its parallel and perpendicular components	• Draw a sketch of the vector on the Cartesian plane showing its magnitude and the angle (θ) between the vector and the x-axis. • Use R_x= Rcos(θ) for the resultant x-component • Use R_y= Rsin(θ) for the resultant y-component		**textbook**	Use examples involving force vectors.

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

					First people to make fire did so using friction.
3 HOURS	Force diagrams, free body diagrams	• Know that a force diagram is a picture of the object(s) of interest with all the forces acting on it (them) drawn in as arrows • Know that in a free-body diagram, the object of interest is drawn as a dot and all the forces acting on it are drawn as arrows pointing away from the dot. • Resolve two-dimensional forces (such as the weight of an object with respect to the inclined plane) into its parallel (x) and perpendicular (y) components. • The resultant or net force in the x-direction is a vector sum of all the components in the x-direction. The resultant or net force in the y-direction is a vector sum of all the components in the y-direction.			
TIME	**Topics Grade 11**	**Contents, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
11 HOURS	Newton's first, second and third laws and Newton's law of Universal Gravitation.	• State Newton's first law: *An object continues in a state of rest or uniform (moving with constant) velocity unless it is acted upon by an unbalanced (net or resultant) force.* • Discuss why it is important to wear seatbelts using Newton's first law. • State Newton's second law: *When a net force, F_{net}, is applied to an object of mass, m, it accelerates in the direction of the net force. The acceleration, a, is directly proportional to the net force and inversely proportional to the mass.* $\vec{F}_{net} = m\vec{a}$ • Draw force diagrams for objects that are in equilibrium (at rest or moving with	**<u>Recommended experiment for formal assessment</u>** Investigate the relationship between force and acceleration (Verification of Newton's second law)	**Materials:** Trolleys, different masses, incline plane, rubber bands, meter rule, ticker tape apparatus, ticker timer and graph paper.	For objects that are in equilibrium (at rest or moving with constant velocity) all forces along the plane of the motion and the forces in the direction perpendicular to the plane of the motion must add up to zero. This is another context in which the idea of **superposition** can be applied. When an object accelerates, the equation F_{net}=ma must be applied separately in the x and y directions. If there is more than one object, a free body diagram must be drawn for each object and

		constant velocity) and accelerating (non-equilibrium). • Draw free body diagrams for objects that are in equilibrium (at rest or moving with constant velocity) and accelerating (non-equilibrium). • Apply Newton's laws to a variety of equilibrium and non-equilibrium problems including a single object moving on a horizontal/inclined plane (frictionless and rough), vertical motion (lifts, rockets etc.) and also two-body systems such as two masses joined by a light (negligible mass) string. • State Newton's third law: *When object A exerts a force on object B, object B <u>simultaneously</u> exerts an oppositely directed force of equal magnitude on object A.* • Identify action-reaction pairs e.g. donkey pulling a cart, a book on a table. • List the properties of action-reaction pairs.			Newton 2 must be applied to each object separately. NOTE: Sum of forces perpendicular to the plane of the motion will always add up to zero.
Time	**Topics Grade 11**	**Contents, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
4 HOURS	Newton's Law of Universal Gravitation	• State Newton's Law of Universal Gravitation • Use the equation for Newton's Law of Universal Gravitation to calculate the force two masses exert on each other. $F = G\frac{m_1 m_2}{d^2}$ • Describe weight as the gravitational force the Earth exerts on any object on or near its surface. • Calculate the acceleration due to gravity on Earth using the equation : $g_{Earth} = G\frac{M_{Earth}}{(R_{Earth})^2}$	**Experiment:** Verify the value for g.		

		N.B. This formula can be used to calculate g on any planet using the appropriate planetary data. • Calculate weight using the expression W= mg, where g is the acceleration due to gravity. Near the earth the value is approximately 9.8 $m \cdot s^{-2}$. • Calculate the weight of an object on other planets with different values of gravitational acceleration. • Distinguish between mass and weight. Know that the unit of weight is the newton (N) and that of mass is the kilogram (kg).			

GRADE 11 CHEMISTRY *(MATTER & MATERIALS)* TERM 1					
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
6 HOURS	**Atomic combinations: molecular structure**	The type of chemical bond in a compound determines the physical and chemical properties of that compound. Through studying the structures of atoms, molecules and ions, and the bonding in elements and compounds, learners will acquire knowledge of some basic chemical principles. By learning the properties of metals, giant ionic substances, simple molecular substances and giant covalent substances, you can appreciate the interrelation between bonding, structures and properties of substances.			

2 HOURS	A chemical bond (is seen as the net electrostatic force two atoms sharing electrons exert on each other)	• Recall the role of models in science and describe the explanations of chemical bonding in this course as an application of a model
		• Deduce the number of valence electrons in an atom of an element
		• Represent atoms using Lewis diagrams
		• Explain, referring to diagrams showing electrostatic forces between protons and electrons, and in terms of energy considerations, why
		  • two H atoms form an H_2 molecule, but
		  • He does not form He_2
		• Draw a Lewis diagram for the hydrogen molecule
		• Describe a covalent chemical bond as a shared pair of electrons
		• Describe and apply simple rules to deduce bond formation, viz.
		  • different atoms, each with an unpaired valence electron can share these electrons to form a
			Activity:
			
			Draw Lewis structures of the elements and determine the number of bonds the element can make.
			
			Activity:
			(1) Describe the formation of the dative covalent (or co-ordinate covalent) bond by means of electron diagram using H_3O^+ and NH_4^+ as examples.
				Teacher support material elaborating on the use of models in science, its benefits and short-comings	The role **of models in scie**nce is a very important issue, but it must be handled very well.
					Bonding is introduced in grade 10. Clear distinction needs to be made regarding what is taught in grade 10 and what in grade 11
					The atom, the arrangement of electrons into core and valence electrons.
					*****************************
					NB!!!
					Increased stability due to lower potential energy (and higher entropy) to be used as the main reason for bonding.
					******************************
					The mainstay of Lewis diagrams is the "rule of two", that is two electrons for a bond rather than the "octet" rule which only applies rigorously to the second period.
					The learner enters into the theory of chemical substances before knowing anything about the chemistry. Rather start with a known molecule like water, H_2O, and start with the

		chemical bond • different atoms with paired valence electrons called lone pairs of electrons, cannot share these four electrons and cannot form a chemical bond • different atoms, with unpaired valence electrons can share these electrons and form a chemical bond for each electron pair shared (multiple bond formation) • atoms with an incomplete complement of electrons in their valence shell can share a lone pair of electrons from another atom to form a **co-ordinate covalent or dative covalent bond** (e.g. NH_4^+, H_3O^+) Draw Lewis diagrams, given the formula and using electron configurations, for • simple molecules (e.g. F_2, H_2O, NH_3, HF, OF_2, HOCℓ) • molecules with multiple bonds e.g. (N_2, O_2 and HCN)			concepts of two H-atoms bond to one O-atom. This leads to the octet rule of electrons. This can again lead to the **Lewis electron pair presentati**on. The "two electrons" per bond is just as untrue as the "octet" rule. Both are just USEFUL MODELS to explain chemical bonding. The octet rule is only problematic if it is taught as an absolute. It is a useful rule of thumb for any but the 'd' block elements. Exceptions are for example BF_3. It is more useful than it is problematic if it is used as a general guideline rather than a rule
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
2 HOURS	Molecular shape as predicted using the Valence Shell Electron Pair Repulsion (VSEPR) theory.	State the major principles used in the VSEPR The five ideal molecular shapes according to the VSEPR model. (Ideal shapes are found when there are NO lone pairs on the central atom ONLY bond pairs.) A is always the central atom and X are the terminal atoms. • linear shape AX_2 (e.g. CO_2 and $BeCl_2$) • trigonal planar shape AX_3 (e.g.	**Activity:** (1) Build the five ideal molecular shapes with Atomic Model kits or with Jelly Tots and tooth picks. (2) If you have a lone pair on the central atom, remove one of the tooth picks. The shape that remains represents		Determine what learners know about VSEPR and what do they need to know. <u>Definition</u> Valence shell electron pair repulsion (VSEPR) model: is a model for predicting the shapes of molecules in which structural electron pairs are arranged around each atom to maximize the angles between them. Structural electron pairs are bond pairs plus lone pairs.

		BF$_3$) • tetrahedral shape AX$_4$ (e.g. CH$_4$) • trigonal bipyramidal shape AX$_5$ (e.g. PCl$_5$) • octahedral shape AX$_6$ (e.g. SF$_6$) Molecules with lone pairs on the central atom CANNOT have one of the ideal shapes e.g. water molecule. Deduce the shape of • molecules like CH_4, NH_3, H_2O, BeF_2 and BF_3 • molecules with more than four bonds like $PC\ell_5$ and SF_6, and • molecules with multiple bonds like CO_2 and SO_2 and C_2H_2 from their Lewis diagrams using VSEPR theory	the shape of the molecule. (3) If you have two lone pairs on the central atom remove two tooth picks. What is the shape of the resulting structure? This structure represents the molecule (e.g. water)	**NOTE:** If you have a lone pair on the central atom ONE “leg” of the ideal shape disappears (represented by the lone pair) and that will be the shape of your molecule.	OR Valence shell electron pair repulsion (VSEPR) model: is a model for predicting the shapes of molecules in which the electron pairs from the outer shell of a reference atom are arranged around this atom so as to minimize the repulsion between them. Note: You only need Lewis diagrams of the molecule to be able to decide the shape of the molecules according to VSEPR. (Hybridization is NOT needed.)
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
1 HOUR	Electronegativity of atoms to explain the polarity of bonds.	• Explain the concepts – electronegativity – Non-polar bond with examples, e.g. H-H – Polar bond with examples e.g. H-Cℓ • Show polarity of bonds using partial charges $\delta+$ H – Cl $\delta-$ • Compare the polarity of chemical bonds using a table of electronegativities • With an electronegativity difference $\Delta EN > 2.1$ electron transfer will take place and the bond would be ionic. • With an electronegativity difference $\Delta EN > 1$ the bond will be covalent and polar. • With an electronegativity difference	**Activity:** (1) Look at ideal molecular shapes (build with atomic model kits) with all the **end atoms the same** (look at electronegativity) and the bond polarity and molecular polarity. (2) Look at ideal molecular shapes (build with atomic model kits) **with DIFFERENT end atoms** (look at electronegativity) and the bond polarity and		Link back to intermolecular forces. **NOTE:** The indications about electronegativety differences are given NOT as exact scientific knowledge but as a guideline for learners to work with in deciding polarity of a molecule. (For teachers: All bonds have covalent and ionic character.)

		$\Delta EN < 1$ the bond will be covalent and very weakly polar. • With an electronegativity difference $\Delta EN = 0$ the bond will be covalent and nonpolar. • Show how polar bonds do not always lead to polar molecules	molecular polarity.		
1 HOUR	Bond energy and length	• Give a definition of bond energy • Give a definition of bond length • Explain what is the relationship between bond energy and bond length • Explain the relationship between the strength of a bond between two chemically bonded atoms and – the length of the bond between them – the size of the bonded atoms – the number of bonds (single, double, triple) between the atoms			Link to potential energy diagram used to explain bonding above and point out the bond energy and bond length on the diagram. BEWARE!! That you don't elevate the Lewis presentations as physical truths in chemical bonding. There are NO PHYSICAL BONDS; the chemical bond just represents an area of high electron density and low potential energy.
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
10 HOURS	**<u>Intermolecular forces</u>**	In a liquid or a solid there must be forces between the molecules causing them to be attracted to one another, otherwise the molecules would move apart and become a gas. These forces are called intermolecular forces (forces between molecules).			Note: This section falls shortly after electronegativity and polarity have been discussed – this section therefore provides a great rationale for the importance of understanding these concepts
6 HOURS	Intermolecular and interatomic forces (chemical bonds). Physical state and density explained in terms of these forces.	• Name and explain the different intermolecular forces: (i) ion-dipole forces, (ii) ion-induced dipole forces and (iii) Van der Waals forces ((a) dipole-dipole forces, (b) dipole-induced dipole forces and (c) induced-dipole-induced dipole forces, with hydrogen bonds a special case of dipole-dipole forces.) • Explain hydrogen bonds.	**<u>Prescribed experiment for formal assessment</u>** **(1)** Intermolecular forces and the effects of intermolecular forces on evaporation, surface tension, solubility, boiling points, and capillarity.	**Materials:** **Evaporation** of ethanol, water, nail polish remover and methylated spirits. **Surface tension** of water, oil, glycerine, nail polish remover and methylated spirits **Solubility** of sodium	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

	Particle kinetic energy and temperature.	• Revise the concept of a <u>covalent molecule</u> • Describe the difference between intermolecular forces and interatomic forces – using a diagram of a group of small molecules; and – in words • Represent a common substance, made of small molecules, like water, using diagrams of the molecules, to show microscopic representations of ice ($H_2O(s)$), water liquid ($H_2O(\ell)$) and water vapour ($H_2O(g)$) • Illustrate the proposition that intermolecular forces increase with increasing molecular size with examples e.g. He, O_2, C_8H_{18} (petrol), $C_{23}H_{48}$(wax). (Only for van der Waals forces.) • Explain density of material in terms of the number of molecules in a unit volume, e.g. compare gases, liquids and solids • Explain the relationship between the strength of intermolecular forces and melting points and boiling points of substances composed of small molecules. • Contrast the melting points of substances composed of small molecules with those of large molecules where bonds must be broken for substances to melt • Describe thermal expansion of a substance and how it is related to the motion of molecules in a substance composed of small molecules e.g. alcohol in a thermometer. • Explain the differences between thermal conductivity in non-metals	**Activity:** (1) Read the labels of different machine oils and motor oils: 15W 40 multi grade SAE 30 mono grade What does the 15W40 stand for? What is the difference between mono grade and multi grade oil? (2) Look at the liquid level in a measuring cylinder (water, oil, mercury…). What do you observe about the meniscus? Explain. **Activity:** (3) Consider copper and graphite and explain how heat conductivity works in both cases.	chloride, iodine, potassium permanganate in water, ethanol and chloroform. **Boiling points** of water, oil, glycerine, nail polish remover and methylated spirits **Capillarity** of water, oil, glycerine, nail polish remover and methylated spirits <u>Viscosity</u> becomes quite tricky when predictions need to be made as intermolecular forces are not the only factor influencing viscosity.	described below. 3 types of forces should be described in this section: **Hydrogen bonding** (10-40 kJ mol^{-1}) – hydrogen bonding occurs when hydrogen is bonded to an atom which has significantly greater electronegativity. Eg. Oxygen. The hydrogen bond is an electrostatic attraction between the partial negative charge on the electronegative atom and the partial positive charge on the hydrogen from a second molecule. (presuming that there are not two such groups on a single molecule) Example – water. **Dipole-dipole interaction** – (5-25 kJ mol^{-1} i.e. weaker than hydrogen bonding). This is the small electrostatic attraction which exists between two permanent dipoles. 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 . **Dispersion (London) forces** –(0.05-40 kJ mol^{-1}) When two non-polar molecules approach each other this is slight distortion in the electron cloud of both molecules which results in a small attraction between the two molecules. Eg CH_4. The larger the molecule the greater the dispersion force. Dispersion forces are only significant in the absence of any other interaction. Also note that molecular size is only

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

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers

ASSESSMENT ***TERM 1***	**<u>TERM 1:Recommended Formal Assessment</u>** **[1] Investigate the relationship between force and acceleration (Verification of Newton's second law)** **[2] Control Test**

GRADE 11 PHYSICS *(WAVES, SOUND & LIGHT)* TERM 2					
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
10 HOURS	**Geometrical optics:**				
3 HOURS	Refraction	• Revision: explain reflection • Revision: State the law of reflection • Define the speed of light as being constant when passing through a given medium and having a maximum value of $c=3\times10^8$ $m.s^{-1}$ in a vacuum. • Define refraction. • Define refractive index as $n=\frac{c}{v}$ • Define optical density • Know that the refracted index is related to the optical density. • Explain that refraction is a change of wave speed in different media, while the frequency remains constant • Define Normal • Define angle of incidence • Define angle of refraction • Sketch ray diagrams to show the path of a light ray through different media	**Practical Demonstration or Experiment or Investigation**: Propagation of light from air into glass and back into air. Propagation of light from one medium into other medium.	**Materials:** Rectangular glass block, ray box, colour filters, glass blocks of other shapes, water, paper, pencil, ruler, protractor	
4 HOURS	Snell's Law	• State the relationship between the angles of incidence and refraction and the refractive indices of the media when light passes from one medium into another (Snell's Law) $n_1 \sin\theta_1 = n_2 \sin\theta_2$ • Apply Snell's Law to problems involving light rays passing from one medium into another • Draw ray diagrams showing the path of light when it travels from a medium with higher refractive index to one of lower refractive index and vice versa.	**Recommended project:** Verifying Snell's Laws and determine the refractive index of an unknown solid transparent material using Snell's law	**Materials:** Glass block, Ray box, 0-360^0 protractor, A4 paper **Materials:** Glass block, Ray box, 0-360^0 protractor, A4 paper, different solid transparent materials	It is useful to use analogies to explain why light waves bend inwards towards the normal when they slow down (pass into a medium with higher refractive index) or outwards when they speed up (pass into a medium with lower refractive index). One analogy is a lawnmower that moves from a patch of short

					grass to a patch of long grass. The tyre in the long grass will go slower than the one in the short grass, causing the path of the lawnmower to bend inwards.
TIME	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
3 HOURS	Critical angles and total internal reflection	• Explain the concept of critical angle • List the conditions required for total internal reflection • Use Snell's Law to calculate the critical angle at the surface between a given pair of media. • Explain the use of optical fibers in endoscopes and telecommunications.	**Recommended experiment for informal assessment:** Determine the critical angle of a rectangular glass (clear) block.	**Materials:** Glass block, Ray box	
3 HOURS	**2D and 3D Wavefronts**				
3 HOURS	Diffraction	• Define a wavefront as an imaginary line that connects waves that are in phase (e.g. all at the crest of their cycle). • State Huygen's principle. • Define diffraction as the ability of a wave to spread out in wavefronts as they pass through a small aperture or around a sharp edge. • Apply Huygen's principle to explain diffraction qualitatively. Light and dark areas can be described in terms of constructive and destructive interference of secondary wavelets. • Sketch the diffraction pattern for a single slit.	**Experiment / Demonstration** Demonstrate diffraction using a single slit.	**Materials:** Single slit (learner's can make this using a small plane mirror or using a small rectangular plane sheet of glass that is painted black on one side) Straight filament bulb, colour filters	It is very helpful to use water waves in a ripple tank to demonstrate diffraction.

GRADE 11 CHEMISTRY *(MATTER & MATERIALS)* TERM 2					
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
8 HOURS	**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. – collisions with each other and the walls of the container – molecules in a sample of gas move at different speeds • Explain the idea of 'average speeds' in the context of molecules of a gas • Describe an ideal gas in terms of the motion of molecules • Explain how a real gas differs from an ideal gas. • State the conditions under which a real gas approaches ideal gas behavior. • Use kinetic theory to explain the gas laws			Integrate the teaching of this section into the treatment of the ideal gas laws that follows Link this section to KMT from grade 10
6 HOURS	Ideal gas law	• Describe the relationship between volume and pressure for a fixed amount of a gas at constant temperature (Boyle's Law) • Describe the relationship between volume and temperature for a fixed amount of a gas at constant pressure (Charles' Law) and • Describe the relationship	**<u>Recommended experiment for informal assessment</u>** (1) Boyle's law **Experiment:** (2) Charles' law (exp2)	**Materials:** Pressure gauge. 10 ml syringe, 3 cm silicone tubing to attach syringe to pressure gauge, water bowl. **Materials:** Burner, glass beaker, 10	This section is an excellent opportunity to show the relationship between macro and micro, e.g. explain the pressure volume relationship in terms of particle motions. It is an important section for illustrating and assessing understanding of investigative

		between pressure and temperature for a fixed amount of a gas at constant temperature (Guy Lussac) – practically using an example – by interpreting a typical table of results – using relevant graphs (introducing the Kelvin scale of temperature where appropriate) – using symbols ('α' and '$1/\alpha$') and the words 'directly proportional' and 'inversely proportional' as applicable – writing a relevant equation • Combine the three gas laws into the ideal gas law, PV = nRT • Use the gas laws to solve problems, $P_1V_1/T_1 = P_2V_2/T_2$ • Give the conditions under which the ideal gas law does not apply to a real gas and explain why • Convert Celsius to Kelvin for use in ideal gas law.		ml syringe, stopper for syringe, thermometer (-10^0 – 100^0C), water bowl, ice.	process, the relationship between theory and experiment, the importance of empirical data and mathematical modelling of relationships. Link to skills topic in grade 10
TIME	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
1 HOUR	Temperature and heating, pressure;	• Explain the temperature of a gas in terms of the average kinetic energy of the molecules of the gas • Explain the pressure exerted by a gas in terms of the collision of the molecules with the walls of the container			

GRADE 11 CHEMISTRY *(CHEMICAL CHANGE)* TERM 2

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
12 HOURS	**<u>Quantitative aspects of chemical change</u>**	The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.			**(Stoichiometry)**
3 HOURS	Molar volume of gases; concentration of solutions.	• 1 mole of gas occupies 22.4 dm^3 at 0^0C (273 K) and 1 atmosphere (101.3 kPa) • Interpret balanced reaction equations in terms of volume relationships for gases under the same conditions of temperature and pressure (volume of gases is directly proportional to the number of particles of the gases). • Calculate molar concentration of a solution	**Experiment:** (1) Make standard solutions of ordinary salts. **Activity:** (2) Do titration calculations (3) Precipitation calculations: calculate the mass of the precipitate.		Make a flow diagram of all the stoichiometry calculations. Link back to gas laws. Express as SI units
6 HOURS	More complex Stoichiometric calculations	• Perform stoichiometric calculations using balanced equations that may include limiting reagents • Do stoichiometric calculation to determine the percent yield of a chemical reaction. • Do calculations to determine empirical formula and molecular formula of compounds (revise empirical formula calculations done in grade 10). • Determine the percent $CaCO_3$ in an impure sample of sea shells (purity or percent composition)	**<u>Recommended experiment for informal assessment</u>** **(1)** Mass PbO_2 prepared from $Pb(NO_3)_2$	**Materials:** Heating stand, watch glass, test tubes, spatula, propettes, glass beaker, burner, funnel, filter paper, measuring cylinder, stirring rod, lead(II) nitrate, water, sodium hydroxide, dilute nitric acid, mass meter, bleaching agent.	Use sub microscale representations to explain how stoichiometric ratios work. **Remember!** Mass meter experiments can also be done without mass meters!!
3 HOURS	Volume relationships in gaseous reactions.	• Do stoichiometric calculations with explosions as reactions during which a great many molecules are produced in the gas phase so that there is a massive increase in volume e.g. ammonium nitrate in mining or petrol in a car cylinder. $2NH_4NO_3 \rightarrow 2N_2(g) + 4H_2O(g) + O_2(g)$ $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ Give the reactions and use it in stoichiometric calculations. • Do as application the functioning of airbags.			The thermal decomposition of ammonium nitrate. $2NH_4NO_3 \rightarrow 2N_2(g) + 4H_2O(g) + O_2(g)$ Reaction must be given when used in calculations.

		Sodium azide reaction: $2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$ Reaction must be given when used in calculations.			

ASSESSMENT ***TERM 2***	**<u>TERM 2:Recommended Formal Assessment</u>** **[1] Experiment (Chemistry): The effects of intermolecular forces.** **[2] Midyear Examination**

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

					the net force acting on the charge positioned at the right angle.

3 HOURS	Electric field	• Describe an electric field as a region of space in which an electric charge experiences a force. The direction of the electric field at a point is the direction that a positive test charge (+1C) would move if placed at that point. • Draw electric field lines for various configurations of charges. • Define the magnitude of the electric field at a point as the force per unit charge ($E = F/q$). E and F are vectors. • Deduce that the force acting on a charge in an electric field is $F = qE$ • Calculate the electric field at a point due to a number of point charges, using the equation $E = \frac{kQ}{r^2}$ to determine the contribution to the field due to each charge.			Discuss the fact that electric field lines, like magnetic field lines (see Grade 10), are a way of representing the electric field at a point. Arrows on the field lines indicate the direction of the field, i.e. the direction a positive test charge would move. Electric field lines therefore point away from positive charges and towards negative charges. Field lines are drawn closer together where the field is stronger. Also, the number of field lines passing through a surface is proportional to the charge enclosed by the surface. The electric fields due to a number of charges can be superposed. As with Coulomb's Law calculations, do not substitute the sign of the charge into the equation for electric field. Instead, choose a positive direction, and then either add or subtract the contribution to the electric field due to each charge depending upon whether it points in the positive or negative direction, respectively.
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
6 HOURS	**Electromagnetism**				
3 HOURS	Magnetic field associated with current carrying wires	• Provide evidence for the existence of a magnetic field (B) near a current carrying wire. • Use the Right Hand Rule to determine the magnetic field (B) associated with: (i) a straight current carrying wire, (ii) a current carrying loop (single) of wire and (iii) a solenoid • Draw the magnetic field lines around (i) a straight current carrying wire, (ii) a current carrying loop (single) of wire and (iii) a solenoid • Discuss qualitatively the environmental impact	**Practical Demonstration:** Get learners to observe the magnetic field around a current carrying wire.	**Materials:** Power supply, wire, retort stand, cardboard, several compasses.	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.

		of overhead electrical cables.			
3 HOURS	Faraday's Law.	• State Faraday's Law. • Use words and pictures to describe what happens when a bar magnet is pushed into or pulled out of a solenoid connected to a galvanometer. • Use the Right Hand Rule to determine the direction of the induced current in a solenoid when the north or south pole of a magnet is inserted or pulled out. • Know that for a loop of area A in the presence of a uniform magnetic field B, the magnetic flux (ϕ) passing through the loop is defined as: ϕ=BAcosθ, where θ is the angle between the magnetic field B and the normal to the loop of area A. • Know that the induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux. • Calculate the induced emf and induced current for situations involving a changing magnetic field using the equation for Faraday's Law: $\varepsilon = -N\frac{\Delta\phi}{\Delta t}$ where ϕ=BAcosθ is the magnetic flux.	**Practical Demonstration:** Faraday's law	**Materials:** Solenoid, bar magnet, galvanometer, connecting wires.	Stress that Faraday's Law relates induced emf to the rate of change of *flux*, which is the product of the magnetic field and the cross-sectional area the field lines pass through. When the north pole of a magnet is pushed into a solenoid the flux in the solenoid increases so the induced current will have an associated magnetic field pointing out of the solenoid (opposite to the magnet's field). When the north pole is pulled out, the flux decreases, so the induced current will have an associated magnetic field pointing into the solenoid (same direction as the magnet's field) to try to oppose the change. The directions of currents and associated magnetic fields can all be found using only the Right Hand Rule. When the fingers of the right hand are pointed in the direction of the current, the thumb points in the direction of the magnetic field. When the thumb is pointed in the direction of the magnetic field, the fingers point in the direction of the current.
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
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	**Recommended experiment for informal assessment**	**Materials:** Light bulb, resistor, connecting wires,	Maximum of four resistors

		• State the difference between Ohmic and non-Ohmic conductors, and give an example of each • Solve problems using the mathematical expression of Ohm's Law, R=V/I, for series and parallel circuits.	Obtain current and voltage data for a resistor and light bulb and determine which one obeys Ohm's law.	ammeter and voltmeter	

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

GRADE 11 CHEMISTRY *(CHEMICAL CHANGE)* TERM 3					
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
4 HOURS	**Energy and chemical change:**	Energy is exchanged or transformed in all chemical reactions and physical changes of matter. Thermodynamics is the science of heat or energy flow in chemical reactions.			
2 HOURS	Energy changes in reactions related to bond energy changes;	• Explain the concept enthalpy and its relationship to heat of reaction • Define exothermic and endothermic reactions • Identify that bond breaking requires energy (endothermic) and that bond formation releases energy (exothermic) • Classify (with reason) the following reactions as exothermic or endothermic: respiration; photosynthesis; combustion of fuels.	**Recommended project for formal assessment** **(1)** Investigate endothermic reactions as for example ammonium nitrate and water, potassium nitrate and water and magnesium sulphate and water. **AND** **(2)** Investigate exothermic reactions as for example calcium chloride and water, dry copper(II) sulphate and water and lithium and water. (Identify and explain the applications of exothermic and endothermic reactions in everyday life and industry)	**Materials:** Glass beaker, thermometer, water bowl, test tubes, spatula, stirring rod, potassium nitrate, potassium bromide, magnesium sulphate, ammonium nitrate, ammonium hydroxide, barium chloride, citric acid, vinegar, sodium carbonate, sodium hydrogen carbonate, sodium thiosulphate, Cal-C-Vita tablets. **Materials:** Glass beaker, thermometer, water bowl, test tubes, spatula, potassium permanganate, copper(II) sulphate, lithium, magnesium ribbon, magnesium powder, dilute sulphuric acid, calcium chloride, glycerine	Link bond making and bond breaking to potential energy diagram used in bonding previously.
1 HOUR	Exothermic and endothermic reactions;	• State that $\Delta H > 0$ for endothermic reactions. • State that $\Delta H < 0$ for exothermic reactions • Draw free hand graphs of endothermic reactions and exothermic reactions (without activation energy)			
1 HOUR	Activation energy.	• Define activation energy • Explain a reaction process in terms of energy change and relate this change to bond breaking and	**Experiment:** (1) Burn magnesium ribbon in air or oxygen and draw a rough energy graph of your results.		

		formation and to “activated complex”. • Draw free hand graphs of endothermic reactions and exothermic reactions (with activation energy)	(Graph of temperature against time)		

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

ASSESSMENT TERM 3	***TERM 3:Recommended Formal Assessment*** ***[1] Recommended (Chemistry) project: Exothermic and endothermic reactions (examples of each type of reactions)*** ***OR recommended (Physics) project: Snell's Law.*** ***[2] Control test***

GRADE 11 CHEMISTRY *(CHEMICAL CHANGE)* TERM 4					
Time	**Topics Grade 11**	**Content, Concepts & Skills**	**Practical Activities**	**Resource Material**	**Guidelines for Teachers**
5 HOURS	Redox reactions;	• Determine the oxidation number from a chemical formula and electronegativities • Identify a reduction - oxidation reaction and apply the correct terminology to describe all the processes. • Describe electrochemical reactions as involving electron transfer • Describe oxidation - reduction reactions as always involving changes in oxidation number • Balance redox reaction equations by using oxidation numbers via the ion-electron method.	**Recommended experiment for informal assessment** (1) Do redox reactions that include synthesis reactions, decomposition reactions and displacement reactions (for informal assessment do at least ONE synthesis, ONE decomposition and ONE displacement reaction). (2) Investigate the reducing action of hydrogen sulphide and the oxidizing action of potassium permanganate on various substances.	**Material:** Depend on the choice of your reactions.	Link redox reactions to oxidation numbers. In this section, care must be taken to emphasise the relationship between the symbolic (chemical reaction equations) and the macroscopic (what you see with your eyes) and sub-microscopic (on molecular level) representations of the reactions.
1 HOUR	Oxidation number of atoms in molecules to explain their relative “richness” in electrons …	• Explain the meaning of ‘oxidation number’ • Assign oxidation numbers to atoms in various molecules like H_2O, CH_4, CO_2, H_2O_2, $HOC\ell$ by using oxidation number guidelines or rules. • Use rules of oxidation to assign oxidation numbers to atoms in a variety of molecules and ions	**Definition of oxidation number:** The oxidation number of an element is a number assigned to each element in a compound in order to keep track of the electrons during a reaction. The concept of oxidation states (also called oxidation numbers) provides a way to keep track of electrons in oxidation-reduction reactions, particularly redox reactions involving covalent substances. Each atom in a molecule or ion is assigned an oxidation state to show how much it is oxidised or reduced. Two very useful rules about oxidation states are: (1) atoms in elements are		Give a short list of rules or <u>guidelines for determining oxidation numbers.</u> Include in document Forms a basis for electrochemistry in grade 12. Link this to grade 12.

			in oxidation state zero, (2) in simple ions the oxidation state is the same as the charge on the ion.		

GRADE 11 CHEMISTRY *(CHEMICAL SYSTEMS)* TERM 4

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
8 HOURS	**Exploiting the lithosphere or earth's crust:**	The lithosphere is the earth's crust and upper mantle. The crust contains non-renewable fossil fuels (created from ancient fossils that were buried and subjected to intense pressure and heat) and minerals, and renewable soil chemicals (nutrients) needed for plant life.			Choose only one mining activity The focus here should be the earth and its resources, sustainable energy, our responsibility towards future generations and not the chemistry or chemical reactions. Skills that should be addressed here are analysis, synthesis, giving own opinions, summarising, concluding, and others.
8 HOURS	Mining and mineral processing – gold, iron, phosphate, (South Africa's strengths); environmental impact of these activities; Platinum (and PGM's) is a major strength in SA. Also the coal, diamond, copper, zinc, chrome, asbestos and manganese mining industries	• Give a brief history of humankind across the ages • linking their technology and the materials they have used to their tools and their weapons • referring to evidence of these activities in South Africa. • Describe the earth's crust as a source of the materials man uses • What is available? (the abundance of the elements on earth) • Where is it found? (the uneven distribution of elements across the atmosphere, the hydrosphere, the biosphere and the lithosphere). • How is it found? (Seldom as elements, inevitably as minerals) • How are the precious materials recovered? (the need to mine and process the minerals and separating them from their surroundings and processing	**Experiment:** (1) Corrosion of iron **Activity:** (2) Describe the methods for the extraction of metals from their ores, such as the physical method, heating alone and heating with carbon. (3) Describe different forms of calcium carbonate in nature **Experiment:** (4) Investigate the actions of heat, water, and acids on calcium carbonate. **Experiment:** (5) Design and perform chemical tests for calcium carbonate. **Experiment:** (6) Oxy-cleaners (exp12) **Discussion**	**Materials:** Glass beaker, water bowl, test tubes, spatula, burner, solid, litmus paper, electrodes (Al, Zn, Cu, Pb), sodium chloride, sodium hydroxide, calcium chloride, sodium carbonate, ammonium hydroxide, dilute sulphuric acid, magnesium ribbon or rod, 14 iron nails (25mm), 14 galvanised iron nails (25mm), cotton wool, Vaseline, paint, oil, water, mass meter, tin rod, steel wool. **Materials:**	Chemistry and its influence on society and the environment are important. Link to aspects of chemical reactions – oxidation, factors affecting rates of reactions etc.

Time	Topics Grade 11	Content, Concepts & Skills	Practical Activities	Resource Material	Guidelines for Teachers
		them to recover the metals or other precious material – use terms like resources, reserves, ore, ore body) • Describe the **recovery of gold** referring to • why it is worth mining? • the location of the major mining activity in South Africa? • the major steps in the process: deep level underground mining separation of the ore from other rock the need to crush the ore bearing rock separating the finely divided gold metal in the ore by dissolving in a sodium cyanide oxygen mixture (oxidation) – simple reaction equation the recovery of the gold by precipitation (Zn) (reduction) – simple reaction equation (this method is outdated, mines use activated carbon) smelting Discuss old mining methods and the impact on the environment of such methods e.g. Mapungubwe. The environmental impact of (1) mining operations and (2) mineral recovery plants • Describe the consequences of the current large scale burning of fossil fuels; many scientists and climatologists are predicting global warming.	(7) Participate in decision-making exercises or discussions on issues related to conservation of natural resources. **Practical investigation:** Learner could investigate the mining industries not chosen by the teacher. Gold; Coal; Copper; Iron; Zinc; Manganese; Chrome; Platinum and Pt group metals (PGM's); Diamonds OR **Practical investigation** Look at the periodic table again and research where all the elements come from and what they are used for with special reference to elements coming from the lithosphere.		**Questions to be asked:** Why is this mining industry important in SA? Where do the mining activities take place? How is the mineral mined? E.g. mining method, major steps in the process, refining method. What is the mineral used for? What is the impact of the mining industry on SA, e.g. environment, economic impact, safety, etc? Google Mapungubwe on the internet and look at the material that can be found. Let learners discuss the issues about environment and mining possibilities in and around Mapungubwe.

ASSESSMENT ***TERM 4***	**<u>TERM 4:Recommended Formal Assessment</u>** **[1] Final Examinations**