ADVICE TO GRADE 12 LEARNERS ON PREPARING FOR PHYSICAL SCIENCES EXAMS
Refering to: PHYSICAL SCIENCES, EXAMINATION GUIDELINES, GRADE 12 2009
And
AMENDMENTS TO EXAMINATION GUIDELINES, PHYSICAL SCIENCES ,GRADE 12 2010

1. Format of Grade 12 Physical Sciences exam paper for 2012

Paper 1: Physics **3 Hours**	**Marks**	**Paper 2: Chemistry** **3 Hours**	**Marks**
SECTION A:		**SECTION A:**	
One word answer	5	One word answers	5
Multiple-choice questions	20	Multiple-choice questions	20
SECTION B: Longer questions assessing all themes	125	**SECTION B:** Longer questions assessing all themes	125
TOTAL	**150**	**TOTAL**	**150**

SECTION A:

QUESTION 1: One – word items
Sub-question numbered 1.1 to 1.5 (1 mark each)
Basic recall questions

QUESTION 2: Multiple choice questions
Sub-questions numbered 2.1 to 2.10 (2 marks each)
Choose the correct answer from four detectors

SECTION B:

QUESTION onwards:
Longer questions assessing skills, knowledge, values at all cognitive levels.

2. DATA SHEET

See annexure A

3. COGNITIVE LEVELS

The final exam paper will adhere to the following weightings of the cognitive levels:

Cognitive level description	**Weighting %**	
	Paper 1	**Paper 2**
Recall (knowledge)	15	15
Comprehension	30	40
Analysis, Application	45	35
Evaluation, Synthesis	10	10

4. Weighting of the Learning Outcomes

Learning Outcome		PAPER 1	PAPER 2
LO1	Practical scientific inquiry and problem solving skills	40%	30%
LO2	Constructing and applying scientific knowledge	45%	45%
LO3	The nature of science and its relationship to technology, society and the environment	15%	25%

Under each learning outcome the following assessment standards will be examined.

Learning Outcomes and Assessment Standards		
LO 1	LO 2	LO 3
AS 12.1.1: Design, plan and conduct a scientific inquiry to collect data systematically with regard to accuracy, reliability and the need to control variables. **AS 12.1.2:** Seek patterns and trends, represent them in different forms, explain the trends, use scientific reasoning to draw and evaluate conclusions, and formulate generalisations. **AS 12.1.3:** Select and use appropriate problem-solving strategies to solve (unseen) problems.(Solve problems with two or more different calculations) **AS 12.1.4:** Communicate and defend scientific arguments with clarity and precision.	**AS 12.2.1:** Define, discuss and explain prescribed scientific knowledge. **AS 12.2.2** Express and explain prescribed scientific principles, theories, models and laws by indicating the relationship between different facts and concepts in own words. **AS 12.2.3:** Apply scientific knowledge in everyday life contexts. (One step calculations)	**AS 12.3.1:** Research, discuss, compare and evaluate scientific and indigenous knowledge systems and knowledge claims by indicating the correlation among them, and explain the acceptance of different claims **AS 12.3.2:** Research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications. **AS 12.3.3:** Evaluate the impact of scientific and technological research and indicate the contribution to the management, utilisation and development of resources to ensure sustainability continentally and globally.

5. Interpretation of learning outcomes

Learning Outcome	Assessment standard	Explanation
LO 12.1: Practical scientific inquiry and problem-solving skills	AS 12.1.1: Design, plan and conduct a scientific inquiry to collect data systematically with regard to accuracy, reliability and the need to control variables	**Experimental design** **Identify and question phenomena** ▪ Formulate an investigative question ▪ List all possible variables ▪ Formulate a testable hypothesis (prediction) **Design/planning of an investigation:** • Identify variables (dependent, independent and controlled variables**)** • List appropriate apparatus • Plan the sequence of steps which should include amongst others o The need for more than one trial to minimize experimental errors) o Identify safety precautions that need to be taken o Set an appropriate control • Suggest an appropriate method of recording of results **Evaluate the experimental design** Identify advantages and limitations of experimental design
	AS 12.1.2: Seek patterns and trends, represent them in different forms, explain the trends, use scientific reasoning to draw and evaluate conclusions, and formulate generalisations	**Graphs** • Draw accurate graphs from given data/information • Interpretation of given graphs • Draw sketch graphs from given information **Results** • Identify patterns/relationships in data • Interpret results **Conclusions** Draw conclusions from information given graphically or in words

		Evaluate the validity of conclusions Describe how results obtained in an investigation can be used to draw a conclusion
Learning Outcome	**Assessment standards**	**Explanation**
LO 12.1: Practical scientific inquiry and problem-solving skills	AS 12.1.3: Select and use appropriate problem-solving strategies to solve (unseen) problems	**Calculations** • Solve problems using two or more different calculations **Descriptions** • Describe methods and ways to solve a given problem
	AS 12.1.4: Communicate and defend scientific arguments with clarity and precision	Explain/describe/argue the validity of a statement/event using scientific principles (Although graphs can be seen as communication when used as part of a report, for examination purposes it will be seen as interpretation of data i.e. AS 12.1.2.)

Learning Outcome	**Assessment standards**	**Explanation**
LO 12.2: Constructing and applying scientific knowledge	AS 12.2.1: Define, discuss and explain prescribed scientific knowledge	Recalling and stating of prescribed knowledge/definitions
	AS 12.2.2: Express and explain prescribed scientific principles, theories, models and laws by indicating the relationship between different facts and concepts in own words	Give relationships between scientific concepts e.g. the relationship between diffraction and the width of the slit
	AS 12.2.3: Apply scientific knowledge in everyday life contexts	**Calculations:** • Application of knowledge to solve one-step calculations **Descriptions** • Use scientific knowledge in different contexts e.g. explain how a cricketer can apply impulse during batting or catching of a cricket ball

Learning Outcome	Assessment standards	Explanation
LO 12.3: The nature of science and its relationship to technology, society and the environment	AS 12.3.1: Research, discuss, compare and evaluate scientific and indigenous knowledge systems and knowledge claims by indicating the correlation among them, and explain the acceptance of different claims	• Given a case study, compare the advantages and limitations of indigenous knowledge of past cultures to present scientific knowledge, for example, o beliefs about lightning o preservation of food o chemicals used as anaesthetics in earlier times as compared to current anaesthetics o the extraction of metals from their ores (as part of electrochemical reactions) o the use of the inclined plane as a simple machine in comparison to cranes and other machines today, etc. • Given a case study, discuss (describe) the changing nature of science i.e. as new knowledge develops, old ideas are replaced with new ideas. For example, o the earlier use of X-rays to make shoes according to the foot size, became in disuse as knowledge about X-rays and the dangers there-of became known o the development of chemical pigments made the extraction of pigments from natural materials unnecessary
	AS 12.3.2: Research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications	• Given a case study, discuss/argue the impact of scientific applications on the life of humans. For example, o the advantages and disadvantages of the use of X-rays on human development o the advantages and disadvantages of the Haber process on human development. • Argue/discuss the impact of scientific knowledge on human development based on prescribed content. For example, o the impact (positive and negative) of the

		production of aluminium on the lives of South Africans NB: When stating an impact of science on human development, listing of aspects is not sufficient. For example, giving ‘fertilisers’ as an answer to the impact of the Haber process on humans, is not sufficient. A complete answer will be ‘fertilisers to produce more food’.

6. MARK ALLOCATION PER KNOWLEDGE AREA

Paper 1 Grade 12

Knowledge Area	Theme	Marks
Mechanics (±33%)	Momentum in 1 D Grade 11	± 50
	Impulse and change in momentum	
	Vertical projectile motion	
	Frames of reference	
	Work, power and energy	
Waves, Sound and Light (±20%)	Doppler effect	± 25
	2D and 3D wavefronts	
Electricity and Magnetism (±37%)	Electrostatics Grade 11	±55
	Electric circuits Grade 11	
	Electrodynamics Grade 12	
	Electromagnetic radiation Grade 12	
Matter and Materials (±10%)	Optical phenomena and properties of materials	± 20
	TOTAL	**150**

7. Paper 2 Grade 12

Knowledge Area	Theme	Marks
Matter and Materials (±33%)	Organic molecules	± 50
Chemical Change (±50%)	Energy and chemical change Grade 11 Rate and extent of reaction	± 75
	Electrochemical reactions	
Chemical Systems (±17%)	Chloralkali industry Fertiliser industry Batteries	±25
	TOTAL	**150**

8. Content to be assessed in Grade 12 Final Examination – 2012

MECHANICS	
Force, momentum and impulse (Grade 11)	**Learners must be able to:**
Pairs of interacting objects exert equal forces on each other (Newton's Third Law)	• State Newton's Third Law (N3): When pairs of objects interact they exert forces on each other. These forces are equal in size and point in opposite directions. • Differentiate between contact and non-contact forces. • Apply Newton's Third Law (N3) to contact and non-contact forces. • Identify N3 pairs e.g. donkey pulling a cart, a book on a table.
Momentum	• Define momentum • Calculate the momentum from a moving object using p = mv. • Describe the vector nature of momentum and illustrate with some simple examples.
A net force on an object causes a change in momentum – if there is no net force on an object/system its	• State Newton's Second Law (N2) in terms of momentum: the net (or resultant) force acting on an object is equal to the rate of change of momentum. • Express Newton 2 in symbols: $F_{net} = \frac{\Delta p}{\Delta t}$

momentum will not change (momentum will be conserved)	• Explain the relationship between net force and change in momentum for a variety of motions. • Calculate the change in momentum when a resultant force acts on an object and its velocity: o Increases in the direction of motion (e.g. 2^{nd} stage rocket engine fires) o Decreases (e.g. brakes are applied). o Reverses its direction of motion e.g. a soccer ball kicked back in the direction it came from. • 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. • Know that in the absence of an external force acting on a system momentum is conserved. • Apply the conservation of momentum to collisions of two objects moving in one dimension (along a straight line).
Momentum (Grade 12)	• Know that the momentum of a system is conserved when no external forces act on it. • *Know that an external force causes the momentum to change. Define impulse as $F_{net} \Delta t = \Delta p$ and use the equation in calculations. • Solve problems involving impulse and change in momentum when the applied force is in the horizontal or vertical direction. • Distinguish between elastic and inelastic collisions. • Solve problems involving elastic and inelastic collisions for objects moving along the same straight line. • Apply the concept of impulse to safety considerations in everyday life, e.g. airbags, seatbelts and arrestor beds.
Vertical projectile motion	**Learners must be able to:**
Represented in words, diagrams, equations and graphs	For vertical projectile motion (near the surface of the Earth if air friction is ignored) • Explain that projectiles: - fall freely with gravitational acceleration 'g' - accelerate downwards with a constant acceleration whether the projectile is moving upward or downward - have zero velocity at their greatest height
	- 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 - can have their motion described by a single set of equations for the upward and downward motion • Use equations of motion, for e.g. to determine - The greatest height reached given the velocity with which the projectile is launched upward (initial velocity) - The time at which a projectile is at a particular height given its initial velocity - The height relative to the ground of the position of a projectile shot vertically upward at launch, given the time for the projectile to reach the ground • Draw position vs time (x vs t), velocity vs time (v vs t) and acceleration vs time (a vs t) graphs for projectile motion. • Give equations for position versus time and velocity versus time for the graphs of motion of particular projectiles and vice versa. • Given x vs t, v vs t or a vs t graphs determine position, displacement, velocity or acceleration at any time t. • Describe the motion of the object e.g. graphs showing a ball: - Bouncing - Thrown vertically upwards - Thrown vertically downward, and so on
Frames of reference (Relative velocity)	**For motion in one dimension (linear motion) only:** • Define a frame of reference. • Give examples of the importance of specifying the frame of reference. • Define relative velocity. • Specify the velocity of an object relative to different frames of reference, e.g. for a person walking inside a train give the velocity relative to the train and relative to the ground.

	• Use vectors to find the velocity of an object that moves relative to something else that is itself moving.
Work, power and energy	**Learners must be able to:**
When a force exerted on an object causes it to move, work is done on the object (except if the force and displacement are at right angles to each other)	• Define the work done on an object by a force. • Give examples of when an applied force does and does not do work on an object. • Calculate the work done by an object when a force F applied at angle θ to the direction of motion causes the object to move a distance, using $W = F\Delta x\cos\theta$.
The work done by an external force on an object / system equals the change in kinetic energy of the object / system	• Know that an object with larger potential energy has a greater capacity to do work. • *Solve problems using the work energy theorem, i.e. the work done on an object by a net force is equal to the change in the object's kinetic energy: $W_{net} = \Delta E_k = E_{kf} - E_{ki}$. Examples may include: o objects on horizontal surfaces o objects moving in a vertical plane o objects on inclined planes • Conservation of mechanical energy (prior knowledge from grade 10)
Power (rate at which work is done)	• Define power as the rate at which work is done or energy is expended. • Calculate the power involved when work is done. • *If a force causes an object to move at a constant velocity, calculate the average power or instantaneous power using P = Fv. • Apply to real life examples, e.g. the minimum power required of an electric motor to pump water from a borehole of a particular depth at a particular rate, the power of different kinds of cars operating under different conditions.

WAVES, SOUND AND LIGHT	
Doppler Effect	**Learners must be able to:**
With sound and ultrasound	• State what the Doppler Effect is for sound and give everyday examples. • Relate the pitch of a sound wave to the frequency of a sound wave and explain why a sound increases in pitch when the source of the sound travels towards a listener and decreases in pitch when it travels away. • Use the equation $f_L = \frac{v \pm v_L}{v \pm v_S} f_S$ to calculate the frequency of sound detected by a listener (L) WHEN EITHER THE LISTENER OR THE SOURCE (S) is moving. • Describe applications of the Doppler Effect with ultrasound waves in medicine, e.g. to measure the rate of blood flow or the heart of a foetus in the womb.
2D and 3D wavefronts	**Learners must be able to:**
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. • Use $\sin\theta = \frac{m\lambda}{a}$ for a slit of width *a* to calculate the position (angle) of the dark bands in a single slit diffraction pattern, where m = ±1, ±2, ±3, …
Interference (special kind of superposition)	• Define interference as when two waves pass through the same region of space at the same time, resulting in superposition of waves. • Explain the concepts of constructive and destructive interference. • Predict areas of constructive and destructive interference from a diagram/source material. • Investigate the interference of waves from two coherent sources vibrating in phase e.g. light waves through a double slit.

	• Draw an interference pattern marking nodal lines and noting positions of maximum interference e.g. interference pattern for a double slit. **(Although the focus here is on light, it will be very useful to use water waves in a ripple tank to demonstrate diffraction and interference.)**
ELECTRICITY AND MAGNETISM	
Electrostatics (Grade 11)	**Learners must be able to:**
Forces charges exert on each other (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.
Electric field around single charges and groups of charges	• 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 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 ($E = \frac{F}{q}$). E and F are vectors. • Deduce that the force acting on a charge in an electric field is F = Eq. • 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.
Electrical potential energy and potential	• Define the electrical potential energy of a charge as the energy it has because of its position relative to other charges that it interacts with. • Use the equation $U=\frac{kQ_1Q_2}{r}$ to calculate the potential energy of a charge due to other charges. • Define the electric potential at a point as the electrical potential energy per unit charge, i.e. the potential energy a positive test charge would have if it were placed at that point. • *Define electric potential difference as the difference in electrical potential energy per unit charge between two points ($V = \frac{W}{q}$). The unit is volt (V), which is the same as joule per coulomb. Thus electrical potential difference is also called voltage. (revision from grade 10). • Explain lightning in terms of electric potential and potential difference and describe measures that can be taken to reduce the risk of being struck by lightning.
Capacitance, physics of the parallel plate capacitor, relation between charge, potential difference and capacitance	• Describe a parallel plate capacitor as a device that consists of two oppositely charged conducting plates separated by a small distance, which stores charge. • Define capacitance as the charge stored per volt, measured in farad (F), mathematically, $C = \frac{Q}{V}$ • Solve problems involving the charge stored by, and voltage across, capacitors. • Use the equation $C = \frac{\varepsilon_0 A}{d}$ to determine the capacitance of a capacitor of given dimensions or design a capacitor of given capacitance. • Calculate the electric field between the plates of a parallel plate capacitor using the equation $E = \frac{V}{d}$. • Explain using words and pictures why inserting a dielectric between the plates of a parallel plate capacitor increases its capacitance.
Capacitor as a circuit device	• Describe what happens to a capacitor in a DC circuit over time. • Describe how a charged capacitor can be used to provide a large potential difference for a very short time.
Electric circuits (Grade 11)	**Learners must be able to:**

Relation between current, voltage and resistance (Ohm's Law)	• *Define electric current. Calculate electric current strength using $I = \frac{q}{\Delta t}$ (revision from grade 10) • Determine the relationship between current, voltage and resistance at constant temperature using a simple circuit. • State the difference between ohmic and non-ohmic conductors, and give an example of each. • Solve problems using the mathematical expression of Ohm's Law, $R = \frac{V}{I}$. • *Calculate the work done or energy transferred in an electric circuit using $W = Vq = VI\Delta t = I^2R\Delta t = \frac{V^2\Delta t}{R}$. • *Calculate the electric power dissipated in an electric circuit using $P = \frac{W}{\Delta t} = VI = I^2R = \frac{V^2}{R}$. Use power to determine, for example, relative brightness of bulbs.
Resistance, equivalent resistance, internal resistance	• Calculate the equivalent resistance of series and parallel arrangements of resistors. • Solve problems involving current, voltage and resistance for circuits containing arrangements of resistors in series and in parallel. • State that a real battery has internal resistance. • Explain why there is a difference between the emf and terminal voltage of a battery if the external resistance in the circuit is comparable in size to the battery's internal resistance. • Solve circuit problems in which the internal resistance of the battery must be considered.
*Series, parallel resistors	*Solve circuit problems involving resistors in series with a maximum of three resistors in parallel.
Electrodynamics	**Learners must be able to:**
Electrical machines (generators, motors)	• State that generators convert mechanical energy to electrical energy and motors convert electrical energy to mechanical energy. • Use Faraday's Law to explain why a current is induced in a coil that is rotated in a magnetic field. • Use words and pictures to explain the basic principle of an AC generator (alternator) in which a coil is mechanically rotated in a magnetic field. • Use words and pictures to explain how a DC generator works and how it differs from an AC generator. • Explain why a current-carrying coil placed in a magnetic field (but not parallel to the field) will turn by referring to the force exerted on moving charges by a magnetic field and the torque on the coil. • Use words and pictures to explain the basic principle of an electric motor. • Give examples of the use of AC and DC generators. • Give examples of the use of motors.
Alternating current	• Explain the advantages of alternating current. • Write expressions for the current and voltage in an AC circuit. • Define the rms (root mean square) values for current and voltage as $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ and $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ respectively, and explain why these values are useful. • *Calculate the average power in an AC circuit using: $P_{average} = V_{rms}I_{rms} = I^2_{rms}R = \frac{V^2_{rms}}{R}$ • Draw a graph of voltage vs time and current vs time for an AC circuit.
Electromagnetic radiation	**Learners must be able to:**
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.

Nature of an EM-wave as mutual induction of oscillating magnetic/electric fields	• Describe the source of electromagnetic waves as an accelerating charge. • Use words and diagrams to explain how an EM wave propagates when an electric field oscillating in one plane produces a magnetic field oscillating in a plane at right angles to it, which produces an oscillating electric field, and so on. • State that these mutually regenerating fields travel through space at a constant speed of 3×10^8 $m \cdot s^{-1}$, represented by c.
EM spectrum	• Given a list of different types of EM radiation, arrange them in order of frequency or wavelength. • Given the wavelength of EM waves, calculate the frequency and vice versa, using the equation $c = f\lambda$. • Give an example of the use of each type of EM radiation, i.e. gamma rays, X-rays, ultraviolet light, visible light, infrared, microwave and radio and TV waves.
Nature of EM as particle – energy of a photon related to frequency and wavelength	• Calculate the energy of a photon using $E = hf = \frac{hc}{\lambda}$
Penetrating ability	• Indicate the penetrating ability of the different kinds of EM radiation and relate it to energy of the radiation. • Describe the dangers of gamma rays, X-rays and the damaging effect of ultra-violet radiation on skin.

MATTER AND MATERIALS (INTEGRATED TOPICS WITH A PHYSICS FOCUS)	
Optical phenomena and properties of materials	**Learners must be able to:**
Transmission and scattering of light	• Explain the interaction of UV and visible radiation: - With metals: reflect (absorb and re-emit) - In terms of the interaction with electromagnetic radiation • Explain why the sky is blue.
Photoelectric effect	• Describe the photoelectric effect as the process that occurs when light shines on a metal and it ejects an electron. • Explain the photoelectric effect in terms of photons and work function. • Recall, use and explain the significance of $hf = W_0 + \frac{1}{2}mv^2$ where W_0 is the work function of a surface. • Give the significance of the photo-electric effect: - It establishes the quantum theory. - It illustrates the particle nature of light.
Emission and absorption spectra	• Explain the source of atomic emission spectra (cf discharge tubes) and their unique relationship to each element. • Relate the lines on the atomic spectrum to electron transitions between energy levels. • Explain the difference between atomic absorption and emission spectra • Use $E = hf$ to determine the energy of photons of UV and visible light of varying colours. • Relate UV and visible light to atomic absorption spectra.

PAPER 2 – Chemistry

MATTER AND MATERIALS (INTEGRATED TOPICS WITH A CHEMISTRY FOCUS)	
Organic molecules	**Learners must be able to:**
Organic molecular structures – functional groups, saturated and unsaturated structures, isomers; *systematic naming and formulae	• Give condensed structural, structural and molecular formulae given the IUPAC name, or give the IUPAC name given the formula for: o *Alkanes - maximum eight carbon atoms in the longest chain; branched alkanes with maximum three alkyl substituents; maximum two carbon atoms per alkyl substituent; number longest chain beginning at end nearest to first substituent; arrange substituents alphabetical in name; know that alkanes are our most important fuels (fossil fuels); combustion of alkanes (oxidation) is highly exothermic and carbon dioxide and water are produced: alkane + $O_2 \rightarrow H_2O + CO_2$ $\Delta H < 0$ (revision from grade 11) o *Cycloalkanes – maximum of six carbon atoms per ring; maximum three alkyl substituents; maximum two carbon atoms per alkyl substituent o *Alkenes - maximum of eight carbon atoms in the longest chain; branched alkenes with maximum three alkyl substituents; maximum two carbon atoms per alkyl substituent o *Cycloalkenes - maximum of six carbon atoms per ring, maximum three alkyl substituents; maximum two carbon atoms per alkyl substituent o *Dienes – conjugated dienes (two double bonds separated by a single bond), isolated dienes (one or more saturated carbon atoms between two double bonds) or cumulated dienes (two double bonds formed to one carbon atom); maximum eight carbon atoms in the longest chain; branched dienes with maximum three alkyl substituents; maximum two carbon atoms per alkyl substituent o *Alkynes - maximum eight carbon atoms in the longest chain; branched alkynes with maximum three alkyl substituents; maximum two carbon atoms per alkyl substituent o *Haloalkanes - maximum eight carbon atoms in the longest chain; branched haloalkanes - maximum two carbon atoms per alkyl group; haloalkanes can have one or more X-groups (X = F, Cl, Br or I) attached; number longest chain beginning at end nearest to first substituent, regardless of whether it is alkyl or halo; give alphabetical preference to substituents when longest chain can be numbered from either side; include cyclic haloalkanes for rings up to six carbon atoms, e.g. 1,2-dibromocyclohexane o *Alcohols - maximum eight carbon atoms in the longest chain; primary, secondary and tertiary alcohols; branched alcohols with maximum three alkyl substituents; maximum two carbon atoms per alkyl substituent; number longest chain beginning at end nearest to hydroxyl group o *Carboxylic acids - maximum eight carbon atoms in the longest chain; branched carboxylic acids with maximum three alkyl substituents; maximum two carbon atoms per alkyl substituent; number longest chain beginning at end nearest to carboxyl group o *Esters – maximum eight carbon atoms in alkyl group (unbranched) attached to oxygen i.e. alcohol side of ester, and maximum of eight carbon atoms in carboxylic acid side (unbranched) of ester; know that an ester is the product of an acid catalysed condensation between an alcohol and a carboxylic acid; identify the alcohol and carboxylic acid used to prepare a given ester and vice versa, and write an equation to represent this preparation
	o *Aldehydes - maximum eight carbon atoms in the longest chain; branched aldehydes with maximum three alkyl substituents; maximum two carbon atoms per alkyl group; number longest chain beginning at end nearest to carbonyl group o *Ketones - maximum of eight carbon atoms in the longest chain; branched ketones with maximum three alkyl substituents; maximum two carbon atoms per alkyl group; number longest chain beginning at end nearest to carbonyl group • Explain the terms functional group, hydrocarbon, saturated, unsaturated, homologous series and isomer (structural isomers only). • Identify compounds that are saturated, unsaturated and are isomers (up to eight carbon atoms).

*Structure and physical property relationships	• Recognise and apply to particular examples (for compounds listed above) the relationship between: ○ physical properties (e.g. melting points, boiling points, vapour pressures, viscosities) and intermolecular forces (hydrogen bonding, Van der Waals) ○ physical properties (e.g. melting points, boiling points, vapour pressures, viscosities) and number and type of functional groups ○ physical properties (e.g. melting points, boiling points, vapour pressures, viscosities) and chain length ○ physical properties (e.g. melting points, boiling points, vapour pressures, viscosities) and branched chains
Substitution, addition and elimination reactions	• ***Addition reactions:** Unsaturated compounds (alkenes, cycloalkenes, alkynes) undergo addition reactions: ○ Hydrohalogenation: Addition of HX to an alkene e.g. $CH_2 = CH_2 + HC\ell \rightarrow CH_3 - CH_2C\ell$ Reaction conditions: HX (X = Cℓ, Br, I) added to alkene; no water must be present (During addition of HX to unsaturated hydrocarbons, the H atom attaches to the C atom already having the greater number of H atoms. The X atom attaches to the more substituted C atom.) ○ Halogenation: Addition of X_2 (X = Cℓ, Br) to alkenes e.g. $CH_2 = CH_2 + C\ell_2 \rightarrow CH_2C\ell\text{-}CH_2C\ell$ Reaction conditions: X_2 (X = Cℓ, Br) added to alkene ○ Hydration: Addition of H_2O to alkenes e.g. $CH_2 = CH_2 + H_2O \rightarrow CH_3 - CH_2OH$ Reaction conditions: H_2O in excess and a small amount of HX or other strong acid (H_3PO_4) as catalyst (During addition of H_2O to unsaturated hydrocarbons, the H atom attaches to the C atom already having the greater number of H atoms. The OH group attaches to the more substituted C-atom.) ○ Hydrogenation: ➢ Addition of H_2 to alkenes e.g. $CH_2 = CH_2 + H_2 \rightarrow CH_3 - CH_3$ Reaction conditions: alkene dissolved in a non polar solvent with the catalyst (Pt, Pd or Ni) in a H_2 atmosphere
	• ***Elimination reactions:** Saturated compounds (haloalkanes, alcohols, alkanes) undergo elimination reactions ○ Dehydrohalogenation: Elimination of HX from a haloalkane e.g. $CH_2C\ell\text{-}CH_2C\ell \rightarrow CH_2 = CHC\ell + HC\ell$ Reaction conditions: heat under reflux (vapours condensate and return to reaction vessel during heating) in a concentrated solution of NaOH or KOH in pure ethanol as the solvent i.e. hot ethanolic NaOH/KOH (If more than one elimination product is possible, the major product is the one where the H atom is removed from the C atom with the least number of H atoms) ○ Dehydration of alcohols: Elimination of H_2O from an alcohol e.g. $CH_3 - CH_2OH \rightarrow CH_2 = CH_2 + H_2O$ Reaction conditions: Acid catalysed dehydration – heating of alcohol with an excess of concentrated H_2SO_4 (or H_3PO_4). Gaseous alkenes e.g. ethene can be produced easier when ethanol vapour is passed over heated Al_2O_3 powder: (If more than one elimination product is possible, the major product is the one where the H atom is removed from the C atom with the least number of H atoms) ○ Cracking of hydrocarbons: Breaking up large hydrocarbon molecules into smaller and more useful bits. Reaction conditions: high pressures and temperatures without a catalyst (thermal cracking), or lower temperatures and pressures in the presence of a catalyst (catalytic cracking.

	• ***Substitution reactions:** o Interconversion between alcohols and haloalkanes: ➢ Reactions of HX (X = Cℓ , Br) with alcohols to produce haloalkanes: Reaction conditions: - Tertiary alcohols are converted into haloalkanes using HBr or HCℓ at room temperature e.g. $C(CH_3)_3OH + HBr \rightarrow C(CH_3)_3Br + H_2O$ - Primary and secondary bromoalkanes: Treat primary and secondary alcohols with concentrated H_2SO_4 and solid NaBr (or KBr). The H_2SO_4 and solid NaBr reacts to form HBr: $H_2SO_4 + NaBr \rightarrow HBr + NaHSO_4$ The HBr reacts with the alcohol to form the bromoalkane: e.g. $CH_3CH_3OH + NaBr\ H_2SO_4 \rightarrow CH_3CH_3Br + NaHSO_4H_2O$ ➢ Reactions of bases with haloalkanes (hydrolysis) to produce alcohols e.g. $C(CH_3)_3X + KOH \rightarrow C(CH_3)_3OH + KBr$ Reaction conditions: Haloalkane dissolved in ethanol before treatment with aqueous sodium hydroxide and warming of the mixture; the same hydrolysis reaction occurs more slowly without alkali, i.e. H_2O added to the haloalkane dissolved in ethanol o Haloalkanes from alkanes (prior knowledge from Grade 11). Reaction conditions: X_2 (X = Br, Cℓ) added to alkane in the presence of light or heat

CHEMICAL CHANGE	
Energy and chemical change (Grade 11)	**Learners must be able to:**
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).
Exothermic and endothermic reactions	• State that $\Delta H > 0$ for endothermic reactions, including graph. • State that $\Delta H < 0$ for exothermic reactions, including graph.
Activation energy	• Define activation energy. • Explain a reaction process in terms of energy change and relate this change to bond breaking and formation, and to the "activated complex".
Rate and extent of reaction	**Learners must be able to:**
Rates of reaction and factors affecting rate (nature of reacting substances, concentration [pressure for gases], temperature and presence of a catalyst)	• Explain what is meant by reaction rate. • List the factors which affect the rate of chemical reactions. Surface area (solid), concentration (solution), pressure (gas), temperature, and catalyst. • Explain in terms of collision theory how the various factors affect the rate of chemical reactions.
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.
Mechanism of reaction and of catalysis	• *Define activation energy – the minimum energy required for a reaction to take place. Colliding molecules must have, apart from the correct orientation, a kinetic energy equal to or bigger than the activation energy of a reaction before the reaction can take place. • Use a graph showing the distribution of molecular energies (number of particles against their kinetic energy) to explain why only some molecules have enough energy to react and hence how adding a catalyst and heating the reactants affects the rate. • Explain (in simple terms) how some catalysts function by reacting with the reactants in such a way that the reaction follows an alternative path of lower activation energy.
Chemical equilibrium and factors affecting	• Explain what is meant by: o Open and closed systems

equilibrium	o A reversible reaction o Dynamic equilibrium • List the factors which influence the position of an equilibrium.
Equilibrium constant	• List the factors which influence the value of the equilibrium constant. • Write down an expression for the equilibrium constant having been given the equation for the reaction. • Perform calculations based on K_c values. • Explain the significance of high and low values of the equilibrium constant.
Application of equilibrium principles	• *State Le Chateliers principle. Use Le Chatelier's principle to identify and explain the effects of changes of pressure, temperature and concentration on the concentrations and amounts of each substance in an equilibrium mixture. Explain the use of a catalyst and its influence on an equilibrium mixture. • *Interpret graphs of equilibrium • Apply the rate and equilibrium principles to important industrial applications.
Electrochemical reactions	**Learners must be able to:**
Electrolytic and galvanic cells	• Define the galvanic cell in terms of: o Self sustaining electrode reactions o Conversion of chemical energy to electrical energy • Define the electrolytic cell in terms of: o Electrode reactions that are sustained by a supply of electrical energy o Conversion of electrical energy into chemical energy • Define oxidation and reduction in terms of electron (e-) transfer/oxidation numbers. • Define anode and cathode in terms of oxidation and reduction. • *Define oxidising and reducing agents in terms of electron transfer/oxidation numbers.
Relation of current and potential to rate and equilibrium	• Give and explain the relationship between current in an electrochemical cell and the rate of the reaction. • State that the pd of the cell (V_{cell}) is related to the extent to which the spontaneous cell reaction has reached equilibrium. • State and use the qualitative relationship between V_{cell} and the concentration of product ions and reactant ions for the spontaneous reaction viz. V_{cell} decreases as the concentration of product ions increases and the concentration of reactant ions decreases until equilibrium is reached at which the V_{cell} = 0 (the cell is 'flat'). (qualitative treatment only - exclude Nernst equation)
Understanding of the processes and redox reactions taking place in cells	• Describe: o movement of ions through the solutions o electron flow in the external circuit of the cell o the half reactions at the electrodes o function of the salt bridge in galvanic cells • *Use cell notation or diagrams to represent a galvanic cell
Standard electrode potentials	• Give the standard conditions under which standard electrode potentials are determined. • Describe: o The standard hydrogen electrode o Explain its role as the reference electrode • Explain how standard electrode potentials can be determined using the reference electrode and state the convention regarding positive and negative values. • *Use the Table of Standard Reduction Potentials to calculate the emf of a standard galvanic cell. • Use a positive value of the standard emf as an indication that the reaction is spontaneous under standard conditions.
Writing of equations representing oxidation and reduction half reactions and redox reactions	• Predict the half-cell in which oxidation will take place when connected to another half-cell. • Predict the half-cell in which reduction will take place when connected to another half-cell. • Write equations for reactions taking place at the anode and cathode. • Deduce the overall cell reaction by combining two half-reactions. • Describe, using half equations and the equation for the overall cell reaction, the following electrolytic processes:

	o The decomposition of copper chloride o A simple example of electroplating (e.g. the refining of copper) • 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: o The production of chlorine (see grade 12 chemical systems: the chloroalkali industry). o The recovery of aluminium metal from bauxite. (South Africa uses bauxite from Australia.)

Chemical Systems	
Chemical industries	**Learners must be able to:**
Chloroalkali industry (soap, PVC, etc.)	• Given diagrams of the membrane cell used industrially to produce chlorine electrolytically: o Explain the process using half reactions and the overall redox reaction taking place in the cells o Identify all the products and give a use of each o Make clear the meaning of the term electrolytic cell o Identify the cathode (reduction, H_2) and anode (oxidation, $C\ell_2$) o Describe the function of the cell membrane where applicable (ion exchange) • Identify the benefits to humankind of the products of this process. • Identify risks associated with operating this cell. • Given a flow diagram of, for example, the membrane cell (or even an unknown process pertinent to the manufacture of these products), be able to answer questions on aspects of the process. • For example identify the reactants and products of a particular step, or the purpose of a sequence of steps.
Fertiliser industry (N, P, K)	• List, for plants: o Three essential nutrients and their source; C, H and O (atmosphere (CO_2) and rain) o Three primary nutrients and their source N, P and K (the soil) • Explain the function of N, P and K in plants. • List for humans the four major elements, and their source, on which the body relies for form and function; C, H, O and N (atmosphere, water and food – animals and plants). • Match the parts of the human body that utilise particular chemical elements with those from a list of primary, secondary and micronutrients in plants (e.g. P, K, Fe, Ca, …). • Give the form in which plants and animals absorb N, P and K (e.g. nitrates, phosphates, potassium salts, … implies the need to fix nitration). • Give the source of N (guano), P (bone meal) and K (German mines) before and after the First World War). • Interpret the N:P:K fertilizer ratio • Describe and explain (rates, yields, neutralisation, …), using chemical equations where ever appropriate, these aspects of the industrial manufacture of fertilizers, given diagrams, flow charts and so on: o N_2 – fractional distillation of air o H_2 – at SASOL from coal and steam o NH_3 – Haber process o HNO_3 – the Ostwald process o H_2SO_4 – including the contact process • Give sources of potash (mined imported potassium salts like KNO_3, K_2SO_4, KNO_3, ….) • Describe the term eutrophication and: o What causes it o Its consequences o Identify circumstances that can lead to it from a supplied text o Suggest ways to prevent it o Suggest ways to solve the problems that arise from it • Evaluate the use of inorganic fertilizers on humans and the environment.

Batteries, torch, car, etc.	• Use the knowledge gained studying galvanic cells to provide, for an unknown cell: o The equation for the cell reaction given the half equations o The cell voltage if applied with the voltage of the half cells • Explain and use the concepts: o Energy stored in cells and batteries W = Vq o Cell capacity and use the unit Amp-hour (Ah and mAh) and the equation $q = I\Delta t$ o Primary cells and secondary cells

9. Marking

9.1.1 Definitions: Two marks will be awarded for a correct definition. No marks will be awarded for an incorrect or partially correct definition.

9.1.2 Calculations:
- o Marks will be awarded for: correct formula, correct substitution, correct answer with unit.
- o No marks will be awarded if an incorrect or inappropriate formula is used, even though there may be relevant symbols and applicable substitutions.

9.1.3 Explanations and interpretations: Allocation of marks to questions requiring interpretation or explanation e.g. AS 1.4, 2.2, 2.3, 3.1, 3.2 and 3.3, will differ and may include the use of rubrics, checklists, memoranda, etc. In all such answers emphasis must be placed on scientific concepts relating to the question.

9.2 FORMULAE AND SUBSTITUTIONS

9.2.1 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.

9.2.2 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.

9.2.3 Marks are only awarded for a formula if a calculation had been **attempted**. i.e. substitutions have been made or a numerical answer given.

9.2.4 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.

9.2.5 All calculations, when not specified in the question, must be done to two decimal places.

9.3 UNITS

9.3.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question or sub-question**.

9.3.2 Units are only required in the final answer to a calculation.

9.3.3 Marks are only awarded for an answer, and not for a unit *per se*. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:
- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit.

9.3.4 SI units must be used except in certain cases, e.g. $V \cdot m^{-1}$ instead of $N \cdot C^{-1}$, and $cm \cdot s^{-1}$ or $km \cdot h^{-1}$ instead of $m \cdot s^{-1}$ where the question warrants this. (This instruction only applies to Paper 1.)

9.4 POSITIVE MARKING

Positive marking regarding calculations will be followed in the following cases:

9.4.1 **Sub-question to sub-question:** When a certain variable is calculated in one sub-question (e.g. 3.1) and needs to be substituted in another (3.2 or 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3, **full marks** are to be awarded for the subsequent sub-questions.

9.4.2 **A multi-step question in a sub-question**: If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.

9.4.3 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.

9.4.4 Questions where a series of calculations have to be made (e.g. a circuit diagram question) do not necessarily always have to follow the same order. FULL MARKS will be awarded provided it is a valid solution to the problem. However, any calculation that will not bring the candidate closer to the answer than the original data, will not count any marks.

9.4.5 If one answer or calculation is required, but two given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.

9.4.6 Normally, if based on a conceptual mistake, an incorrect answer cannot be correctly motivated. If the candidate is therefore required to motivate in question 3.2 the answer given to question 3.1, and 3.1 is incorrect, no marks can be awarded for question 3.2. However, if the answer for e.g. 3.1. is based on a calculation, the motivation for the incorrect answer in 3.2 could be considered.

9.4.7 If instructions regarding method of answering are not followed, e.g. the candidate does a calculation when the instruction was to ***solve by construction and measurement***, a candidate may forfeit all the marks for the specific question.

9.4.8 For an **error of principle, no marks** are awarded (Rule 1) e.g.: If the potential difference is 200 V and resistance is 25 Ω, calculate the current.

CORRECT	ANSWER (1)	POSSIBLE	ANSWER (2)	POSSIBLE
$I=\frac{V}{R}$ ✓ $=\frac{200}{25}$ ✓ = 8 A✓ (3)	$R=\frac{V}{I}$ ✓ $=\frac{200}{25}$ × = 8 A × (1)	$R=\frac{I}{V}$ × $=\frac{200}{25}$ = 8 A (0)	$R=\frac{V}{I}$ ✓ $I=\frac{R}{V}$ × $=\frac{25}{200}$ ✓ = 0,125 A × (2)	$I=\frac{V}{R}$ ✓ = 8 A ✓ (2)

9.5 GENERAL PRINCIPLES OF MARKING IN CHEMISTRY (PAPER 2)

The following are a number of guidelines that specifically apply to Paper 2.

9.5.1 When a chemical **FORMULA** is asked, and the **NAME** is given as answer, only one of the two marks will be awarded. The same rule applies when the **NAME** is asked and the **FORMULA** is given.

9.5.2 When redox half-reactions are to be written, the correct arrow should be used. If the equation

$H_2S \rightarrow S + 2\,H^+ + 2e^-$ ($\frac{2}{2}$)

is the correct answer, the following marks will be given:

$H_2S \rightleftharpoons S + 2\,H^+ + 2e^-$ ($\frac{1}{2}$)

$H_2S \leftarrow S + 2\,H^+ + 2e^-$ ($\frac{0}{2}$)

$S + 2H^+ + 2e^- \leftarrow H_2S$ ($\frac{2}{2}$)

$S + 2H^+ + 2e^- \rightleftharpoons H_2S$ ($\frac{0}{2}$)

9.5.3 When candidates are required to give an explanation involving the relative strength of oxidising and reducing agents, the following is unacceptable:

- Stating the position of a substance on table 4 only (e.g. Cu is above Mg).
- Using relative reactivity only (e.g. Mg is more reactive than Cu).
- The correct answer would for instance be: Mg is a stronger reducing agent than Cu, and therefore Mg will be able to reduce Cu^{2+} ions to Cu. The answer can also be given in terms of the relative strength as electron acceptors and donors.

9.5.4 One mark will be forfeited when the charge of an ion is omitted per equation.

9.5.5 The error carrying principle does not apply to chemical equations or half reactions. For example, if a learner writes the wrong oxidation/reduction half-reaction in the sub-question and carries the answer to another sub-question (balancing of equations or calculation of E^{θ}_{cell}) then the learner is not credited for this substitution.

9.5.6 *When a calculation of the cell potential of a galvanic cell is expected, marks will only be awarded for the formula if one of the formulae indicated on the data sheet (Table 2) is used. The use of any other formula using abbreviations etc. will carry no marks.

9.5.7 In the structural formula of an organic molecule all hydrogen atoms must be shown. Marks will be deducted if hydrogen atoms are omitted.

9.5.8 When a structural formula is asked, marks will be deducted if the candidate writes the condensed formula.

9.5.9 *When an IUPAC name is asked, and the candidate omits the hyphen (e.g. instead of 1 –pentene the candidate writes 1 pentene), marks will be forfeited.

10. Tips for the writing the exam

When you start the paper you will get 10 minutes reading time. As you read decide which question you know the most of and then answer that question first.

When you get stuck on a question move to a next question. Learners tend to waste time on the 10% higher ability question and then they cannot get to the questions that were easier.

11. USE PAST PAPERS

You are referred in particular to the following papers:

- NCS Feb-Mar 2012 Supplementary Paper
- NCS November 2011 Examination Papers
- NCS Feb-Mar 2011 Supplementary Paper
- NCS November 2010 Examination Papers
- NCS Feb-Mar 2010 Supplementary Paper
- NCS November 2009 Examination Papers
- NCS Feb-Mar 2009 Supplementary Paper
- NCS November 2008 Examination Papers

Your teachers will have copies of all these papers. If you have access to the Internet you can obtain these papers by logging on to www.education.gov.za. Click on Assessment and then choose Examinations then national Senior Certificate Previous exam papers and then go to Non-Languages and then Physical Sciences.

Do these papers carefully and mark them yourself from the model answer.

HOW TO STUDY

- **Extract from "Mathematical methods in the Physical Sciences" by Mary Boas**
  One point ….that cannot be emphasized enough: to use mathematics effectively in applications, you need not just knowledge, but *skills*. Skill can only be obtained through practice.
  You can obtain a certain *superficial knowledge* of mathematics (or science) by listening to lecturers, but you cannot obtain skills this way.
  How many students have I heard say: "it looks so easy when you do it", or "I understand it but I can't do the problems!". Such statements show lack of practice and consequent lack of skill. The only way to develop the skill necessary ….. is to practice by solving many problems.
  Always study with pencil and paper at hand. Don't just read through a solved problem – try to do it yourself! Then solve some similar ones.
  But this means practice, practice, practice! The only way to learn to solve problems *is* to solve problems.

Annexure A

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}\ m{\cdot}s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J{\cdot}s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}\ N{\cdot}m^{2}{\cdot}C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$
Permittivity of free space *Permittiwiteit van vry ruimte*	ε_0	$8,85 \times 10^{-12}\ F{\cdot}m^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/*of* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p = mv_f - mv_i$	$w = mg$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = E_P = mgh$
$K = E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K = \Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$ or/*of* $v = \nu\lambda$	$T = \frac{1}{f}$ or/*of* $T = \frac{1}{\nu}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/*of* $E = h\nu$ or/*of* $E = h\frac{c}{\lambda}$
$\sin\theta = \frac{m\lambda}{a}$	$hf = W_0 + \frac{1}{2}mv^2 = hf_0 + \frac{1}{2}mv^2$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$E = \frac{F}{q}$
$U = \frac{kQ_1Q_2}{r}$	$V = \frac{W}{q}$
$C = \frac{Q}{V}$	$C = \frac{\varepsilon_0 A}{d}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$
$R_s = R_1 + R_2 + ...$	emf/*emk*$(\varepsilon) = I(R + r)$
$q = I\Delta t$	$W = Vq = VI\Delta t = I^2R\Delta t = \frac{V^2\Delta t}{R}$
$P = \frac{W}{\Delta t} = VI = I^2R = \frac{V^2}{R}$	

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{average} = V_{rms}I_{rms} = I_{rms}^2R = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = V_{wgk}I_{wgk} = I_{wgk}^2R = \frac{V_{wgk}^2}{R}$

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4\ dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$c = \frac{n}{V}$ or $c = \frac{m}{MV}$
$q = I\Delta t$ $W = Vq$	$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

KEY/*SLEUTEL*

Electronegativity / *Elektronegatiwiteit*	Atomic number / *Atoomgetal*	Symbol / *Simbool*	Approximate relative atomic mass / *Benaderde relatiewe atoommassa*
1,9	29	Cu	63,5

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 1 H 1																	2 He 4
1,0 3 Li 7	1,5 4 Be 9											2.0 5 B 11	2.5 6 C 12	3.0 7 N 14	3.5 8 O 16	4.0 9 F 19	10 Ne 20
0,9 11 Na 23	1,2 12 Mg 24											1.5 13 Aℓ 27	1.8 14 Si 28	2.1 15 P 31	2.5 16 S 32	3.0 17 Cℓ 35,5	18 Ar 40
0,8 19 K 39	1,0 20 Ca 40	1,3 21 Sc 45	1,5 22 Ti 48	1.6 23 V 51	1,6 24 Cr 52	1.5 25 Mn 55	1.8 26 Fe 56	1.8 27 Co 59	1.8 28 Ni 59	1.9 29 Cu 63,5	1.6 30 Zn 65	1.6 31 Ga 70	1.8 32 Ge 73	2.0 33 As 75	2,4 34 Se 79	2.8 35 Br 80	36 Kr 84
0,8 37 Rb 86	1,0 38 Sr 88	1,2 39 Y 89	1.4 40 Zr 91	41 Nb 92	1.8 42 Mo 96	1.9 43 Tc	2.2 44 Ru 101	2.2 45 Rh 103	2.2 46 Pd 106	1.9 47 Ag 108	1.7 48 Cd 112	1.7 49 In 115	1.8 50 Sn 119	1.9 51 Sb 122	2.1 52 Te 128	2.5 53 I 127	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137	57 La 139	1.6 72 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1.8 81 Tℓ 204	1.8 82 Pb 207	1.9 83 Bi 209	2.0 84 Po	2.5 85 At	86 Rn
0,7 87 Fr	0,9 88 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↑)

Increasing reducing ability/*Toenemende reduserende vermoë* (↓)

Half-reactions/*Halfreaksies*			E^{θ} (V)
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$Na^+ + e^-$	⇌	Na	– 2,71
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Cs^+ + e^-$	⇌	Cs	- 2,92
$K^+ + e^-$	⇌	K	– 2,93
$Li^+ + e^-$	⇌	Li	– 3,05