basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES

EXAMINATION GUIDELINES

GRADE 11

2025

These guidelines consist of 32 pages.

TABLE OF CONTENTS

1. INTRODUCTION

The Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences outlines the nature and purpose of the subject Physical Sciences. This guides the philosophy underlying the teaching and assessment of the subject in Grade 11.

The purpose of these Examination Guidelines is to:

- Provide clarity on the depth and scope of the content to be assessed in the common/national Grade 11 examination in Physical Sciences.
- Assist teachers to adequately prepare learners for the examinations.

This document deals with the final Grade 11 examinations. It does not deal in any depth with the school-Based Assessment (SBA).

These Examination Guidelines should be read in conjunction with:

- *The National Curriculum Statement (NCS) Curriculum and Assessment Policy Statement (CAPS): Physical Sciences*
- The National Protocol of Assessment: *An addendum to the policy document, the National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF), regarding the National Protocol for Assessment (Grades R–12)*
- The national policy pertaining to the programme and promotion requirements of the National Curriculum Statement, Grades R–12

- **Should be read in conjunction with 2025 ATP. The ATP's were already released so there should be nothing extra in this document with regard to content etc)**

2. ASSESSMENT IN GRADE 11

2.1 Format of question papers

Paper	Types of questions	Duration	Total	Date	Marking
1	**Physics** 10 multiple-choice questions – 20 marks Structured questions – 130 marks	3 hours	150	October/November	Internal
2	**Chemistry** 10 multiple-choice questions – 20 marks Structured questions – 130 marks	3 hours	150	October/November	Internal

2.2 Numbering and sequence of questions

QUESTION 1: Multiple-choice questions
Subquestions numbered 1.1 to 1.10 (2 marks each)
Questions will be set across all cognitive levels and arranged from lower to higher cognitive levels.

QUESTION 2 onwards:
Longer questions that will assess skills and knowledge across cognitive levels. Numbering starts with QUESTION 2 and will be continuous. Subquestions will be numbered by two digits, e.g. 2.1, 2.2. Numbering is restricted to a maximum of three digits, e.g. 2.1.1, 2.1.2.

2.3 Information sheets

The separate information sheets for Paper 1 and Paper 2 are included in this document.

2.4 Weighting of cognitive levels

Papers 1 and 2 will include questions across all four cognitive levels. The distribution of cognitive levels in Physics and Chemistry papers is given below.

Cognitive level	Description	Paper 1 (Physics)	Paper 2 (Chemistry)
1	Remembering/ Recall	15%	15%
2	Understanding/ Comprehension	35%	40%
3	Applying and analysing	40%	35%
4	Evaluating and creating (synthesis)	10%	10%

2.5 Weighting of prescribed content

Paper 1: Physics Focus							
Content	**Marks**	**Total**	**Duration**	**Weighting of cognitive levels**			
Mechanics	83	150 marks	3 hours	15	35	40	10
Electricity and magnetism	67						

Paper 2: Chemistry Focus							
Content	**Marks**	**Total**	**Duration**	**Weighting of cognitive levels**			
Chemical change	90	150 marks	3 hours	15	40	35	10
Matter and materials	60						

2.6 Skills in Physical Sciences

- Identify and question phenomena:
  - Formulate an investigative question.
  - List all possible variables.
  - Formulate a testable hypothesis.

- Design/Plan of an investigation:
  - Identify variables (dependent, independent and controlled variables).
  - List appropriate apparatus.
  - Plan the sequence of steps which should include, amongst others:
    - The need for more than one trial to minimise experimental errors.
    - Identify safety precautions that need to be taken.
    - Identify conditions that ensure a fair test.
    - Set an appropriate control.

- Graphs:
  - Draw accurate graphs from given data/information.
  - Interpret graphs.
  - Draw sketch graphs from given information.

- Results:
  - Identify patterns/relationships in data.
  - Interpret results.

- Conclusions:
  - Draw conclusions from given information, e.g. tables, graphs.
  - Evaluate the validity of conclusions.

- Calculations:
  - Solve problems using two or more different calculations (multistep calculations).

- Descriptions:
  - Explain/Describe/Argue the validity of a statement/event using scientific principles.

2.7 Prior knowledge from Grade 10

All skills and application of knowledge learnt in Grade 10 are applicable to assessment in Grade 11. Skills and knowledge from Grades 10 that may be assessed in Grade 11 include the following:

- The scientific method
- The periodic table
- Writing of formulae and balanced equations
- The kinetic molecular theory
- Chemical bonding
- The mole concept and stoichiometric calculations
- Vectors and scalars

3. ELABORATION OF THE CONTENT FOR GRADE 11 (CAPS)

The final examination in Physical Sciences will cover the topics outlined below.

3.1 Paper 1: Physics

Vectors in two dimensions
(This section must be read in conjunction with the CAPS, p. 61.)

Resultant of vectors

- Define a resultant as the vector sum of two or more vectors, i.e. a single vector having the same effect as two or more vectors together.
- Determine the resultant of vectors (maximum four) on a Cartesian plane, using the component method, i.e. find the vertical and horizontal components of each vector and then add co-linear vertical components and co-linear horizontal components to obtain the resultant vertical vector (R_y) and resultant horizontal vector (R_x).
- Sketch the resultant vertical vector (R_y) and the resultant horizontal vector (R_x) on a Cartesian plane.
- Calculate the magnitude of the resultant using the theorem of Pythagoras.
- Determine the direction of the resultant using simple trigonometric ratios.
- Determine the resultant (R) of two vectors graphically using either the tail-to-head or tail-to-tail method (parallelogram method) as well as by calculation (component method) for a maximum of four vectors in both 1-dimension and 2-dimensions.
- Explain the meaning of a closed vector diagram.

Resolution of a vector into its horizontal and vertical components

- Use $R_x = R\cos\theta$ for the resultant x component if θ is the angle between R and the x-axis.
- Use $R_y = R\sin\theta$ for the resultant y component if θ is the angle between R and the x-axis.

Newton's laws and application of Newton's laws
(This section must be read in conjunction with the CAPS, p. 62–66.)

Different kinds of forces: weight, normal force, frictional force, applied force (push, pull), tension (strings or cables)

- Define normal force, N, as the force or the component of a force which a surface exerts on an object in contact with it, and which is perpendicular to the surface.
  NOTE: The normal force acts perpendicular to the surface irrespective of whether the plane is horizontal or inclined. For horizontal planes the only forces perpendicular to the plane should be the weight, w, and the normal force, N. All other forces should be parallel to the plane. For inclined planes the only forces perpendicular to the plane is the component of weight, $w\cos\theta$, and the normal, N. All other forces should be parallel to the plane.
- Define frictional force, f, as the force that opposes the motion of an object, and which acts parallel to the surface.
  Know that a frictional force:
  - Is proportional to the normal force.
  - Is independent of the area of the surfaces that are in contact with each other.
- Define the static frictional force, f_s, as the force that opposes the tendency of motion of a stationary object relative to a surface. The static frictional force can have a range of values from zero up to a maximum value, $\mu_s N$. If a force, F, applied to an object parallel to the surface, does not cause the object to move, F is equal in magnitude to the static frictional force.

- State that the static frictional force is a maximum, f_s^{max}, just before the object starts to move across the surface. The maximum static frictional force, f_s^{max}, is equal to the magnitude of the maximum horizontal force that can be applied to the object without it starting to move across the surface.
- Solve problems using $f_s^{max} = \mu_sN$ where f_s^{max} is the maximum static frictional force and μ_s is the coefficient of static friction. If the applied force exceeds f_s^{max}, a net force accelerates the object.
- Define the kinetic frictional force, f_k, as the force that opposes the motion of a moving object relative to a surface. The kinetic frictional force on an object is constant for a given surface and equals μ_kN.
- Solve problems using $f_k = \mu_kN$, where f_k is the kinetic frictional force and μ_k the coefficient of kinetic friction.

Force diagrams, free body diagrams.

- Draw force diagrams. In a force diagram the force is represented by an arrow. The direction of the arrow indicates the direction of the force, and the length of the arrow indicates the magnitude of the force.
- Draw free-body diagrams. Such a diagram shows the relative magnitudes and directions of forces acting on an object that has been isolated from its surroundings. The object is drawn as a dot and all the forces acting on it are drawn as arrows pointing away from the dot. The length of the arrows is proportional to the magnitude of the respective forces.
- Resolve a two-dimensional force, e.g. the weight of an object on an inclined plane, into its parallel ($F_{//}$) and perpendicular ($F_{\perp}$) components. For calculation purposes. but no components of weight in free body diagram . will this be in future gr 12 NCS MSM Determine the resultant/net force of two or more forces.

Newton's first, second and third laws of motion

- State Newton's first law of motion: A body will remain in its state of rest or motion at constant velocity unless a non-zero resultant/net force acts on it.
- Define inertia as the resistance of an object to any change in its state of motion. The mass of an object is a quantitative measure of its inertia.
- Discuss why it is important to wear seatbelts using Newton's first law of motion.
- State Newton's second law of motion: When a resultant/net force acts on an object, the object will accelerate in the direction of the force at an acceleration directly proportional to the force and inversely proportional to the mass of the object.

  In symbols: $a \propto F_{net}$, constant m and $a \propto \frac{1}{m}$, constant F_{net}, and therefore $F_{net} = ma$
- Draw force diagrams and free-body diagrams for objects that are in equilibrium or accelerating.
- Apply Newton's second law of motion, and therefore, to a variety of equilibrium and non-equilibrium problems including:
  - o A single object:
    - Moving in a horizontal plane with or without friction
    - Moving on an inclined plane with or without friction
    - Moving in the vertical plane (lifts, rockets, etc.)
  - o Two-body systems (joined by a light inextensible string):
    - Both on a flat horizontal plane with or without friction
    - One in a horizontal plane with or without friction, and a second hanging vertically from a string over a frictionless pulley
    - Both on an inclined plane with or without friction. (exclude double incline)!!
    - Both hanging vertically from a string over a frictionless pulley

NOTE: When an object accelerates, the equation $F_{net} = ma$ must be applied separately in the x and y directions. If there is more than one object, a free-body diagram must be drawn for each object and Newton's second law must be applied to each object separately.

- State Newton's third law of motion: When object A exerts a force on object B, object B SIMULTANEOUSLY exerts an oppositely directed force of equal magnitude on object A. (The forces are therefore an interaction between two bodies.)
- Identify Newton III force pairs (action-reaction pairs) and list the properties of the force pairs (action-reaction pairs). When identifying the forces, it must be clearly stated which body exerts a force on which body, and what kind of force it is, e.g. the earth exerts a downward gravitational force on the object, and the object exerts an upward gravitational force of equal magnitude on the earth.

Newton's Law of Universal Gravitation

State Newton's law of universal gravitation: Each particle in the universe attracts every other particle with a gravitational force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.

- Solve problems using $F = \frac{Gm_1m_2}{r^2}$.
- Describe weight as the gravitational force, exerted by the Earth on an object. Calculate weight using the expression $w = mg$.
- Calculate the weight of an object on other planets with different values of gravitational acceleration.
- Distinguish between mass and weight.
- Explain weightlessness as the sensation experienced when all contact forces are removed, i.e. no external objects touch one's body. For example, when in free fall, the only force acting on your body is the force of gravity that is a non-contact force. Since the force of gravity cannot be felt without any other opposing forces, you would have no sensation of it and you would feel weightless when in free fall.
- Calculate acceleration due to gravity on Earth using $g = \frac{GM}{r_E^2}$, and on another planet using $g = \frac{GM_P}{r_P^2}$, where M_P is the mass of the planet and r_P is the radius of the planet.
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Electrostatics

(This section must be read in conjunction with the CAPS, p. 84–85.)

Coulomb's law

- State Coulomb's law: The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (r) between them:
- Solve problems using the equation $F = \frac{kQ_1Q_2}{r^2}$ for charges in one dimension (1D) (restrict to three charges).
- Solve problems using the equation $F = \frac{kQ_1Q_2}{r^2}$ for charges in two dimensions (2D) – for three charges in a right-angled formation (limit to charges at the 'vertices of a right-angled triangle').

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 would move if placed at that point.
- Draw electric field lines for the following configurations:

  - A single point charges.
  - Two-point charges (one negative, one positive OR both positive OR both negative)
  - A charged sphere (Restrict to charges identical in magnitude.)

Define the *electric field at a point*: The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point. In symbols: $E = \frac{F}{q}$.

- Solve problems using the equation $E = \frac{F}{q}$.
- Calculate the electric field at a point due to several point charges, using the equation $E = \frac{kQ}{r^2}$ to determine the contribution to the field due to each charge. Restrict to three charges in a straight line.

Electric Circuits

(This section must be read in conjunction with the CAPS, p. 88–89 & 121.)

Ohm's law

- State Ohm's law in words: The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.
- Determine the relationship between current, potential difference and resistance at constant temperature using a simple circuit.
- Interpret data/graphs on the relationship between current, potential difference and resistance at constant temperature.
- State the difference between ohmic conductors and non-ohmic conductors and give an example of each.
- Solve problems using $R = \frac{V}{I}$ for series and parallel circuits (maximum four resistors).

Power, energy

- Define *power* as the rate at which work is done.
- Solve problems using $P = \frac{W}{\Delta t}$.
- Recall that W = VQ, and therefore, by substituting V = IR in the equation, $W = VI\Delta t$, $W = I^2R\Delta t$ and $W = \frac{V^2}{R}\Delta t$ are obtained.
- Deduce, by substituting $P = \frac{W}{\Delta t}$ into above equations, the following equations: $P = VI$, $P = I^2R$ and $P = \frac{V^2}{R}$.
- Solve problems using $P = VI$, $P = I^2R$ or $P = \frac{V^2}{R}$.
- Solve circuit problems involving the concepts of power and electrical energy.
- Deduce 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, the duration and the cost of 1 kWh.

Internal resistance, series and parallel networks

Explain the term internal resistance. Do a demonstration showing “loss volts” to show that a cell has internal resistance etc

- Solve problems involving current, voltage and resistance for circuits containing arrangements of resistors in series and in parallel (maximum four resistors excluding internal resistance).
- Define the term *emf* as the maximum energy provided by a battery per unit charge passing through it.
- Solve circuit problems using $\varepsilon = V_{load} + V_{internal\ resistance}$ or $\varepsilon = IR_{ext} + Ir$.
- Solve circuit problems, with internal resistance, involving series-parallel networks of resistors (maximum four resistors).

Electromagnetism

(This section must be read in conjunction with the CAPS, p. 86–88.)

Magnetic field associated with current-carrying conductors.

- Use the right-hand rule to determine the magnetic field (B) associated with a:
  - Straight current-carrying conductor
  - Current-carrying loop (single turn)
  - Solenoid
- Draw the magnetic field pattern around a:
  - Straight current-carrying wire
  - Current-carrying loop (single turn)
  - Solenoid

Faraday's law

- State Faraday's law of electromagnetic induction: The magnitude of the induced emf across the ends of a conductor is directly proportional to the rate of change in the magnetic flux linkage with the conductor.
- 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 of the solenoid.
- Define:-The Magnetic flux, (f = BAcosθ, where for a loop of area A in the presence of a uniform magnetic field B, the magnetic flux (Φ) passing through the loop, f = BAcosθ, where θ is the angle between the magnetic field B and the normal to the loop of area A). the induced current flows in a direction so as to set up to oppose the change in the magnetic flux.
- Calculate:induced emf and induced current, for situations involving a changing magnetic
- field, use the equation for Faraday’s Law, $\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$ where Φ = BA cos θ is the magnetic flux

3.2 Paper 2: Chemistry

Atomic combinations: molecular structure
(This section must be read in conjunction with the CAPS, p. 67–71.)

A chemical bond

- Define a chemical bond as a mutual attraction between two atoms resulting from the simultaneous attraction between their nuclei and the outer electrons. (**NOTE:** The energy of the combined atoms is lower than that of the individual atoms resulting in higher stability.)
- Draw Lewis dot diagrams of elements.

A Lewis dot diagram is a structural formula in which valence electrons are represented by dots or crosses. It is also known as an electron dot formula, a Lewis formula, or an electron diagram.

- Determine the number of valence electrons in an atom of an element.

Valence electrons or outer electrons are the electrons in the highest energy level of an atom in which there are electrons.

- Explain, in terms of electrostatic forces between protons and electrons, and in terms of energy considerations, why:
- Two H atoms form an H_2 molecule.
- He does not form He_2

Interpret the graph of potential energy versus the distance between nuclei for two approaching hydrogen atoms.

- Define a covalent bond as the sharing of electrons between two atoms to form a molecule.

Define a Molecule as a A group of two or more atoms covalently bonded and that function as a unit.

- Draw Lewis diagrams, given the formula and using electron configurations, for simple molecules, e.g. H_2, F_2, H_2O, NH_3, HF, OF_2, HOCℓ and molecules with multiple bonds, e.g. N_2, O_2 and HCN.
- Discuss molecular shapes of H_2 (linear) H_2O (angular), NH_3 (pyramidal), CO_2 (linear), CH_4 (tetrahedral).
- Describe rules for bond formation:
  - ➢ Different atoms, each with an unpaired valence electron, can share these electrons to form a chemical bond, e.g. two H atoms form a H_2 molecule by sharing an electron pair.
- Different atoms with paired valence electrons, called lone pairs, cannot share these four electrons and cannot form a chemical bond, e.g. no bond forms between two He atoms.
- Different atoms, with unpaired valence electrons, can share these electrons and form a chemical bond for each electron pair shared. The two atoms can form multiple bonds between them. If two pairs of electrons are shared, a double bond is formed, e.g. between two O atoms to form O_2.
- Atoms with an empty valence shell can share a lone pair of electrons from another atom to form a coordinate covalent or dative covalent bond, e.g. in NH_4^+ the lone pair of nitrogen is shared with H^+ and in H_3O^+ the lone pair of oxygen is shared with H^+.
- Define a bonding pair as a pair of electrons that is shared between two atoms in a covalent bond.
- Define a lone pair as a pair of electrons in the valence shell of an atom that is not shared with another atom.
- Describe the formation of the dative covalent (or coordinate covalent) bond by means of electron diagrams using NH_4^+ and H_3O^+ as examples.

Electronegativity of atoms to explain the polarity of bonds.

- Define electronegativity as a measure of the tendency of an atom in a molecule to attract bonding electrons.
- Describe a non-polar covalent bond as a bond in which the electron density is shared equally between the two atoms. An example is the bond between two H atoms.
- Describe a polar covalent bond as a bond in which the electron density is shared unequally between the two atoms. An example is the bond between an H atom and a Cℓ atom.
- Show polarity of bonds using partial charges, e.g. $^{\delta+}$ H - Cℓ $^{\delta-}$
- Compare the polarity of chemical bonds using a table of electronegativities:
    - o With an electronegativity difference ΔEN > **2,1** electron transfer will take place and the bond will be ionic.
    - o With an electronegativity difference ΔEN > 1 the bond will be polar covalent.
    - o With an electronegativity difference ΔEN < 1 the bond will be very weakly polar covalent.
    - o With an electronegativity difference ΔEN = 0 the bond will be nonpolar. covalent
- Explain that the character of a bond varies from purely covalent (when ΔEN = 0) to almost purely ionic (when ΔEN > 3). The above difference in electronegativity is only a guideline, many bonds have both ionic and covalent character.
- Use difference in electronegativity and molecular shape to explain that polar bonds do not always lead to polar molecules.

Bond energy and bond length

- Define bond energy of a compound as the energy needed to break one mole of its molecules into separate atoms.
- Define bond length as the average distance between the nuclei of two bonded atoms.
- Explain the relationship between bond energy and bond length, i.e. bonds with a shorter bond length require more energy to break than bonds with a longer bond length.
- Explain the relationship between the strength of a chemical bond between two atoms and the:
    - o Length of the bond between them
      If the force of attraction between two atoms is strong, the nuclei come very close together resulting in a short bond length.
    - o Size of the bonded atoms
      The bond length between larger atoms is longer than the bond length between smaller atoms.
    - o Number of bonds (single, double, triple) between the atoms
      Bond strength increases as the number of bonds between atoms increases, i.e. triple bonds are stronger than double bonds, which are stronger than single bonds.

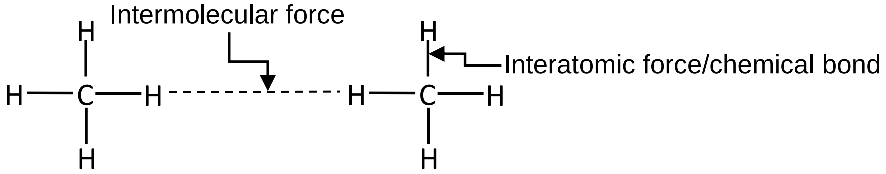
Intermolecular forces

(This section must be read in conjunction with the CAPS, p. 71–75.)

Intermolecular forces and interatomic forces (chemical bonds)

- Name and explain the different intermolecular forces (Van der Waals forces):
    - (i) Mutually induced dipole forces or London forces: Forces between non-polar molecules
    - (ii) Dipole-dipole forces: Forces between two polar molecules
    - (iii) Dipole-induced dipole forces: Forces between polar and non-polar molecules
    - (iv) Hydrogen bonding: Forces between molecules in which hydrogen is covalently bonded to nitrogen, oxygen, or fluorine – a special case of dipole-dipole forces.
    - (v) Ion-dipole forces: Forces between ions and polar molecules

- Describe the difference between intermolecular forces and interatomic forces (intramolecular forces) using a diagram of a group of small molecules, and in words.
  Example:



- State the relationship between intermolecular forces and molecular mass. For non-polar molecules the strength of induced dipole forces increases with molecular size.
- Explain the effect of intermolecular forces on boiling point, melting point, vapour pressure and solubility.
  Boiling point: The temperature at which the vapour pressure of a substance equals atmospheric pressure. The stronger the intermolecular forces, the higher the boiling point.
  Melting point: The temperature at which the solid and liquid phases of a substance are at equilibrium. The stronger the intermolecular forces, the higher the melting point.
  Vapour pressure: The pressure exerted by a vapour at equilibrium with its liquid in a closed system. The stronger the intermolecular forces, the lower the vapour pressure.
  Solubility: The property of a solid, liquid, or gaseous chemical substance (solute) to dissolve in a solid, liquid, or gaseous solvent to form a homogeneous solution.

Ideal gases and thermal properties

(This section must be read in conjunction with the CAPS, p. 79–81.)

Motion of particles; Kinetic theory of gases

- Describe the motion of individual gas molecules:
  - Molecules are in constant motion and collide with each other and the walls of the container.
  - There are forces of attraction between molecules.
  - Molecules in a gas move at different speeds.
- Describe an ideal gas as a gas:
  - That has identical particles of zero volume.
  - With no intermolecular forces between particles
  - In which all collisions of the molecules with themselves or the walls of the container, are perfectly elastic.
- Explain that real gases deviate from ideal gas behaviour at high pressures and low temperatures.
- State the conditions under which a real gas approaches ideal gas behaviour.

Ideal gas law

- State Boyle's law: The pressure of an enclosed gas is inversely proportional to the volume it occupies at constant temperature.

  In symbols: $p\,\alpha\,\frac{1}{V}$, therefore $p_1V_1 = p_2V_2$, T = constant
- For each of the above three relationships:
  - Interpret a table of results or a graph.
  - Draw a graph from given results.
  - Solve problems using a relevant equation.
  - Use kinetic theory to explain the gas laws.

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.

Representing Chemical Change

(This section must be read in conjunction with the CAPS, p. 37.)

Quantitative aspects of chemical change

(This section must be read in conjunction with the CAPS, p. 50–52 and 82–83.)

The mole concepts. QUICK REVISION OF GR 10 WORK

- Describe the mole as the SI unit for amount of substance.
- Define one mole as the amount of substance having the same number of particles as there are atoms in 12 g carbon-12.
- Describe Avogadro's number, N_A, as the number of particles (atoms, molecules, formula-units) present in one mole ($N_A = 6{,}023 \times 10^{23}$ particles·mol^{-1}).
- Define molar mass as the mass of one mole of a substance measured in g·mol^{-1}.
- Calculate the molar mass of a substance given its formula.

Molar volume of gases

- State Avogadro's Law, i.e. one mole of any gas occupies the same volume at the same temperature and pressure.
- Know the molar gas volume, VM, at STP is 22,4 dm3□mol-1.
- Do calculations using $n = \frac{m}{M},$, $n = \frac{V}{V_M}$, $n = \frac{\text{number of particles}}{N_A}$
- At STP: 1 mole of any gas occupies 22,4 dm^3 at 0 °C (273 K) and 1 atmosphere (101,3 kPa). Thus the molar gas volume, V_M, at STP = 22,4 dm^3·mol^{-1}.

Volume relationships in gaseous reactions

- Interpret balanced equations in terms of volume relationships for gases, i.e. under the same conditions of temperature and pressure, equal amounts (in mole) of all gases occupy the same volume.

Concentration of solutions

- Define concentration as the amount of solute per litre of solution.
- Calculate concentration in mol·dm^{-3} using $c = \frac{n}{V}$.
- Define and Prepare a standard solution

More complex stoichiometric calculations

- Determine the empirical formula and molecular formula of compounds.
- Determine the percentage yield of a chemical reaction.
- Determine percentage purity or percentage composition, e.g. the percentage $CaCO_3$ in an impure sample of seashells.
- Do stoichiometric calculations based on balanced equations that may include limiting reagents.

Energy and chemical change

(This section must be read in conjunction with the CAPS, p. 90–91.)

Energy changes in reactions related to bond energy changes.

- Define heat of reaction (ΔH) as the energy absorbed or released per mole in a chemical reaction.
  $\Delta H = H_{products} - H_{reactants}$, where $H_{products}$ and $H_{reactants}$ are the heat (energy) of the products and reactants respectively.
- Define exothermic reactions as reactions that release energy.
- Define endothermic reactions as reactions that absorb energy.
- Classify, with reason, reactions as exothermic or endothermic.

Exothermic and endothermic reactions

- State that $\Delta H > 0$ for endothermic reactions, i.e. reactions in which energy is absorbed.
- State that $\Delta H < 0$ for exothermic reactions, i.e. reactions in which energy is released.

Activation energy

- Define activation energy as the minimum energy needed for a reaction to take place.
- Define an activated complex as the unstable transition state from reactants to products.
- Draw or interpret fully labelled sketch graphs (potential energy versus course of reaction graphs) of catalysed and uncatalysed endothermic and exothermic reactions.

Types of reaction

(This section must be read in conjunction with the CAPS, p. 91–94.)

Acid-base reactions

- Define acids and bases according to Arrhenius and Lowry-Brønsted:
  Arrhenius theory: An acid is a substance that produces hydrogen ions (H^+)/hydronium ions (H_3O^+) when it dissolves in water. A base is a substance that produces hydroxide ions (OH^-) when it dissolves in water.
  Lowry-Brønsted theory: An acid is a proton/H^+ ion donor. A base is a proton/H^+ ion acceptor.
- Identify conjugate acid-base pairs for given compounds. When the acid, HA, loses a proton, its conjugate base, A^-, is formed. When the base, A^-, accepts a proton, its conjugate acid, HA, is formed. These two are a conjugate acid-base pair.
- Describe a substance that can act as either acid or base, as amphiprotic or as an ampholyte. Water is a good example of an ampholyte. Write equations to show how an amphiprotic substance can act as acid or base.
- Write names and formulae of common acids: hydrochloric acid, nitric acid, sulphuric acid and ethanoic acid (acetic acid).
- Write names and formulae of common bases: ammonia, sodium carbonate (washing soda), sodium hydrogen carbonate, sodium hydroxide (caustic soda) and potassium hydroxide.
- Write reaction equations for the dissolution of acids and bases in water.
  Examples: $HC\ell(g) + H_2O(\ell) \rightarrow H_3O^+(aq) + C\ell^-(aq)$
  $NH_3(g) + H_2O(\ell) \rightarrow NH_4^+(aq) + OH^-(aq)$
  $H_2SO_4(aq) + 2H_2O(\ell) \rightarrow 2H_3O^+(aq) + SO_4^{2-}(aq)$

- Write the overall equations for reactions of acids with metal hydroxides, metal oxides and metal carbonates:
  $HC\ell(aq) + NaOH(aq) \rightarrow NaC\ell(aq) + H_2O(\ell)$
  $HC\ell(aq) + KOH(aq) \rightarrow KC\ell(aq) + H_2O(\ell)$
  $HNO_3(aq) + NaOH(aq) \rightarrow NaNO_3(aq) + H_2O(\ell)$
  $HNO_3(aq) + KOH(aq) \rightarrow KNO_3(aq) + H_2O(\ell)$
  $H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$
  $H_2SO_4(aq) + KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(\ell)$
  $CH_3COOH\ (aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(\ell)$
  $2HC\ell(aq) + CaO(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell)$
  $2HC\ell(aq) + MgO(aq) \rightarrow MgC\ell_2(aq) + H_2O(\ell)$
  $2HC\ell(aq) + MgO(aq) \rightarrow MgC\ell_2(aq) + H_2O(\ell)$
  $2HC\ell(aq) + CuO(aq) \rightarrow CuC\ell_2(aq) + H_2O(\ell)$
  $2HC\ell(aq) + Na_2CO_3(aq) \rightarrow 2NaC\ell(aq) + H_2O(\ell) + CO_2(g)$
  $2HC\ell(aq) + CaCO_3(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$
- Describe an acid-base indicator as a weak acid, or a weak base, which colour changes as the H^+ ion concentration or the OH^- ion concentration in a solution changes.

- Know the colours of litmus, methyl orange, phenolphthalein, and bromothymol blue in acids and in bases.
- Identify the acid and the base needed to prepare a given salt and write an equation for the reaction.
- Write down neutralisation reactions of common laboratory acids and bases.
- Titration experiment, Volumetric analysis, $\frac{C_aV_a}{C_bV_b} = \frac{n_a}{n_b}$
- Explain the pH scale as a scale of numbers from 0 to 14 used to express the acidity or alkalinity of a solution.
- Calculate pH values of strong acids and strong bases using $pH = -\log[H_3O^+]$.

Oxidation numbers of atoms in molecules

- Explain the meaning of oxidation number.
- Assign oxidation numbers to atoms in various ions and molecules, e.g. H_2O, CH_4, CO_2, H_2O_2 and $HOC\ell$, by using oxidation number guidelines or rules.

Redox reactions

- Describe a redox (oxidation-reduction) reaction as involving an electron transfer.
- Describe a redox (oxidation-reduction) reaction as always involving changes in oxidation numbers.
- Identify a redox reaction and apply the correct terminology to describe all the processes:
  Oxidation: A loss of electrons. /An increase in oxidation number.
  Reduction: A gain of electrons. /A decrease in oxidation number.
  Reducing agent: A substance that is oxidised/that loses electrons/whose oxidation number increases.
  Oxidising agent: A substance that is reduced/that gains electrons/whose oxidation number decreases.
- Balance redox reactions by using half-reactions from the Table of Standard Reduction Potentials (Tables 4A and 4B).

Electrochemical Reactions

(This section must be read in conjunction with the CAPS, p. 134–137.)

Galvanic cells

- Define the *galvanic cell* as a cell in which chemical energy is converted to electrical energy.
- Define *oxidation* and *reduction* in terms of electron (e^-) transfer:
  Oxidation is a loss of electrons. Reduction is a gain of electrons.
- Define *oxidation* and *reduction* in terms of oxidation numbers:
  Oxidation: An increase in oxidation number
  Reduction: A decrease in oxidation number
- Define an *oxidising agent* and a *reducing agent* in terms of oxidation and reduction:
  Oxidising agent: A substance that is reduced/gains electrons.
  Reducing agent: A substance that is oxidised/loses electrons.
- Define an *anode* and a *cathode* in terms of oxidation and reduction:
  Anode: The electrode where oxidation takes place
  Cathode: The electrode where reduction takes place
- Define an *electrolyte* as a substance whose aqueous solution contains ions OR a substance that dissolves in water to give a solution that conducts electricity.

Relation of current and potential difference to rate and equilibrium

- State that the potential difference of a galvanic 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, namely 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. Nernst equation is NOT required.)

Understanding of the processes and redox reactions taking place in galvanic cells

- Describe the movement of ions in the solutions.
- State the direction of electron flow in the external circuit.
- Write down the half-reactions that occur at the electrodes.
- State the function of the salt bridge.
- Use cell notation or diagrams to represent a galvanic cell.
  When writing cell notation, the following convention should be used:
  - The $H_2|H^+$ half-cell is treated just like any other half-cell.
  - Cell terminals (electrodes) are written on the outside of the cell notation.
  - Active electrodes:
    reducing agent | oxidised species || oxidising agent | reduced species
  - Inert electrodes (usually Pt or C):
    Pt | reducing agent | oxidised species || oxidising agent | reduced species | Pt
    Example: Pt | $C\ell^-(aq)$ |$C\ell_2(g)$ || $F_2(g)$ | $F^-(aq)$ | Pt
- Predict the half-cell in which oxidation will take place when two half-cells are connected
- Predict the half-cell in which reduction will take place when connected to another half-cell.

- Write down the overall cell reaction by combining two half-reactions.
- 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.

Standard electrode potentials

- Write down the standard conditions under which standard electrode potentials are determined.
- Describe the standard hydrogen electrode and explain its role as the reference electrode.
- Explain how standard electrode potentials can be determined using the reference electrode and state the convention regarding positive and negative values.
  -

4. GENERAL INFORMATION

4.1 Quantities, symbols and units

The most common quantities, symbols and SI units used in introductory Physics are listed below. **A quantity should not be confused with the units in which it is measured**.

Quantity	Preferred symbol	Alternative symbol	Unit name	Unit symbol
mass	m		kilogram	kg
position	x, y		metre	m
displacement	Δx, Δy	s	metre	m
velocity	v_x, v_y	u, v	metre per second	$m \cdot s^{-1}$
initial velocity	v_i	u	metre per second	$m \cdot s^{-1}$
final velocity	v_f	v	metre per second	$m \cdot s^{-1}$
acceleration	a		metre per second per second	$m \cdot s^{-2}$
acceleration due to gravity	g		metre per second per second	$m \cdot s^{-2}$
time (instant)	t		second	s
time interval	Δt		second	s
energy	E		joule	J

kinetic energy	K	E_k	joule	J
potential energy	U	E_p	joule	J
work	W		joule	J
work function	W_0		joule	J
power	P		watt	W
momentum	p		kilogram metre per second	$kg \cdot m \cdot s^{-1}$
force	F		newton	N
weight	w	F_g	newton	N
normal force	N	F_N	newton	N
tension	T	F_T	newton	N
friction force	f	F_f	newton	N
coefficient of friction	μ, μ_s, μ_k		(none)	
torque	τ		newton metre	N·m
wavelength	λ		metre	m
frequency	f	ν	hertz or per second	Hz or s^{-1}
period	T		second	s
speed of light	c		metre per second	$m \cdot s^{-1}$
charge	Q, q		coulomb	C
electric field	E		newton per coulomb or volt per metre	$N \cdot C^{-1}$ or $V \cdot m^{-1}$
electric potential at point P	V_P		volt	V
potential difference	ΔV, V		volt	V
emf	**E**	ε	volt	V
current	I, i		ampere	A
resistance	R		ohm	Ω
internal resistance	r		ohm	Ω
magnetic field	B		tesla	T
magnetic flux	Φ		tesla·metre^2 or weber	$T \cdot m^2$ or Wb

Conventions (e.g. signs, symbols, terminology and nomenclature)
The syllabus and question papers will conform to generally accepted international practices.

NOTE:

1. For marking purposes, alternative symbols will also be accepted.
2. Separate compound units with a multiplication dot, not a full stop, for example $m{\cdot}s^{-1}$.
   For marking purposes, $m.s^{-1}$ will also be accepted.
3. Use the equal sign only when it is mathematically correct, for example:
   Incorrect: 1 cm = 1 m (on a scale drawing)
   Correct: 1 cm = 10^{-2} m 1 cm represents 1 m (on a scale drawing)

4.2 Information sheets – Paper 1 (Physics)

TABLE 1: PHYSICAL CONSTANTS

GENERAL INFORMATION

4.1 Quantities, symbols and units

The most common quantities, symbols and SI units used in introductory Physics are listed below. **A quantity should not be confused with the units in which it is measured**.

Quantity	Preferred symbol	Alternative symbol	Unit name	Unit symbol
mass	m		kilogram	kg
position	x, y		metre	m
displacement	$\Delta x, \Delta y$	s	metre	m
velocity	v_x, v_y	u, v	metre per second	$m{\cdot}s^{-1}$
initial velocity	v_i	u	metre per second	$m{\cdot}s^{-1}$
final velocity	v_f	v	metre per second	$m{\cdot}s^{-1}$
acceleration	a		metre per second per second	$m{\cdot}s^{-2}$
acceleration due to gravity	g		metre per second per second	$m{\cdot}s^{-2}$
time (instant)	t		second	s
time interval	Δt		second	s
energy	E		joule	J
kinetic energy	K	E_k	joule	J
potential energy	U	E_p	joule	J
work	W		joule	J
work function	W_0		joule	J
power	P		watt	W
momentum	p		kilogram metre per second	$kg{\cdot}m{\cdot}s^{-1}$
force	F		newton	N
weight	w	F_g	newton	N
normal force	N	F_N	newton	N
tension	T	F_T	newton	N
friction force	f	F_f	newton	N
coefficient of friction	μ, μ_s, μ_k		(none)	
torque	τ		newton metre	$N{\cdot}m$
wavelength	λ		metre	m
frequency	f	ν	hertz or per second	Hz or s^{-1}
period	T		second	s
speed of light	c		metre per second	$m{\cdot}s^{-1}$

charge	Q, q		coulomb	C
electric field	E		newton per coulomb or volt per metre	$N\cdot C^{-1}$ or $V\cdot m^{-1}$
electric potential at point P	V_P		volt	V
potential difference	ΔV, V		volt	V
emf	**E**	ε	volt	V
current	I, i		ampere	A
resistance	R		ohm	Ω
internal resistance	r		ohm	Ω
magnetic field	B		tesla	T
magnetic flux	Φ		tesla·metre^2 or weber	$T\cdot m^2$ or Wb

Conventions (e.g. signs, symbols, terminology and nomenclature)
The syllabus and question papers will conform to generally accepted international practices.

NOTE:

1. For marking purposes, alternative symbols will also be accepted.
2. Separate compound units with a multiplication dot, not a full stop, for example $m{\cdot}s^{-1}$.
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   Correct: 1 cm = 10^{-2} m 1 cm represents 1 m (on a scale drawing)

4.2 Information sheets – Paper 1 (Physics)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9{,}8\ m{\cdot}s^{-2}$
Universal gravitational constant	G	$6{,}67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Radius of Earth	R_E	$6{,}38 \times 10^6\ m$
Mass of Earth	M_E	$5{,}98 \times 10^{24}\ kg$
Speed of light in a vacuum	c	$3{,}0 \times 10^8\ m{\cdot}s^{-1}$
Planck's constant	h	$6{,}63 \times 10^{-34}\ J{\cdot}s$
Coulomb's constant	k	$9{,}0 \times 10^9\ N{\cdot}m^2{\cdot}C^{-2}$
Charge on electron	e	$-1{,}6 \times 10^{-19}\ C$
Electron mass	m_e	$9{,}11 \times 10^{-31}\ kg$

TABLE 2: FORMULAE

MOTION

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

FORCE

$F_{net} = ma$	$w = mg$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F = G\frac{m_1 m_2}{d^2}$ or $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or $g = G\frac{M}{r^2}$

ELECTROMAGNETIC INDUCTION

$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$	$\Phi = BA\cos\theta$

ELECTROSTATICS

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ OR $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS

$R = \frac{V}{I}$	emf (ε) = I(R + r)
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\,\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

4.3 Information sheets – Paper 2 (Chemistry)

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

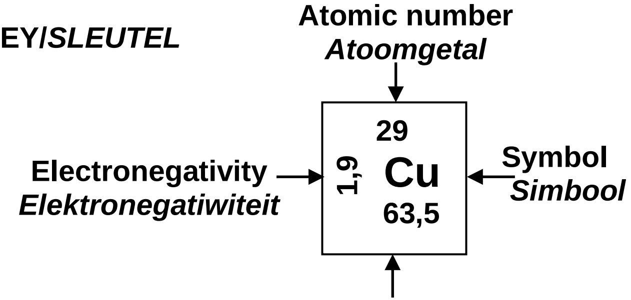
NAME/*NAAM*	**SYMBOL/*SIMBOOL***	**VALUE/*WAARDE***
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}
Standard pressure *Standaarddruk*	p^θ	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4$ $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^θ	273 K

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	pH = $-\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

KEY/*SLEUTEL*



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)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 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	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 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: STANDAARDREDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë*

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

Increasing reducing ability/*Toenemende reduserende vermoë*

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARDREDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë*

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

Increasing reducing ability/*Toenemende reduserende vermoë*

5. MARKING GUIDELINES: PAPER 1

5.1 Calculations

5.1.1 **Marks will be awarded for:** correct formula, correct substitution, correct answer with unit.

5.1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.

5.1.3 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.

5.1.4 If **no formula** is given, but **all substitutions are correct**, the candidate will **forfeit one mark**.

5.1.5 **No penalisation if zero substitutions are omitted** in calculations where **correct formula/principle is given correctly**.

5.1.6 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.

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

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

5.1.9 Final answers to all calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.

5.1.10 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.

5.1.11 Questions in which 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.

5.2 Units

5.2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.

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

5.2.3 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

5.2.4 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.

5.3 General

5.3.1 If one answer or calculation is required, but two are 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.

5.3.2 For marking purposes, alternative symbols (s, u, t, etc.) will also be accepted.

5.3.3 Separate compound units with a multiplication dot, not a full stop, e.g. $m{\cdot}s^{-1}$. For marking purposes, $m.s^{-1}$ and m/s will also be accepted.

5.4 Positive marking

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

5.4.1 Subquestion to subquestion: When a certain variable is incorrectly calculated in one subquestion (e.g. 3.1) and needs to be substituted into another subquestion (3.2 or 3.3), full marks are to be awarded for the subsequent subquestions.

5.4.2 A multistep question in a subquestion: 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.

5.5 Negative marking

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

6. MARKING GUIDELINES: PAPER 2

6.1 Calculations

6.1.1 **Marks will be awarded for:** correct formula, correct substitution, correct answer with unit.

6.1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.

6.1.3 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.

6.1.4 If **no formula** is given, but **all substitutions are correct**, the candidate will **forfeit one mark**.

Example: No K_c expression, correct substitution:

$$K_c = \frac{(2)^2}{(2)(1)^3}\ \checkmark = 2\ \checkmark \qquad \left(\frac{2}{3}\right)$$

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

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

6.1.7 The final answer to all calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.

6.1.8 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.

6.1.9 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.

Example:

CORRECT	**ANSWER (1)**	**POSSIBLE**	**ANSWER (2)**	**POSSIBLE**
$n=\frac{m}{M}$ ✓ 0,01✓ $= \frac{m}{52}$ ✓ m = 0,52 g ✓ (4)	$n=\frac{m}{M}$ ✓ 0,01 ✓$= \frac{52}{m}$ ✗ m = 5 200 g ✗ (2)	$m=\frac{n}{M}$ ✗ $= \frac{0,01}{52}$ = 0,002 g (0)	$n=\frac{m}{M}$ ✓ $m=\frac{M}{n}$ ✗ $= \frac{52\ \checkmark}{0,01\checkmark}$ = 5 200 g✗ (3)	$n=\frac{m}{M}$ ✓ = 0,52 g ✓ (2)

6.2 Units

6.2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.

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

6.2.3 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

6.2.4 Separate compound units with a multiplication dot, not a full stop, for example $mol{\cdot}dm^{-3}$. Accept $mol.dm^{-3}$ (or mol/dm^3) for marking purposes.

6.3 General

6.3.1 If one answer or calculation is required, but two are 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.

6.3.2 When a chemical **FORMULA** is asked, and the **NAME** is given as answer, the candidate forfeits the marks. The same rule applies when the **NAME** is asked and the **FORMULA** is given.

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

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

is the correct answer, the marks must be given as follows:

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

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

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

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

6.3.4 When candidates are required to give an explanation involving the relative strength of oxidising and reducing agents, the following is not accepted:

- 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 be for instance: 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.

6.3.5 One mark is forfeited when the charge of an ion is omitted per equation (not for the charge on an electron).

6.3.6 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 subquestion and carries the answer to another subquestion (balancing of equations or calculation of E^{θ}_{cell}), then the learner will not be credited for this substitution.

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

6.3.8 When a structural formula is required, marks will be deducted if the learner writes the condensed formula.

6.3.9 When a IUPAC name is asked and the candidate omits the hyphen(s) (e.g. instead of pent-1-ene or 1-pentene the candidate writes pent 1 ene or 1 pentene), marks will be forfeited.

6.3.10 When a chemical reaction is asked, marks are awarded for correct reactants, correct products and correct balancing.
If only a reactant(s) followed by an arrow, or only a product(s) preceded by an arrow, is/are written, marks may be awarded for the reactant(s) or product(s). If only a reactant(s) or only a product(s) is/are written, without an arrow, no marks are awarded for the reactant(s) or product(s).

Examples:

$N_2 + 3H_2 \checkmark \rightarrow 2NH_3 \checkmark$	bal. ✓	3/3
$N_2 + H_2 \rightarrow \checkmark$		1/3
$\rightarrow NH_3 \checkmark$		1/3
$N_2 + H_2$		0/3
NH_3		0/3

6.4 Positive marking

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

6.4.1 **Subquestion to subquestion:** When a certain variable is calculated in one subquestion (e.g. QUESTION 3.1) and needs to be substituted in another (QUESTION 3.2 or QUESTION 3.3), e.g. if the answer for QUESTION 3.1 is incorrect and is substituted correctly in QUESTION 3.2 or QUESTION 3.3, **full marks** are to be awarded for the subsequent subquestions.

6.4.2 **A multistep question in a subquestion**: 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.

6.5 Negative marking

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

7. CONCLUSION

This Examination Guidelines document is meant to articulate the assessment aspirations espoused in the CAPS document. It is therefore not a substitute for the CAPS document, which educators should teach to.

Qualitative curriculum coverage as enunciated in the CAPS cannot be over-emphasised.