GCSE CHEMISTRY

Total Marks: 100

Practice Paper 2 - Mark Scheme (Unofficial)

MARKING GUIDANCE

- Alternative responses are indicated by a slash (/).
- Underlined terms are key marking points that must be included.
- Brackets () indicate words that are not required for marks.
- Error Carried Forward (ECF) allows credit for correct calculation steps using an incorrect previous answer.

Question 1 (Topic 1) - Plum Pudding vs Nuclear Model [4 Marks]

Compare the plum pudding model and the nuclear model.

M1 **Similarities:** Both models contain negatively charged electrons / both have an overall neutral charge (in their standard states) [1 mark].

M2 **Differences (Plum Pudding):** The plum pudding model describes the atom as a single ball of positive charge with electrons embedded inside it [1 mark].

M3 **Differences (Nuclear Model):** The nuclear model states that the positive charge is concentrated in a tiny central nucleus [1 mark].

M4 **Differences (Nuclear Model Structure):** The nuclear model states that the atom is mostly empty space, with electrons orbiting the nucleus [1 mark].

> **Reject**
> Do not award M3 if they state neutrons are in the nucleus in the plum pudding model, or if they claim the plum pudding model has a nucleus.

Question 2 (Topic 1) - Periodic Table & Electron Configurations [12 Marks]

(a) Electronic configurations of Mg and Ca, and Group 2 placement.

M1 Magnesium electronic configuration: 2,8,2 [1 mark].

M2 Calcium electronic configuration: 2,8,8,2 [1 mark].

M3 **Group explanation:** Both elements have 2 electrons in their outer shell [1 mark].

M4 **Periodic table rule:** The group number in the periodic table corresponds to the number of electrons in the outer shell [1 mark].

M5 **Subatomic particles:** Magnesium has 12 protons/electrons, calcium has 20 protons/electrons [1 mark].

M6 **Shell structure:** Magnesium has outer electrons in the 3rd shell (3 energy levels), calcium has outer electrons in the 4th shell (4 energy levels) [1 mark].

(b) Group 7 reactivity down the group.

M1 Reactivity of Group 7 elements decreases because they need to gain one electron to form a full outer shell / form a 1- ion [1 mark].

M2 Down the group, the atoms get larger / have more electron shells [1 mark].

M3 The outer shell is further from the nucleus [1 mark].

M4 There is more shielding by inner electron shells [1 mark].

M5 There is a weaker electrostatic attraction between the nucleus and the incoming electron [1 mark].

M6 Therefore, it is harder to attract/gain an electron down the group [1 mark].

Question 3 (Topic 2) - Silicon Dioxide vs Diamond [6 Marks]

Compare structure/bonding and explain melting points and conductivity.

M1 Both have a giant covalent lattice / macromolecular structure [1 mark].

M2 In diamond, each carbon atom is bonded to 4 other carbon atoms; in silicon dioxide, each silicon is bonded to 4 oxygen atoms and each oxygen to 2 silicon atoms [1 mark].

M3 Both contain strong covalent bonds [1 mark].

M4 High melting point because a large amount of energy is required to break these strong covalent bonds [1 mark].

M5 Do not conduct electricity because all outer electrons are shared / localise in covalent bonds [1 mark].

M6 Thus, there are no delocalised electrons / no free ions to carry charge [1 mark].

Question 4 (Topic 2) - Covalent Bonding in Water [6 Marks]

(a) Dot-and-cross diagram of H2O and electrostatic attractions.

M1 **Diagram:** Two hydrogen circles overlapping with one oxygen circle, showing 1 pair of shared electrons (one dot, one cross) in each overlap area [1 mark].

M2 **Diagram:** Oxygen shown with 2 lone pairs (4 non-bonding electrons) [1 mark].

M3 **Diagram:** Hydrogen atoms have no other electrons besides the shared pair [1 mark].

M4 **Electrostatic attraction:** Covalent bonds are formed by the electrostatic attraction between the shared pair of electrons and the positive nuclei of the hydrogen and oxygen atoms [1 mark].

(b) Low boiling point of water vs MgO.

M1 Water is simple molecular, so it only has weak intermolecular forces between molecules which require little energy to overcome [1 mark].

M2 MgO has a giant ionic lattice with strong electrostatic forces of attraction between oppositely charged ions, requiring much more energy to break [1 mark].

Reject

Do not award M1 if they state covalent bonds are broken when water boils.

Question 5 (Topic 2) - Properties Table Evaluation [6 Marks]

Evaluate student's claims about A, B, and C.

M1 **Substance A:** Claim is incorrect. It is metallic because it conducts electricity in both solid and liquid states, and has a high melting point [1 mark].

M2 Reason: Giant covalent structures do not conduct electricity in the solid state (except graphite) [1 mark].

M3 **Substance B:** Claim is incorrect. It is giant covalent because it has a very high melting/boiling point, is insoluble in water, and does not conduct electricity in either solid or liquid states [1 mark].

M4 Reason: Simple molecular structures have low melting and boiling points / weak intermolecular forces [1 mark].

M5 **Substance C:** Claim is correct. It is giant ionic because it conducts electricity when liquid/molten but not as a solid, and has a high melting point [1 mark].

M6 Reason: Ionic compounds are soluble in water, and ions are free to move and carry charge only in liquid/solution form [1 mark].

Question 6 (Topic 2) - Metallic Bonding [4 Marks]

M1 Metallic bonding is the electrostatic attraction between a lattice of positive metal ions and a sea of delocalised electrons [1 mark].

M2 Conducts electricity because the delocalised electrons are free to move throughout the structure and carry charge [1 mark].

M3 Malleable because the metal ions are arranged in regular layers [1 mark].

M4 These layers of ions can slide over each other when a force is applied, without breaking the metallic bond [1 mark].

Question 7 (Topic 3) - Chromatography (RP6) [8 Marks]

(a) Separation in terms of mobile and stationary phases.

M1 The mobile phase (solvent) moves up the paper, carrying the dissolved dyes with it [1 mark].

M2 The stationary phase (paper) does not move [1 mark].

M3 Dyes separate because different components have different solubilities in the mobile phase / different attractions to the stationary phase [1 mark].

(b) Pencil start line.

M1 Pencil is insoluble in the solvent / will not dissolve and run up the paper (unlike ink, which would separate and interfere with the results) [1 mark].

(c) Rf calculations.

M1 Rf formula: distance moved by substance / distance moved by solvent [1 mark].

M2 Dye A working: 2.4 cm / 8.0 cm = 0.30 (allow 0.3) [1 mark].

M3 Dye B working: 6.4 cm / 8.0 cm = 0.80 (allow 0.8) [1 mark].

M4 Both answers given with no units (Rf is a ratio) [1 mark].

Question 8 (Topic 3) - Limiting Reactant & Mass of LiOH [5 Marks]

M1 Calculate moles of lithium: 3.50 g / 7.0 = 0.50 mol [1 mark].

M2 Calculate moles of water: 18.0 g / 18.0 = 1.00 mol [1 mark].

M3 **Limiting reactant proof:** The molar ratio from the equation is 2 Li : 2 H_2O (1:1). 0.50 mol of Li requires 0.50 mol of H_2O. Since 1.00 mol of H_2O is present, H_2O is in excess and lithium is the limiting reactant [1 mark].

M4 Moles of LiOH produced = Moles of Li reacted = 0.50 mol [1 mark].

M5 Mass of LiOH: 0.50 mol * 24.0 g/mol (Mr of LiOH) = 12.0 g [1 mark].

> **Error Carried Forward (ECF)**
> Allow ECF from M1/M2/M3 to calculate final mass in M5. For example, if they identify H_2O as limiting (1.00 mol), theoretical mass is 1.00 * 24.0 = 24.0 g (score max 3 marks: M2, M4-equivalent, M5-equivalent).

Question 9 (Topic 3) - Percentage Yield [2 Marks]

M1 Percentage yield formula: (actual yield / theoretical yield) * 100 [1 mark].

M2 Calculation: (9.00 g / 12.0 g) * 100 = 75.0% (allow 75%) [1 mark].

> **Error Carried Forward (ECF)**
> Allow ECF from Question 8 theoretical yield. If theoretical yield was calculated as 24.0 g: (9.00 / 24.0) * 100 = 37.5%.

Question 10 (Topic 3) - Hydrogen Gas Volume [4 Marks]

M1 From equation: 2 moles of Li produce 1 mole of H_2 (2:1 ratio) [1 mark].

M2 Moles of H_2 produced: 0.50 mol Li / 2 = 0.25 mol [1 mark].

M3 Volume calculation: 0.25 mol * 24.0 dm^3/mol [1 mark].

M4 Final volume = 6.0 dm^3 (allow 6.00 / 6) [1 mark].

> **Error Carried Forward (ECF)**

Allow ECF from Question 8 moles of lithium.

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Topic 3 & Topic 4

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Question 11 (Topic 3) - Titration Calculation [6 Marks]

M1 Calculate moles of HNO_3: (25.0 / 1000) * 0.050 = 0.00125 mol [1 mark].

M2 From equation: 2 moles of HNO_3 react with 1 mole of $Ba(OH)_2$. Moles of $Ba(OH)_2$ = 0.00125 / 2 = 0.000625 mol [1 mark].

M3 Calculate concentration of $Ba(OH)_2$ in mol/dm^3: 0.000625 mol / (20.0 / 1000) = 0.03125 mol/dm^3 [1 mark].

M4 Calculate Mr of $Ba(OH)_2$: 137.0 + 2 * (16.0 + 1.0) = 171.0 [1 mark].

M5 Calculate concentration of $Ba(OH)_2$ in g/dm^3: 0.03125 * 171.0 = 5.34375 g/dm^3 [1 mark].

M6 Round both values to 3 significant figures: concentration = 0.0313 mol/dm^3 and 5.34 g/dm^3 [1 mark].

> **Error Carried Forward (ECF)**
> Allow full ECF throughout. If M2 ratio is missed (1:1 used), concentration is 0.0625 mol/dm^3 (M3) and 10.7 g/dm^3 (M5/M6), scoring max 5 marks.

Question 12 (Topic 4) - Electrolysis of Potassium Bromide [10 Marks]

(a) Four chemical ions in solution.

M1 Potassium ions (K^+) and Bromide ions (Br^-) [1 mark].

M2 Hydrogen ions (H^+) and Hydroxide ions (OH^-) [1 mark].

(b) Positive electrode (anode) product and half-equation.

M1 Product is bromine (gas/liquid) [1 mark].

M2 Half-equation: $2Br^- \rightarrow Br_2 + 2e^-$ / $2Br^- - 2e^- \rightarrow Br_2$ [1 mark].

M3 **Explanation:** Both Br^- and OH^- ions are attracted to the anode [1 mark].

M4 Halide ions (Br^-) are discharged preferentially to hydroxide ions (OH^-) / halide ions are easier to oxidise than OH^- [1 mark].

(c) Negative electrode (cathode) product and half-equation.

M1 Product is hydrogen (gas) [1 mark].

M2 Half-equation: $2H^+ + 2e^- \rightarrow H_2$ [1 mark].

M3 **Explanation:** Both K^+ and H^+ ions are attracted to the cathode [1 mark].

M4 Hydrogen is less reactive than potassium, so hydrogen ions are discharged preferentially / reduced preferentially [1 mark].

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Question 13 (Topic 4) - pH and Hydrogen Ion Concentration [4 Marks]

M1 State that pH is related to hydrogen ion concentration by the base-10 relationship: [H+] = 10^-pH [1 mark].

M2 Calculate [H+] at pH 1.0 = 10^-1 = 0.1 mol/dm3 [1 mark].

M3 Calculate [H+] at pH 3.0 = 10^-3 = 0.001 mol/dm3 [1 mark].

M4 Ratio of concentrations: 0.1 / 0.001 = 100. Therefore, as pH increases from 1.0 to 3.0, the [H+] decreases by a factor of 100 / 10^2 [1 mark].

Question 14 (Topic 4) - Displacement Required Practical (RP4) [9 Marks]

(a) Polystyrene cup vs glass beaker.

M1 Polystyrene is a good thermal insulator [1 mark].

M2 It reduces heat loss to the surroundings, making the recorded maximum temperature rise more accurate [1 mark].

(b) Ionic equation.

M1 Correct formula and species: Zn(s) + Cu2+(aq) → Zn2+(aq) + Cu(s) [1 mark].

M2 All state symbols correct: (s), (aq), (aq), (s) [1 mark].

(c) Temperature rise and leveling off.

M1 Temperature increases because the reaction is exothermic, releasing thermal energy to the solution [1 mark].

M2 As more zinc is added, more copper ions react, releasing more energy [1 mark].

M3 The temperature stops rising because copper(II) sulfate is the limiting reactant and has completely reacted. Any excess zinc does not react, and heat is lost to the surroundings [1 mark].

(d) Zinc oxidation half-equation.

M1 Zinc atoms lose electrons: Zn → Zn2+ + 2e- [1 mark].

M2 Identify this process as oxidation (loss of electrons) [1 mark].

Turn over →

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Question 15 (Topic 5) - Endothermic Energy Profile [8 Marks]

(a) Endothermic reaction definition.

M1 A reaction that takes in heat/energy from the surroundings, leading to a decrease in temperature of the surroundings [1 mark].

(b) Identify labels W, X, Y, Z.

M1 **W:** Reactants / Calcium carbonate / $CaCO_3(s)$ [1 mark].

M2 **X:** Products / Calcium oxide and carbon dioxide / $CaO(s) + CO_2(g)$ [1 mark].

M3 **Y:** Activation energy / Ea [1 mark].

M4 **Z:** Overall energy change / Enthalpy change / ΔH [1 mark].

(c) Endothermic reaction in terms of bond breaking and bond making.

M1 Energy is taken in to break chemical bonds in the reactants ($CaCO_3$) [1 mark].

M2 Energy is released when new bonds are made in the products ($CaO + CO_2$) [1 mark].

M3 The reaction is endothermic because more energy is absorbed to break bonds than is released when making them [1 mark].

Question 16 (Topic 5) - Bond Energy [6 Marks]

(a) Calculate overall enthalpy change.

M1 Energy absorbed to break reactant bonds: H-H + Br-Br = 436 + 193 = 629 kJ/mol [1 mark].

M2 Energy released to make product bonds: 2 * H-Br = 2 * 366 = 732 kJ/mol [1 mark].

M3 Enthalpy change (ΔH) = 629 - 732 = -103 kJ/mol [1 mark].

> **Error Carried Forward (ECF)**
> Allow ECF from M1 and M2. If they calculate 629 - 366 = +263 kJ/mol, award 1 mark. If they calculate 732 - 629 = +103 kJ/mol, award 2 marks (missing negative sign).

(b) Exothermic explanation.

M1 Bond breaking absorbs energy (endothermic) and bond making releases energy (exothermic) [1 mark].

M2 The energy released when making 2 H-Br bonds (732 kJ/mol) is greater than the energy absorbed to break H-H and Br-Br bonds (629 kJ/mol) [1 mark].

M3 Therefore, there is a net release of energy to the surroundings / negative enthalpy change, making it exothermic [1 mark].

END OF MARK SCHEME