Mark Scheme - Paper 1

Question 1	Answer	Marks
01.1	Plum pudding model has uniform positive charge throughout, nuclear model has positive charge in the centre (nucleus) Plum pudding model has electrons embedded in the sphere, the nuclear model has electrons orbiting the nucleus. Plum pudding model has mass uniformly distributed, nuclear model has mass concentrated in the centre (nucleus)	1 1 1
01.2	Most alpha particles passed through, some deflected. Acceptance of the Nuclear Model Deflection of alpha particles suggested a small, dense, positively charged nucleus surrounded by mostly empty space.	1 1
01.3	Form coloured compounds Variable oxidation states	1 1
01.4	Volume = (30 nm) * (30 nm) * (30 nm) = **27,000 nm^3**	1
01.5	Enhanced reactivity due to **increased surface area-to-volume ratio**.	1

Question 2	Answer	Marks
02.1	1 lone pair on central atom 3 bonding pairs between each N and H	1 1
02.2	Covalent	1
02.3	simple covalent intermolecular forces a small amount	1 1 1
02.4	**Diamond:** Each carbon atom forms four strong covalent bonds. Giant covalent/macromolecular. The strong covalent bonds require a significant amount of energy to break, making diamond very hard. **Graphite:** Each carbon atom forms three covalent bonds, creating layers of hexagonal rings. The layers are held together by weak van der Waals forces, allowing them to slide over one another. This structure results in a soft and slippery material.	 1 1 1 1 1 1

Question 3	Answer	Marks
03.1	Indicative content • measure volume of (hydrochloric) acid • with a measuring cylinder • pour (hydrochloric) acid into a suitable container eg polystyrene cup • measure the initial temperature (of hydrochloric acid) • with a thermometer • add a known mass of magnesium • measured with a balance • stir • measure the highest temperature reached • repeat with different concentration of hydrochloric acid • repeat the whole investigation • use the same starting temperature • use the same volume of (hydrochloric) acid each time	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced. 5–6 marks **Level 2:** The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced. 3–4 marks **Level 1:** The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear. 1–2 marks
03.2	Any **one** from: Magnesium oxide, magnesium hydroxide, magnesium carbonate or magnesium hydrogen carbonate	1
03.3	Magnesium atom loses 2 electrons to achieve a stable octet configuration, forming Mg^{2+} ions. Each chlorine atom gains 1 electron, forming Cl^- ions. The oppositely charged ions are attracted to each other, resulting in the formation of magnesium chloride ($MgCl_2$) through ionic bonding.	1 1 1 1
03.4	solid, l, gas, aq	1

<table>
<tr><th>Question 4</th><th>Answer</th><th>Marks</th></tr>
<tr><td>04.1</td><td>
<table>
<tr><td></td><td>mass</td><td>charge</td><td>location</td></tr>
<tr><td>proton</td><td>1</td><td>+(1)</td><td>nucleus</td></tr>
<tr><td>neutron</td><td>1</td><td>0</td><td>nucleus</td></tr>
<tr><td>electron</td><td>Very small</td><td>-(1)</td><td>shell</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>04.2</td><td>Groups
Undiscovered</td><td>1
1</td></tr>
<tr><td>04.3</td><td>2 electrons in the inner shell
8 electrons in the outer shell</td><td>1
1</td></tr>
<tr><td>04.4</td><td>(69.15% of 63) + (30.85% of 65) =
(0.6915 * 63) + (0.3085 * 65) =

43.6545 + 20.0525 = 63.7</td><td>1

1</td></tr>
</table>

Question 5	Answer	Marks
05.1	Conversion of volume NaOH to dm^3 (1 mark) Amount of substance of NaOH = 0.250 mol/dm^3 × 0.0200 dm^3 = 0.005 mol (1 mark) The ratio of sodium hydroxide to sulfuric acid is 2:1 (1 mark) so 0.005 mol of NaOH reacts with 0.0025 mol of H_2SO_4. (1 mark) Concentration of the acid = amount of substance / volume = 0.0025 mol / 0.015 dm^3 = 0.1667 (1 mark) 3 sig. fig. **0.167 mol/dm³** (1 mark)	1 1 1 1 1 1
05.2	A substance which releases H^+ ions	1
05.3	Strong - full dissociation/ionisation of H^+ ions Weak - partial dissociation/ionisation of H^+ ions	1 1
05.4	Calculate the Relative Formula Mass of Na2SO4 - 142 (1 mark) total RFM of the reactants - 288 (1 mark) Percentage Atom Economy = (142 / 288) × 100% (1 mark) 3 sig. fig. **49.3%** (1 mark)	1 1 1 1
05.5	Moles of Na_2SO_4 = 30 g / 142 = 0.2113 mol Mass of $MgCO_3$ produced = 0.2113 x 84 = **17.7 g**	1 1 1

Question 6	Answer	Marks
06.1	At the cathode (negative electrode): H_2 (g) –> $2e^-$ $+2H^+$ (aq) At the anode (positive electrode): $4H^+$ (aq) + O_2 (g) + $4e^-$ $\rightarrow 2H_2O$(g) For each equation: Correct equation balanced	 1 1
06.2	**Advantage:** Clean energy source, emitting only water as a byproduct. Higher energy density compared to traditional batteries, allowing for longer driving ranges. **Disadvantage:** Limited hydrogen infrastructure, making refuelling stations scarce. Production of hydrogen often relies on energy-intensive processes, reducing overall efficiency.	1 1
06.3	Fully labelled diagram	2
06.4	Exothermic energy profile diagram Activation energy labelled	2
06.5	Total energy absorbed = 1305 kJ + 336 kJ + 464 kJ + 996 kJ = 3101 kJ Total energy released = 830 kJ + 1856 kJ = 2686 kJ Overall energy change = 3101 kJ - 2686 kJ = **415 kJ**	1 1 1

Question 7	Answer	Marks
07.1	Immerse each metal in different sulfate solutions. Observe any signs of displacement reactions, such as colour changes or the formation of a solid precipitate. Compare the reactions to establish the order of reactivity. No reaction implies lower reactivity compared to the metals involved in displacement reactions.	1 1 1 1
07.2	$2CuO + C \rightarrow 2Cu + CO_2$	1
07.3	Copper ions gain electrons to form copper metal	1

Question 8	Answer	Marks
08.1	Dissolved **ions** are free to **move through the solution**	2
08.2	Positive electrode - oxygen gas Negative electrode - copper metal	1 1
08.3	Positive electrode - chlorine gas Negative electrode - hydrogen gas	1 1
08.4	Carbon reacts with oxygen being produced So the electrodes disappear over time $C + O_2 \rightarrow CO_2$	1 1 1
08.5	$Al^{3+} + 3e^- \rightarrow Al$	

Question 9	Answer	Marks
09.1	Moles of NH3 = 100 g / 17 = 5.88 mol Moles of NH2Cl = 400 g / 51.5 = 7.77 mol Fewer moles of NH3 than NH2Cl Therefore NH3 is limiting	1 1 1 1
09.2	Theoretical yield = 5.88 mol × 32 g/mol = 188.16 g Percentage Yield = (26 g / 188.16 g) × 100% Percentage Yield = 0.1382 × 100% Percentage Yield = 13.82%	1 1 1
09.3	Step 1: Calculate moles of N_2H_4: 20 g / 32 = 0.6248 mol Step 2: Moles of gas produced: N_2 (0.6248 mol) and H_2 (2 * 0.6248 mol = 1.2496 mol) Step 3: Volume of N_2 gas: 0.6248 mol * 24 dm³ = 14.9952 dm³ Step 4: Volume of H_2 gas: 1.2496 mol * 24 dm³ = 29.9904 dm³ Step 5: Total volume of gas produced: 14.9952 dm³ + 29.9904 dm³ = 45.0 dm³.	1 1 1 1 1