

Name: _____

Topic 1 Chemistry 2022 Exam

Date:

Time:

Total marks available:

Total marks achieved: _____

Mark Scheme

Q1.

Question Number	Indicative content	Mark
*	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <ul style="list-style-type: none"> • in all structures the carbon atoms bonded by single covalent bonds • shared pair of electrons • strong bonds • in diamond each carbon atom joined to four others • diamond has a giant covalent {structure/lattice} • graphene has a giant covalent {structure/lattice} • fullerene has a molecular structure • in graphene and fullerene each carbon atom joined to three others • in diamond and graphene many bonds need to be broken to melt • need lots of energy • therefore very high melting / sublimation points • in fullerene weak forces between molecules • less energy needed to separate molecules • fullerene has the lowest melting / sublimation point • because diamond and graphene have lots of strong covalent bonds so both are very strong materials • because weak forces between fullerene molecules so its strength is very low • in diamond there are no free electrons • so diamond does not conduct • in graphene and fullerene each carbon atom has one free electron • hence delocalised electrons • graphene conducts electricity • fullerene only conducts electricity across the surface of the molecule • no/little movement of electrons between molecules • so fullerene is poor conductor of electricity (/ semi conductor) 	(6) AO 1 1

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	<ul style="list-style-type: none"> Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas, enquiry, techniques and procedures lacks detail. (AO1) Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	<ul style="list-style-type: none"> Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and fully devolved. (AO1) Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	<ul style="list-style-type: none"> Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully devolved. (AO1) Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Q2.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation linking two of the following points</p> <ul style="list-style-type: none"> {metal ions / cations} surrounded by (delocalised) electrons (1) strong {forces of attraction / bonding} (between (delocalised) electrons and {metal ions / cations}) (1) needs lots of energy to {separate the particles / break bonds / break forces of attraction} (1) 	<p>ignore metal nuclei</p> <p>allow electrostatic bonds / metallic bonds</p> <p>ignore separating electrons</p> <p>any mention of intermolecular forces / covalent bonding / molecules / ionic bonding / atoms – max 1 mark</p> <p>marking points independent</p>	<p>(2)</p> <p>AO 1 1</p>

Q3.

Question Number	Answer	Mark	
(i)	<p>B -78 -33 does not conduct</p> <p>The only correct answer is B</p> <p><i>A is not correct because simple molecular, covalent substances do not have high mpt and bpt</i></p> <p><i>C is not correct because ammonia is a gas at room temperature and does not conduct</i></p> <p><i>D is not correct because simple molecular, covalent substances do not have these properties</i></p>	<p>(1)</p> <p>AO 2 1</p>	
Question Number	Answer	Additional guidance	Mark
(ii)	<p>$N_2 + 3H_2 \rightarrow 2NH_3$ (2)</p> <p>left hand side formulae (1) balancing of correct formulae (1)</p>	<p>accept multiples allow = or \rightleftharpoons in place of \rightarrow ignore state symbols even if incorrect do not allow N2, n2, etc</p>	<p>(2)</p> <p>AO 2 1</p>

Q4.

Question Number	Answer	Additional guidance	Mark
	iron $\frac{10.00}{56} = 0.179 / 0.18 / 0.2$ and copper $\frac{11.34}{63.5} = 0.179 / 0.18 / 0.2$ (1) (ratio 1:1) so reaction A (1)	allow max 1 mark for Fe : $\frac{56}{10.00} = 5.6$ Cu : $\frac{63.5}{11.34} = 5.6$ so reaction A other methods of calculation include 10.00 g Fe forms $\frac{10.00}{56} \times 63.5$ (1) g copper $= 11.34$ g copper so reaction A (1) second mark dependent on first	(2) AO 3 2a AO 3 2b

Q5.

Question Number	Answer	Acceptable answers	Mark
	$\text{CaCl}_2 = 40 + 35.5 + 35.5$ (=111) (1) THEN moles = $11.1 / 111$ (= 0.1) (1) conc = <u>moles</u> x 1000/500 (=0.2) (1) OR mass conc = $11.1 \times 1000/500$ (=22.2) (1) conc = <u>mass conc</u> /111 (= 0.2) (1)	<u>0.2 scores 3</u> ecf: 11.1 / Mr ecf: mass conc / 111	(3)

Q6.

Question number	Answer	Additional guidance	Mark
(i)	<p>D oxidation</p> <p>Answers A and B are physical processes rather than chemical reactions.</p> <p>C is wrong because it is not neutralisation.</p>		(1)

Question number	Answer	Additional guidance	Mark
(ii)	<p>A description linking any three from:</p> <ul style="list-style-type: none">• lift lid from time to time/ leave small gap between crucible and lid (1)• find mass (of crucible, lid and product) (1)• {repeat / heat} to constant mass (1)• final mass – start mass = mass of oxygen (1)	<p>allow 'weigh'</p> <p>allow find the change in mass</p>	(3)

Q7.

Question number	Indicative content	Mark
	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>A03 (6 marks)</p> <ul style="list-style-type: none">• A is copper oxide• copper oxide is black• copper oxide reacts with sulfuric acid to make {copper sulfate / blue solution} but no gas <ul style="list-style-type: none">• B is magnesium• magnesium is silver coloured• magnesium reacts/ bubbles with water• magnesium reacts with sulfuric acid to give hydrogen / equation <ul style="list-style-type: none">• C is sodium hydroxide• sodium hydroxide is white• sodium hydroxide solution is colourless• sodium hydroxide reacts with sulfuric acid to form a colourless solution / equation• sodium hydroxide solution is alkaline• sodium hydroxide has hydroxide ions <ul style="list-style-type: none">• D is copper carbonate• copper carbonate is green• carbonates are insoluble• copper carbonate reacts with sulfuric acid to form copper sulfate and {gas / carbon dioxide}• copper carbonate reacts with sulfuric acid to form carbon dioxide / equation• copper sulfate (solution) is blue	(6)

Level	Mark	Descriptor
	0	<ul style="list-style-type: none">No rewardable material.
Level 1	1-2	<ul style="list-style-type: none">Deconstructs scientific information but understanding and connections are flawed. An unbalanced or incomplete argument that provides limited synthesis of understanding.Judgements are supported by limited evidence. (AO3)
Level 2	3-4	<ul style="list-style-type: none">Deconstructs scientific information and provides some logical connections between scientific concepts. An imbalanced argument that synthesises mostly relevant understanding, but not entirely coherently.Judgements are supported by evidence occasionally. (AO3)
Level 3	5-6	<ul style="list-style-type: none">Deconstructs scientific information and provide logical connections between scientific concepts throughout. A balanced, well-developed argument that synthesises relevant understanding coherently.Judgements are supported by evidence throughout. (AO3)

Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then: No solids are correctly identified/ One solid is identified but no reason is given
Level 1	1–2	<u>Additional Guidance</u> Three solids are correctly identified but only one or none have valid reasoning (2) Two solids are correctly identified and one has valid reasoning (2) Two solids are correctly identified but neither has valid reasoning (1) One solid is correctly identified with a valid reason (1)	<u>Possible candidate response</u> A is copper oxide. D is copper carbonate because carbonates fizz with acid. – 2 correctly identified, one has a sufficient reason (2)
Level 2	3–4	<u>Additional Guidance</u> All four solids are correctly identified but only one or none have valid reasoning -No solid has valid reasoning (3) -One solid has valid reasoning (4) Three solids are correctly identified and at least two have valid reasoning -Three have valid reasoning (4) -Two have valid reasoning (3) Two solids are correctly identified and both have valid reasoning (3)	<u>Possible candidate response</u> A is copper oxide because it has pH 7, B is magnesium because metals are silver coloured, C is sodium hydroxide because it reacts with acid, D is copper carbonate because it has pH 7. – 4 correctly identified, only 1 has a sufficient reason (magnesium is silver) (4)
Level 3	5–6	<u>Additional Guidance</u> All four solids are correctly identified and at least two have valid reasoning. -Two or three solids have valid reasoning (5) -All four have valid reasoning (6)	<u>Possible candidate response</u> A is copper oxide because it is the only black solid. B is magnesium because metals are silver coloured. C is sodium hydroxide because it dissolves to form an alkaline solution. D is copper carbonate because it forms copper sulfate which is blue in the reaction with acid <u>and fizzes</u> . 4 correctly identified, 4 with sufficient reasons (6)

Question Number	Answer	Mark	
(i)	<p>C iron oxide is reduced</p> <p>The only correct answer is C</p> <p><i>A is not correct because carbon gains oxygen</i></p> <p><i>B is not correct because it is not an acid-base reaction</i></p> <p><i>D is not correct because iron oxide loses oxygen</i></p>	<p>(1)</p> <p>AO 1 1</p>	
Question Number	Answer	Additional guidance	Mark
(ii)	<p>final answer of 168 (tonnes) with or without working (3)</p> <p>OR</p> <p>relative formula mass $\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)$ (1)</p> <p>160 tonnes Fe_2O_3 produces $\{2 \times 56 / 112\}$ tonnes Fe (1)</p> <p>240 tonnes Fe_2O_3 produces $\frac{2 \times 56}{160} \times 240$ (1) = 168 (tonnes)</p> <p>OR</p> <p>relative formula mass $\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)$ (1)</p> <p>$\frac{240}{160}$ (1) = 1.5</p> <p>1.5×112 (1) = 168 (tonnes)</p> <p>OR</p> <p>relative formula mass $\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)$ (1)</p> <p>$\frac{112}{160}$ (1) = 0.7</p> <p>0.7×240 (1) = 168 (tonnes)</p>	<p>allow ECF throughout</p> <p>$M_r [\text{Fe}_2\text{O}_3] = 160$ seen without working (1)</p> <p>allow 320 tonnes : 224 tonnes (1)</p> <p>final answer 84 (tonnes) with or without working (2)</p> <p>Note : final answer 1.5 scores 2 overall</p>	<p>(3)</p> <p>AO 2 1</p>

Question number	Indicative content	Mark
	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;">A01 (3 marks) and A02 (3 marks)</p> <p>STRUCTURE</p> <ul style="list-style-type: none">• calcium chloride is an ionic compound with lattice of positive and negative ions• calcium is a metal and so has a metallic structure of delocalised electrons and {calcium/Ca²⁺ ions}• chlorine is a simple molecular covalent compound <p>MELTING POINT</p> <ul style="list-style-type: none">• there are strong electrostatic forces of attraction/ionic bonds between the ions in calcium chloride• a large amount of heat energy is required to break the electrostatic forces (so calcium chloride has a high melting point)• strong electrostatic forces between ions and delocalised electrons in calcium• a large amount of heat energy is required to break the electrostatic forces (so calcium has a high melting point)• chlorine has weak forces of attraction between its molecules and these weak forces only take a small amount of energy to break down (so chlorine has a low melting point)	(6)

	<p>CONDUCTIVITY WHEN SOLID</p> <ul style="list-style-type: none">ions are fixed in a lattice and so cannot move (therefore calcium chloride cannot conduct a current)delocalised electrons in metallic structure can move to carry a current (so calcium can conduct a current)there are no delocalised electrons/ions/charged particles/overall charges in chlorine molecules and (so chlorine cannot conduct a current) <p>CONDUCTIVITY WHEN MOLTEN</p> <ul style="list-style-type: none">however, when molten ions are free to move (and therefore molten calcium chloride can conduct a current)delocalised electrons in metallic structure can move to carry a current (so calcium can conduct a current)there are no delocalised electrons/ions/charged particles/overall charges in chlorine molecules and (so chlorine cannot conduct a current) <p>all incorrect information/explanations should be ignored reject contradictory explanations</p>	
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Level	Mark	Additional Guidance	General additional guidance Eg - At each level, as well as content, the scientific coherency of what is stated backed up by planning detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1-2	<u>Additional guidance</u> Three structures named OR one structure described OR one property explained for one substance	<u>Possible candidate responses</u> <ul style="list-style-type: none"> calcium is metallic, chlorine is a molecule (1) calcium chloride is ionic with positive calcium ions and negative chloride ions (2) calcium is metallic, chlorine is covalent, calcium chloride is ionic (2) calcium is metallic it conducts when solid as it has mobile electrons (2)
Level 2	3-4	<u>Additional guidance</u> Three structures described or three properties explained.	<u>Possible candidate responses</u> <ul style="list-style-type: none"> calcium has a metallic lattice of cations and delocalised electrons. Chlorine is made of simple molecules with weak intermolecular forces between them (3) calcium has a metallic lattice of cations and delocalised electrons. Chlorine is made of simple molecules with weak intermolecular forces between them, this means that chlorine has a low melting point because little energy is needed to overcome these forces. (4)
Level 3	5-6	<u>Additional guidance</u> Six properties explained.	<u>Possible candidate responses</u> <ul style="list-style-type: none"> calcium chloride has strong electrostatic forces between the ions so a high melting point and these ions are fixed in a lattice so the solid does not conduct. When melted, the ions are free to move and so the liquid does conduct. There are weak intermolecular forces between chlorine molecules so the melting point is low.(5) calcium chloride has strong electrostatic forces between the ions so a high melting point and these ions are fixed in a lattice so the solid does not conduct. When melted, the ions are free to move and so the liquid does conduct. There are weak intermolecular forces between chlorine molecules so the melting point is low and molecules are uncharged so chlorine does not conduct electricity when solid or liquid (6)

Q10.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking <ul style="list-style-type: none"> • {rate/ mass loss} is slowing down (1) • as amount of reactant falls (1) OR <ul style="list-style-type: none"> • mass decreases (1) • as further decomposition occurs/ reaction continues / {gas/CO₂} {is produced/ escapes/ lost} (1) 	allow amount of calcium carbonate decreases do not allow 'as time goes on' for 2 nd mark: must explain in terms of a reaction	(2)
(ii)	mass may decrease further / not heated to constant mass / last two mass figures not the same	allow mass is still decreasing ignore there is still 5.2g solid reject mass has not gone to zero	(1)

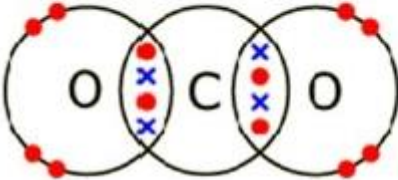
Q11.

Question number	Answer	Additional guidance	Mark
	An explanation linking: <ul style="list-style-type: none"> • (calcium) nitrate {is soluble/ dissolves}/ (calcium) carbonate {is insoluble/ does not dissolve} (1) • so ions {free to move in solution / not free in solid} (1) 	calcium nitrate dissolves so ions can move (2) or reverse argument for calcium carbonate	(2)

Q12.

Question number	Answer	Additional guidance	Mark
	<p>An explanation that combines identification – knowledge (1 mark) and reasoning/justification – understanding (1 mark):</p> <ul style="list-style-type: none"> • {delocalised/free} electrons (1) • (electrons) move (between the layers) (1) 	<p>ignore 'spare electrons' allow sea of electrons</p> <p>ignore 'carry the charge' / 'current to flow' reject between molecules</p> <p>free flowing electrons (2) electrons free to move (1)</p>	<p>(2) EXP</p>

Q13.

Question number	Answer	Additional guidance	Mark
(i)	 <ul style="list-style-type: none"> • {2 pairs of/four} electrons shared between an oxygen atom and the carbon atom (1) • rest of structure correct (1) 	<p>ignore any inner electrons shown remaining electrons on oxygen either singly or paired allow all dots or all crosses</p> <p>2nd mark dependent on 1st</p>	<p>(2) EXP</p>

Question number	Answer	Additional guidance	Mark
(ii)	<p>An explanation that makes reference to identification – knowledge (1 mark) and reasoning /justification – knowledge (1 mark):</p> <ul style="list-style-type: none"> • diamond has a giant (covalent) structure / strong (covalent) bonds / each carbon atom is bonded to four other carbon atoms / all carbon atoms in diamond are bonded together (1) • large amount of (heat) energy is needed to {separate the carbon atoms / break the bonds / break up lattice} (1) 	<p>reject ionic lattice reject layers reject bonds between molecules</p> <p>reject intermolecular forces being broken ignore just high heat</p> <p>mark independently</p>	<p>(2)</p> <p>GRAD</p>

Q14.

Question number	Answer	Additional guidance	Mark
	$\frac{2.24}{56.0} = 0.04$ and $\frac{0.96}{16.0} = 0.06$ (1) 1 : 1.5 / 2 : 3 (1) Fe_2O_3 (1) $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$ (1)	<p>allow ECF for MP2 and MP3 only.</p> <p>allow $\frac{2.24}{56.0} = 0.04$ and $\frac{0.96}{32.0} = 0.03$ (1)</p> <p>1.33 : 1 / 4 : 3 (1)</p> <p>Fe_2O_3 (1)</p> <p>$4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$ (1)</p> <p>NOTE: equation alone gains no marks.</p>	(4)

Q15.

Question number	Answer	Additional guidance	Mark
	<p>A description that combines three of the following points to provide a method:</p> <ul style="list-style-type: none">heat the magnesium (in crucible) (1) <p>and any two from</p> <ul style="list-style-type: none">lift lid from time to time/allow to cool (1)determine mass of crucible, lid and product (1) <ul style="list-style-type: none">subtract to find mass of oxygen combined (1)	<p>allow heat crucible (containing magnesium)</p> <p>allow use of weigh in place of determine mass ignore 'measure' alone allow heat to constant mass allow weigh at end /OWTTE</p>	<p>(3)</p> <p>EXP</p>

Q16.

Question Number	Answer	Additional guidance	Mark
	final answer of 94 (g dm^{-3}) with or without working (2) OR $\frac{23.5}{250}$ (1) (= 0.094) 0.094×1000 (1) OR $\frac{250}{1000}$ (dm^3) (1) (= 0.25 (dm^3)) $\frac{23.5}{0.25}$ (1) OR $\frac{1000}{250}$ (1) = 4 4×23.5 (1)	allow ECF (error carried forward) throughout other final answers: $0.094 / 9.4$ (1) 0.000094 or 9.4×10^{-5} (1) 0.25 (dm^3) (1) allow $\frac{250}{23.5} \times 1000$ or 10638(.3) (1)	(2) AO 2 1

Q17.

Question number	Indicative content	Additional guidance	Mark
(i)	straight line of best fit (1 cm^3 to 5 cm^3)	ignore line between 0 and 1 and after 5 must be a single ruled line	(1)

Question number	Indicative content	Additional guidance	Mark
(ii)	<ul style="list-style-type: none"> any line extrapolated to 6cm³ (1) value read from their extrapolated line +/- 1 small square (1) 	<p>2nd mark dependent on 1st</p> <p>no line = 0</p>	(2)

Q18.

Question number	Answer	Additional guidance	Mark
(i)	Left : H ₂ SO ₄ (1) Right : CuSO ₄ (1)	reject superscript numbers reject superscript numbers incorrect balancing max 1	(2)

Question number	Answer	Mark
(ii)	63.5 + 12 + 3x16 (1) = 123.5 (1)	(2)

Question number	Answer	Mark
(iii)	<p>A bubble the gas through limewater, limewater turns cloudy</p> <p>The only correct answer is A</p> <p>B is not correct because test shows only an acidic gas C is not correct because test shows only that the gas does not support combustion D is not correct because test shows only an acidic gas</p>	(1)

Q19.

Question Number	Answer	Additional guidance	Mark
	1 mol of hydrogen atoms = a mass of 1.00 g = 6.02×10^{23} atoms 6.02×10^{23} H atoms has mass = 1.00 g (1) mass of 1 H atom = $\frac{1.00}{6.02 \times 10^{23}}$ (1) $= 1.66 \times 10^{-24}$ (g) (1)	correct answer alone (3) if $1 \times 6.02 \times 10^{23}$ is followed by atoms or particles, then award 1 st marking point on answer line 3.32×10^{-24} (g) (2) ignore sig figs except for one	(3) AO 2 1

Q20.

Question number	Answer	Additional guidance	Mark
(i)	100 with or without working scores 2 $40 + 12 + 3 \times 16$ (1) $= 100$ (1)	ignore any units ecf for MP2 if using 12, 16 and 40, using addition and multiplication only	(2)
(ii)	56% without working scores 0 $\frac{56}{100}$ (1) $(\times 100) = 56$ (%) (1)	56/answer to 4(d)(i) (1) $\times 100$ (1) MP2 only for correctly $\times 100$ some figure derived from the data given 100% scores 0	(2)

Q21.

Question number	Answer	Additional guidance	Mark
	0.005/ 5×10^{-3} mol with or without working scores 3 $M_r = 63.5 + 32 + 4 \times 16$ (1) (=159.5) AND EITHER mass of copper sulfate = $50/1000 \times 15.95$ (1) (= 0.7975 g) moles = $0.7975/159.5$ (1) (= 0.005 mol) OR conc = $15.95/159.5$ (1) (=0.1 mol dm^{-3}) moles = $50/1000 \times 0.1$ (= 0.005 mol)	2 marks for (MUST show working): 5 0.1 ecf in all stages	(3)

Q22.

Question number	Answer	Additional guidance	Mark
(i)	relative formula mass $= 192 + 12 + 28 + 16$ (1) = 248 number of moles $= 0.50/248$ or 0.002 or 2.0×10^{-3} or 2.02×10^{-3} (1)	award full marks for correct numerical answer without working. allow 1 mark max for ecf using incorrectly calculated value for relative formula mass allow any number of sig figs	(2) EXP
Question number	Answer	Additional guidance	Mark
(ii)	number of molecules $= 2 \times 6.02 \times 10^{23}$ (1) = $1.2(04) \times 10^{24}$	allow $12(.04) \times 10^{23}$ without working	(1) GRAD

Q23.

Question number	Answer	Additional guidance	Mark
	final answer of $1.2(04) \times 10^{22}$ with or without working (2) OR $\frac{3.94}{197} = 0.02$ (1) $0.02 \times 6.02 \times 10^{23} = 1.2(04) \times 10^{22}$ (1)	allow ECF allow $0.12(04) \times 10^{23}$	(2)

Q24.

Question number	Answer	Additional guidance	Mark
	$1.8... \times 10^{24}$ with or without working scores 2 <ul style="list-style-type: none"> • $3 \times 6.02 \times 10^{23}$ (1) • $= 1.8 \times 10^{24}$ (1) 	allow 18×10^{23} , 1.81×10^{24} , 1.806×10^{24} or any other form of correct answer to 2-4 sig figs allow $2 \times 6.02 \times 10^{23} = 1.2 \times 10^{24}$ (1)	(2)

Q25.

Question number	Answer	Additional guidance	Mark
	2.8g with or without working scores 2 0.043×65 (1) (=2.795) $= 2.8$ g (1)	allow 1 mark for a different calculation using 65 and 0.043, correctly evaluated, with working, rounded to 1 decimal place	(2)

Q26.

Question number	Answer	Additional guidance	Mark
	<p>MP1 for dividing by atomic mass</p> $\begin{array}{ccc} \mathbf{A} & : & \mathbf{G} \\ \underline{3.5} & : & \underline{4.0} \\ 7 & & 16 \end{array} \quad (1)$ <p>MP2 for deriving ratio from MP1</p> <p>OR</p> $0.5 \quad : \quad 0.25$ $2 \quad : \quad 1 \quad (1)$ <p>MP3 for ratio in MP2 to formula empirical formula A₂G (1)</p>	<p>A₂G with no relevant working (1) ONLY AG₂ (0)</p> <p>For MP2: If they go on to calculate a different ratio in addition to 0.5:0.25 or 2:1 do not award MP2</p> <p>ecf on step 1: If inverted,</p> $\begin{array}{ccc} \underline{7} & : & \underline{16} \\ 3.5 & & 4.0 \end{array} \quad (0)$ $= 2 \quad : \quad 4$ <p>or</p> $1 \quad : \quad 2 \quad (1)$ <p>AG₂ (1)</p> <p>allow 1 in empirical formula</p> <p>allow Li for A and O for G</p> <p>do not penalise incorrect case in formula</p>	(3)

Q27.

Question number	Answer	Additional guidance	Mark
	$\begin{array}{ccc} \text{Al} & : & \text{Cl} \\ 0.270/27 & : & 1.065/35.5 \\ 0.01 & : & 0.03 \end{array} \quad (1)$ <p>OR</p> $1 \quad : \quad 3$ <p>empirical formula AlCl₃ (1)</p>	<p>allow ECF</p> <p>Al : 0.270/27 = 0.01 (1) Cl : 1.065/35.5 = 0.03 (1)</p> <p>27/0.27 : 35.5/1.065 100 : 33.3 (1) OR 3 : 1 Al₃Cl (1)</p> <p>formula alone with no working scores no marks.</p>	(3) EXP

Q28.

Question number	Answer	Additional guidance	Marks
	250 cm ³ contains 6.36 g		(3)
	(1 cm ³ solution contains) $\frac{6.36}{250}$ (g) (1) (=0.02544)	0.02544	EXP
	(1000 cm ³ solution contains) $\frac{6.36}{250} \times 1000$ (g) (1)	25.44 with or without working (2)	
	concentration = 25.44 (g dm ⁻³)	25.4 with or without working (3)	
	= 25.4 (g dm ⁻³) (1)	(answer to 3 sig fig)	
	OR	other allows:	
	volume of solution = 250/1000 (1) (=0.250)	2.544 1 mark	
	(mass) concentration = $\frac{\text{mass (in g)}}{\text{volume (in dm}^3\text{)}}$	2.54 2 marks	
	= $\frac{6.36 \times 1000}{250}$ (1)	0.0254 2 marks	
	concentration = 25.44 (g dm ⁻³)	2.544 x 10 ⁻⁵ 1 mark	
	= 25.4 (g dm ⁻³) (1)	2.54 x 10 ⁻⁵ 2 marks	
		with working:	
		39.31 0 marks	
		39.3 1 mark	
		(answer to 3 sig fig)	

Q29.

Question number	Answer	Additional guidance	Mark
	final answer of 114 (g dm ⁻³) with or without working (3) OR $\frac{28.4}{250} (1) (= 0.1136)$ $0.1136 \times 1000 (1) (= 113.6)$ $= 114 \text{ (g dm}^{-3}\text{)} (1)$	allow ECF throughout $\frac{250}{1000} \text{ (dm}^3\text{)} (1) (= 0.250 \text{ (dm}^3\text{)})$ $\frac{28.4}{0.250} (1) (= 113.6)$ OR $\frac{1000}{250} (1) = 4$ $4 \times 28.4 (1) (= 113.6)$ Must have 3sf for MP3 0.114 scores 2 Lose MP1 if rounded incorrectly e.g, to 0.11 or 0.113 but mark on	(3)

Name: _____

Topic 3 Chemistry 2022 Exam

Date:

Time:

Total marks available:

Total marks achieved: _____

Mark Scheme

Q1.

Question Number	Answer	Acceptable answers	Mark
(i)	D salt and water only		(1)

Question Number	Answer	Acceptable answers	Mark
(ii)	A description to include two from <ul style="list-style-type: none">• (green) solid {disappears / dissolves} (1)• effervesces / bubbles (of colourless gas) given off (1)• blue (solution) forms (1)	ignore references to names of products fizz goes blue ignore incorrect colours of solution ignore temperature rise	(2)

Q2.

Question Number	Answer	Acceptable answers	Mark
(i)	D salt and water only		(1)

Question Number	Answer	Acceptable answers	Mark
(ii)	A description to include two from <ul style="list-style-type: none">• (green) solid {disappears / dissolves} (1)• effervesces / bubbles (of colourless gas) given off (1)• blue (solution) forms (1)	ignore references to names of products fizz goes blue ignore incorrect colours of solution ignore temperature rise	(2)

Q3.

Question number	Answer	Additional guidance	Mark
(i)	ACID use measuring cylinder / pipette / burette (1) BASE balance / scales / weigh out amount (1)	must name apparatus ignore weigh the liquid allow use portion of known mass / use measured amount in g / specific mass given [from 0.1 to 10g] allow weight for mass	(2)
(ii)	START colourless END pink / magenta	both START and END required for mark ignore clear	(1)
(iii)	An explanation linking <ul style="list-style-type: none"> {hydrogen ions/ H⁺} {reacted / neutralised} (1) {concentration falls/ fewer} H⁺ / {concentration rises/ more} OH⁻ (1) 	allow H ⁺ + OH ⁻ H ₂ O (1) for MP1	(2)

Q4.

Question number	Answer	Additional guidance	Mark
(i)	ACID use measuring cylinder / pipette / burette (1) BASE balance / scales / weigh out amount (1)	must name apparatus ignore weigh the liquid allow use portion of known mass / use measured amount in g / specific mass given [from 0.1 to 10g] allow weight for mass	(2)
(ii)	START colourless END pink / magenta	ignore clear	(1)

Question number	Answer	Additional guidance	Mark
(iii)	An explanation linking <ul style="list-style-type: none"> {hydrogen ions/ H⁺} {reacted / neutralised} (1) {concentration falls/ fewer} H⁺ / {concentration rises/ more} OH⁻ (1) 	allow H ⁺ + OH ⁻ → H ₂ O for MP1	(2)

Q5.

Question Number	Answer	Additional guidance	Mark
(i)	C neutral (1)		(1)

Question Number	Answer	Mark
(ii)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark) <ul style="list-style-type: none"> to react all the (nitric) acid in the solution (1) so that the calcium nitrate solution is pure (1) 	(2)

Question Number	Answer	Mark
(iii)	$\text{CaCO}_3 + 2\text{HNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{H}_2\text{O} + \text{CO}_2$ (3) left hand side formulae (1) right hand side formulae (1) balancing correct formulae (1)	(3)

Q6.

Question Number	Answer	Mark
	<p>An answer that combines knowledge (1 mark) and understanding (2 marks) to provide a logical description</p> <ul style="list-style-type: none"> • use of a pH (probe and) meter / suitable universal indicator paper (1) • (after each addition of calcium oxide) stir (1) • record pH after each addition (1) 	(3)

Q7.

Question number	Answer	Additional guidance	Mark
(i)	<p>Left : H_2SO_4 (1)</p> <p>Right : CuSO_4 (1)</p>	<p>reject superscript numbers</p> <p>reject superscript numbers</p> <p>incorrect balancing max 1</p>	(2)

Question number	Answer	Mark
(ii)	<p>$63.5 + 12 + 3 \times 16$ (1)</p> <p>$= 123.5$ (1)</p>	(2)

Question number	Answer	Mark
(iii)	<p>A bubble the gas through limewater, limewater turns cloudy</p> <p>The only correct answer is A</p> <p>B is not correct because test shows only an acidic gas</p> <p>C is not correct because test shows only that the gas does not support combustion</p> <p>D is not correct because test shows only an acidic gas</p>	(1)

Q8.

Question number	Answer	Additional guidance	Mark
(i)	Left : H ₂ SO ₄ (1) Right : CuSO ₄ (1)	reject superscript numbers reject superscript numbers incorrect balancing max 1	(2)

Question number	Answer	Mark
(ii)	63.5 + 12 + 3x16 (1) = 123.5 (1)	(2)

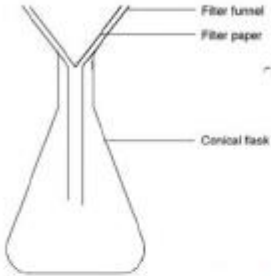
Q9.

Question number	Answer	Mark
	C lead and bromine is the only correct answer A is incorrect because lead is produced at the cathode B is incorrect because lead and bromine are produced D is incorrect because bromine is produced at the anode	(1)

Q10.

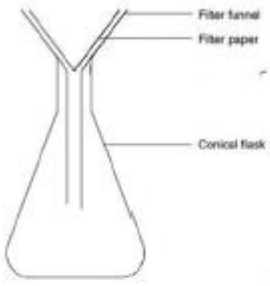
Question number	Answer	Mark
	C lead and bromine is the only correct answer A is incorrect because lead is produced at the cathode B is incorrect because lead and bromine are produced D is incorrect because bromine is produced at the anode	(1)

Q11.

Question number	Answer	Additional guidance	Mark
(i)	 <p style="text-align: right;">(2)</p> <p>OR</p> <p>diagram: funnel with separate filter paper and (conical) flask (1)</p> <p>labels: (filter) funnel and filter paper and (conical) flask (1)</p>	<p>reject diagram with funnel 'closed' at bottom/top but can score MP2</p> <p>allow 'closed' filter paper</p> <p>allow any suitable apparatus for conical flask e.g. beaker</p> <p>'flask' label should be appropriate to apparatus drawn</p> <p>ignore labelling of filtrate/residue etc</p>	(2)

Question number	Answer	Additional guidance	Mark
(ii)	<p>a description including any three from:</p> <ul style="list-style-type: none">• heat solution (to concentrate) (1) <p>then either</p> <ul style="list-style-type: none">• leave solution {in warm place / to crystallise} (1)• scrape crystals (from container) / pat dry between filter papers (1) <p>OR</p> <ul style="list-style-type: none">• leave solution {to crystallise / to cool} (1)• filter off crystals / decant liquid from the crystals / pat dry between filter papers / dry in oven (1)	<p>if no other marks are scored , allow max 1 for crystallisation (1)</p>	(3)

Q12.

Question number	Answer	Additional guidance	Mark
(i)	 <p style="text-align: right;">(2)</p> <p>OR</p> <p>diagram: funnel with separate filter paper and (conical) flask (1)</p> <p>labels: (filter) funnel and filter paper and (conical) flask (1)</p>	<p>reject diagram with funnel 'closed' at bottom/top but can score MP2</p> <p>allow 'closed' filter paper</p> <p>allow any suitable apparatus for conical flask e.g. beaker</p> <p>'flask' label should be appropriate to apparatus drawn</p> <p>ignore labelling of filtrate/residue etc</p>	(2)

Question number	Answer	Additional guidance	Mark
(ii)	<p>a description including any three from:</p> <ul style="list-style-type: none"> • heat solution (to concentrate) (1) <p>then either</p> <ul style="list-style-type: none"> • leave solution {in warm place / to crystallise} (1) • scrape crystals (from container) / pat dry between filter papers (1) <p>OR</p> <ul style="list-style-type: none"> • leave solution {to crystallise / to cool} (1) • filter off crystals / decant liquid from the crystals / pat dry between filter papers / dry in oven (1) 	<p>if no other marks are scored , allow max 1 for crystallisation (1)</p>	(3)

Q13.

Question number	Answer	Additional guidance	Mark
(i)	<p>A description including</p> <ul style="list-style-type: none"> • apply lighted splint (1) • gas burns / (squeaky) pop (1) 	<p>allow flame / ignite gas ignore 'squeaky pop test' / glowing splint</p> <p>second mark is dependent on first</p>	(2)

Question number	Answer	Mark
(ii)	<p>B oxygen</p> <p>The only correct answer is B</p> <p>A, C & D these gases are not produced in the electrolysis of sodium sulfate solution</p>	(1)

Question number	Answer	Additional guidance	Mark
(iii)	<ul style="list-style-type: none"> electrical energy / electricity (1) {decomposes / breaks down / splits} {electrolytes / (ionic) compounds / substances} (1) 	<p>allow electric current</p> <p>allow <u>separates</u> ions</p> <p>reject decomposing elements for MP2</p>	(2)

Q14.

Question number	Answer	Additional guidance	Mark
(i)	<p>A description including</p> <ul style="list-style-type: none"> apply lighted splint (1) gas burns / (squeaky) pop (1) 	<p>allow flame / ignite gas</p> <p>ignore 'squeaky pop test' / glowing splint</p> <p>second mark is dependent on first</p>	(2)

Question number	Answer	Mark
(ii)	<p>B oxygen is the only correct answer</p> <p>A, C & D these gases are not produced in the electrolysis of sodium sulfate solution</p>	(1)

Question number	Answer	Additional guidance	Mark
(iii)	<ul style="list-style-type: none"> electrical energy / electricity (1) {decomposes / breaks down / splits} {electrolytes / (ionic) compounds / substances} (1) 	allow electric current allow separates ions reject decomposing elements for MP2	(2)

Q15.

Question Number	Answer	Mark
(i)	chlorine (1)	(1)

Question Number	Answer	Mark
(ii)	A description to include <ul style="list-style-type: none"> lighted splint / ignite gas (1) gas burns / (squeaky) pop (if air is present) (1) 	(2)

Q16.

Question Number	Answer	Additional guidance	Mark
(i)	A diagram of a workable apparatus showing a complete circuit including <ul style="list-style-type: none"> electrodes labelled in (copper sulfate) solution (1) {power supply / power pack / battery} connected (1) 	max 1 if circuit not complete allow labelling as 'electrodes' or 'anode' and 'cathode' or 'copper' ignore 'connected to mains' allow symbol for cell/battery even if wrong way round	(2) AO 1 2

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation linking the following point to a maximum of four</p> <ul style="list-style-type: none"> anode lost copper and cathode gained copper / reaction at cathode is reverse of reaction at anode / copper ions move into solution at anode AND copper ions move out of solution at cathode (1) <p>and any three from</p> <ul style="list-style-type: none"> at anode copper atoms become copper ions (1) and lose two electrons (1) OR (at anode) $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}$ (2) at cathode copper ions become copper atoms (1) and gain two electrons (1) OR (at cathode) $\text{Cu}^{2+} + 2\text{e} \rightarrow \text{Cu}$ (2) 	<p>ignore references to zinc, chlorine and zinc chloride</p> <p>allow copper atoms are oxidised (1)</p> <p>marking points independently</p> <p>allow copper ions are reduced (1)</p> <p>marking points independently</p> <p>penalise wrong use of atom / ion once only</p> <p>penalise wrong use of reduced / oxidised once only</p>	<p>(4)</p> <p>AO 2 1</p>

Q17.

Question Number	Answer	Additional guidance	Mark
(i)	<p>A diagram of a workable apparatus showing a complete circuit including</p> <ul style="list-style-type: none"> electrodes labelled in (copper sulfate) solution (1) {power supply / power pack / battery} connected (1) 	<p>max 1 if circuit not complete</p> <p>allow labelling as 'electrodes' or 'anode' and 'cathode' or 'copper'</p> <p>ignore 'connected to mains'</p> <p>allow symbol for cell/battery even if wrong way round</p>	<p>(2)</p> <p>AO 1 2</p>

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation linking the following point to a maximum of four</p> <ul style="list-style-type: none"> anode lost copper and cathode gained copper / reaction at cathode is reverse of reaction at anode / copper ions move into solution at anode AND copper ions move out of solution at cathode (1) <p>and any three from</p> <ul style="list-style-type: none"> at anode copper atoms become copper ions (1) and lose two electrons (1) OR (at anode) $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$ (2) at cathode copper ions become copper atoms (1) and gain two electrons (1) OR (at cathode) $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ (2) 	<p>ignore references to zinc, chlorine and zinc chloride</p> <p>allow copper atoms are oxidised (1)</p> <p>marking points independently</p> <p>allow copper ions are reduced (1)</p> <p>marking points independently</p> <p>penalise wrong use of atom / ion once only</p> <p>penalise wrong use of reduced / oxidised once only</p>	<p>(4)</p> <p>AO 2 1</p>

Q18.

Question Number	Answer	Mark
(i)	<p>C chlorine zinc</p> <p>The only correct answer is C</p> <p><i>A is not correct because oxygen cannot be produced by the electrolysis of this molten salt</i></p> <p><i>B is not correct because hydrogen cannot be produced by the electrolysis of this molten salt</i></p> <p><i>D is not correct because hydrogen and oxygen cannot be produced by the electrolysis of this molten salt</i></p>	<p>(1)</p> <p>AO 2 1</p>

Question Number	Answer	Mark
(ii)	<p>D it contains ions that can move</p> <p>The only correct answer is D</p> <p><i>A is not correct because molten zinc chloride does not contain molecules</i></p> <p><i>B is not correct because molten zinc chloride does not have a giant structure</i></p> <p><i>C is not correct because delocalised electrons are not present</i></p>	<p>(1)</p> <p>AO 1 1</p>

Q19.

Question Number	Answer	Mark
(i)	<p>C chlorine zinc</p> <p>The only correct answer is C</p> <p><i>A is not correct because oxygen cannot be produced by the electrolysis of this molten salt</i></p> <p><i>B is not correct because hydrogen cannot be produced by the electrolysis of this molten salt</i></p> <p><i>D is not correct because hydrogen and oxygen cannot be produced by the electrolysis of this molten salt</i></p>	<p>(1)</p> <p>AO 2 1</p>

Question Number	Answer	Mark
(ii)	<p>D it contains ions that can move</p> <p>The only correct answer is D</p> <p><i>A is not correct because molten zinc chloride does not contain molecules</i></p> <p><i>B is not correct because molten zinc chloride does not have a giant structure</i></p> <p><i>C is not correct because delocalised electrons are not present</i></p>	<p>(1)</p> <p>AO 1 1</p>

Q20.

Question Number	Answer	Acceptable answers	Mark
(i)	electrical (energy) / electricity / direct (electric) current		(1)

Question Number	Answer	Acceptable answers	Mark
(ii)	A description including <ul style="list-style-type: none"> {light / ignite} gas / lighted splint (1) gas burns / (squeaky) pop (if air is present) (1) 	reject glowing splint second mark conditional on first	(2)

Q21.

Question Number	Answer	Acceptable answers	Mark
(i)	electrical (energy) / electricity / direct (electric) current		(1)

Question Number	Answer	Acceptable answers	Mark
(ii)	A description including <ul style="list-style-type: none"> {light / ignite} gas / lighted splint (1) gas burns / (squeaky) pop (if air is present) (1) 	reject glowing splint second mark conditional on first	(2)

Q22.

Question Number		Indicative Content	Mark
QWC	*	<p>A description / explanation including some of the following points marks can be scored from diagrams incorrectly balanced equations can be used as evidence of reaction occurring but po not otherwise credited</p> <p>electrolysis process</p> <ul style="list-style-type: none"> ions move when current passed negative ions move to anode overall decomposition of water $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$ <p>Anode/ positive electrode</p> <ul style="list-style-type: none"> sulphate ions move to anode hydroxide ions move to anode hydroxide ions lose electrons/oxidation hydroxide ions form oxygen half equation: $4\text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^-$ half volume gas at this electrode oxygen test: glowing splint in gas relights <p>cathode/ negative electrode</p> <ul style="list-style-type: none"> sodium ions move to cathode hydrogen ions move to cathode hydrogen ions gain electrons / reduction hydrogen ions form hydrogen half equation: $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ double volume gas at this electrode hydrogen test: lit splint in gas burns/ pops hence double volume of hydrogen gas 	(6)
Level	0	No rewardable content	
1	1 - 2	<ul style="list-style-type: none"> a limited description e.g. states which ions go to which electrode the answer communicates ideas using simple language and uses limited scientific terminology spelling, punctuation and grammar are used with limited accuracy 	
2	3 - 4	<ul style="list-style-type: none"> a simple explanation e.g. explain formation of one product the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately spelling, punctuation and grammar are used with some accuracy 	
3	5 - 6	<ul style="list-style-type: none"> a detailed explanation e.g. explaining formation of BOTH products at electrodes the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately spelling, punctuation and grammar are used with few errors 	

Q23.

Question Number	Indicative Content	Mark
QWC *	<p>A description / explanation including some of the following points marks can be scored from diagrams incorrectly balanced equations can be used as evidence of reaction occurring but po not otherwise credited</p> <p>electrolysis process</p> <ul style="list-style-type: none"> • ions move when current passed • negative ions move to anode • overall decomposition of water • $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$ <p>Anode/ positive electrode</p> <ul style="list-style-type: none"> • sulphate ions move to anode • hydroxide ions move to anode • hydroxide ions lose electrons/oxidation • hydroxide ions form oxygen • half equation: $4\text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^-$ • half volume gas at this electrode • oxygen test: glowing splint in gas relights <p>cathode/ negative electrode</p> <ul style="list-style-type: none"> • sodium ions move to cathode • hydrogen ions move to cathode • hydrogen ions gain electrons / reduction • hydrogen ions form hydrogen • half equation: $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ • double volume gas at this electrode • hydrogen test: lit splint in gas burns/ pops • hence double volume of hydrogen gas 	(6)

Level	0	No rewardable content
1	1 - 2	<ul style="list-style-type: none"> a limited description e.g. states which ions go to which electrode the answer communicates ideas using simple language and uses limited scientific terminology spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	<ul style="list-style-type: none"> a simple explanation e.g. explain formation of one product the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately spelling, punctuation and grammar are used with some accuracy
3	5 - 6	<ul style="list-style-type: none"> a detailed explanation e.g. explaining formation of BOTH products at electrodes the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately spelling, punctuation and grammar are used with few errors

Q24.

Question Number	Answer	Acceptable answers	Mark
(a)	Cl ⁻ and OH ⁻	Reject if any other ions given Allow names / chloride and hydroxide	(1)

Question Number	Answer	Acceptable answers	Mark
(b)	D lead and bromine		(1)

Question Number	Answer	Acceptable answers	Mark
(c)	A explanation to include: oxidation is the loss of electrons (1) reduction is the gain of electrons (1)	oxidation is the gain of electrons AND reduction is the loss of electrons (1)	(2)

Question Number	Answer	Acceptable answers	Mark
(d)	<p>A explanation to include any two from:</p> <p>to put a layer of one metal onto another metal (1)</p> <p>change / improve the appearance (of metal objects) (1)</p> <p>improve the resistance to corrosion (of metal objects) (1)</p> <p>qualified reference to cost eg thin layer of expensive metal on cheaper metal (1)</p>	<p>allow to give shiny appearance / look nicer</p> <p>allow prevents corrosion ignore rusting unless linked to iron/steel</p>	(2)

Q25.

Question Number	Answer	Acceptable answers	Mark
(a)	Cl^- and OH^-	Reject if any other ions given Allow names / chloride and hydroxide	(1)
Question Number	Answer	Acceptable answers	Mark
(b)	D lead and bromine		(1)
Question Number	Answer	Acceptable answers	Mark
(c)	<p>A explanation to include:</p> <p>oxidation is the loss of electrons (1)</p> <p>reduction is the gain of electrons (1)</p>	<p>oxidation is the gain of electrons AND reduction is the loss of electrons (1)</p>	(2)

Question Number	Answer	Acceptable answers	Mark
(d)	<p>A explanation to include any two from:</p> <p>to put a layer of one metal onto another metal (1)</p> <p>change / improve the appearance (of metal objects) (1)</p> <p>improve the resistance to corrosion (of metal objects) (1)</p> <p>qualified reference to cost eg thin layer of expensive metal on cheaper metal (1)</p>	<p>allow to give shiny appearance / look nicer</p> <p>allow prevents corrosion ignore rusting unless linked to iron/steel</p>	(2)

Q26.

Question Number	Answer	Acceptable answers	Mark
(i)	cathode Reject anode		(1)

Question Number	Answer	Acceptable answers	Mark
(ii)	A description to include ANODE/IMPURE COPPER/ +VE ELECTRODE <ul style="list-style-type: none"> becomes smaller/ loses mass / loses copper / copper atoms form ions / copper is oxidised / copper (ions) enter solution (1) CATHODE/ PURE COPPER/ -VE ELECTRODE <ul style="list-style-type: none"> {red-brown/copper} deposit/ becomes larger / gains mass / gains copper / copper ions are reduced / copper (ions) from solution add to electrode (1) 	allow half equation allow half equation	(2)

Question Number	Answer	Acceptable answers	Mark
(iii)	D reduction		(1)

Question Number	Answer	Acceptable answers	Mark
(iv)	An explanation linking <u>ions</u> / cations / copper ions / anions / sulfate ions (1) (are free to) <u>move</u> (in solution) (1)	reject electrons / atoms / molecules ignore 'charged particles' allow flow 2 nd mark dependent on 1 st MP	(2)

Q27.

Question Number	Answer	Additional guidance	Mark
(i)	C neutral (1)		(1)
Question Number	Answer		Mark
(ii)	<p>An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark)</p> <ul style="list-style-type: none"> to react all the (nitric) acid in the solution (1) so that the calcium nitrate solution is pure (1) 		(2)
Question Number	Answer		Mark
(iii)	<p>$\text{CaCO}_3 + 2\text{HNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{H}_2\text{O} + \text{CO}_2$ (3)</p> <p>left hand side formulae (1) right hand side formulae (1) balancing correct formulae (1)</p>		(3)

Q29.

Question number	Answer	Mark
	<p>An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (3 marks):</p> <ul style="list-style-type: none"> hydrogen (H^+) and sodium (Na^+) ions attracted to cathode, hydroxide (OH^-) ions and sulfate (SO_4^{2-}) ions attracted to anode (1) because the ions are attracted to the oppositely charged electrode (1) 2 hydrogen ions/2 H^+ accept 2 e to form hydrogen molecule/H_2 (1) 4 hydroxide ions/4 OH^- lose 4 e to form oxygen molecule/O_2 (1) 	(4)

Q30.

Question Number	Answer	Mark
	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark) <ul style="list-style-type: none"> acid is diluted 10 times (1) causes increase in pH by 1 / pH of diluted solution is 2 (1) 	(2)

Q31.

Question number	Answer	Additional guidance	Mark
(i)	an explanation linking <ul style="list-style-type: none"> fully dissociates (1) to form {H⁺/hydrogen} ions (1) 	allow ionises/splits up	(2)

Question number	Answer	Mark
(ii)	3 / pH 3	(1)

Q32.

Question number	Answer	Additional guidance	Mark
(i)	an explanation linking <ul style="list-style-type: none"> fully dissociates (1) to form {H⁺/hydrogen} ions (1) 	allow ionises/splits up	(2)

Question number	Answer	Mark
(ii)	3 / pH 3	(1)

Q33.

Question Number	Answer	Mark
	<p>An explanation that combines identification - application of knowledge (2 marks) and reasoning/justification - application of understanding (2 marks)</p> <ul style="list-style-type: none">• hydrochloric acid is (almost) fully dissociated into ions (1)• ethanoic acid is only slightly dissociated into ions (1)• but the concentration of acid in the hydrochloric acid is lower (1)• so the concentration of hydrogen ions in the hydrochloric acid is lower (1)	(4)

Q34.

Question Number	Answer	Mark
	<p>An explanation that combines identification via a judgment (1 mark) to reach a conclusion via justification/reasoning (1 mark)</p> <ul style="list-style-type: none">• solution is alkaline (1)• excess hydroxide ions are present / sodium and hydroxide ions in solution / sodium hydroxide solution formed (1)	(2)

Q35.

Question Number	Answer	Mark
	<p>An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark):</p> <ul style="list-style-type: none">• sodium and chloride ions present (1)• these ions can move (in solution) (1)	(2)

Q36.

Question number	Answer	Additional guidance	Mark
(i)	<p>An explanation linking</p> <ul style="list-style-type: none"> • solution from titration contains an indicator (1) • therefore second solution used with no indicator / indicator would contaminate salt (1) 	<p>MP2 dependant on MP1</p> <p>allow original mixture was contaminated by indicator so doesn't form a pure salt (2)</p>	(2)

Question number	Answer	Additional guidance	Mark
(ii)	<p>final answer of 120% with or without working (2)</p> <p>OR</p> <p>$\frac{0.84}{0.70}$ (=1.2) (1)</p> <p>$\frac{0.84}{0.70} \times 100$ (=120(%)) (1)</p>	<p>allow any fraction x100 (1)</p>	(2)

Question number	Answer	Additional guidance	Mark
(iii)	<p>{the salt/solid/potassium chloride} was still wet/ not all of the water had been evaporated off</p>		(1)

Question number	Answer	Additional guidance	Mark
(iv)	final answer of 80.5 with or without working (4) OR total mass: $56 + 36.5 (=92.5) /$ $74.5 + 18 (=92.5) (1)$ $\frac{74.5}{92.5} (= 0.8054) (1)$ $\frac{74.5}{92.5} \times 100 (=80.540) (1)$ $= 80.5 (1)$	allow ECF throughout 92.5 seen (1) incorrect answer with working to 1 decimal place (1) 50.0/100.0 does not score MP4	(4)

Q37.

Question Number	Answer	Additional guidance	Mark
	$2\text{H}^+ + 2\text{e}^{(-)} \rightarrow \text{H}_2 /$ $2\text{H}^+ \rightarrow \text{H}_2 - 2\text{e}^{(-)} (2)$ species in correct place as shown above (1) balancing of correct species in correct place (1)	allow use of = or \rightleftharpoons in place of \rightarrow allow multiples reject h2 / h ₂ / H2 / H ²	(2) AO 1 1

Q38.

Question Number	Answer	Additional guidance	Mark
	$2\text{H}^+ + 2\text{e}^{(-)} \rightarrow \text{H}_2$ / $2\text{H}^+ \rightarrow \text{H}_2 - 2\text{e}^{(-)}$ (2) species in correct place as shown above (1) balancing of correct species in correct place (1)	allow use of = or \rightleftharpoons in place of \rightarrow allow multiples reject h2 / h ₂ / H2 / H ²	(2) AO 1 1

Q39.

Question number	Answer	Additional guidance	Mark
(i)	pH meter/ pH probe	ignore data logger alone reject litmus / phenolphthalein / universal indicator solution / pH paper	(1)

Question number	Answer	Additional guidance	Mark
(ii)	<ul style="list-style-type: none"> increases pH (1) until pH above 7 (1) and an explanation linking REACTION <ul style="list-style-type: none"> {magnesium hydroxide / base / alkali / OH⁻ ions} {reacts with / neutralises} {the acid / the H⁺ ions} IONS REMAINING <ul style="list-style-type: none"> so the hydrogen ions concentration is reduced / all hydrogen ions reacted / there is an excess of hydroxide ions (1) 	allow until pH = 7 ignore until neutral ignore there is an excess of magnesium hydroxide	(4)

Q40.

Question number	Answer	Additional guidance	Mark
(i)	pH meter/ pH probe	ignore data logger alone reject litmus / phenolphthalein / universal indicator solution / pH paper	(1)

Question number	Answer	Additional guidance	Mark
(ii)	<ul style="list-style-type: none"> increases pH (1) until pH above 7 (1) and an explanation linking REACTION <ul style="list-style-type: none"> {magnesium hydroxide / base / alkali / OH⁻ ions} {reacts with / neutralises} {the acid / the H⁺ ions} IONS REMAINING <ul style="list-style-type: none"> so the hydrogen ions concentration is reduced / all hydrogen ions reacted / there is an excess of hydroxide ions (1) 	allow until pH = 7 ignore until neutral ignore there is an excess of magnesium hydroxide	(4)

Q41.

Question Number	Answer	Mark
	$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ (2) correct species (1) balancing of correct species (1)	(2)

Q42.

Question Number	Answer	Mark
	$2\text{H}^+ + 2\text{e} \rightarrow \text{H}_2$ (2) correct species (1) balancing of correct species (1)	(2)

Q43.

Question Number	Answer	Additional guidance	Mark
	pH {increases / goes up} by <u>one</u> / moves <u>1</u> closer to neutral	ignore {increases / goes up} alone	(1) AO 1 1

Q44.

Question Number	Answer	Additional guidance	Mark
	pH {increases / goes up} by <u>one</u> / moves <u>1</u> closer to neutral	ignore {increases / goes up} alone	(1) AO 1 1

Q45.

Question number	Answer	Mark
	D	(1)

Q46.

Question number	Answer	Mark
	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): <ul style="list-style-type: none"> • J and K are electrolytes (1) • because their solutions conduct electricity and are decomposed (1) 	(2)

Q47.

Question number	Answer	Mark
	Any two of the following points. For the acid, use the same: <ul style="list-style-type: none"> • volume (1) • concentration (1) • temperature (1) 	(2)

Q48.

Question number	Answer	Mark
(i)	C	(1)

Question number	Answer	Mark
(ii)	C	(1)

Q49.

Question number	Answer	Mark												
	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>salt</th> <th>soluble</th> <th>insoluble</th> </tr> </thead> <tbody> <tr> <td>ammonium chloride</td> <td style="text-align: center;">✓</td> <td></td> </tr> <tr> <td>lithium sulfate</td> <td style="text-align: center;">✓</td> <td></td> </tr> <tr> <td>magnesium carbonate</td> <td></td> <td style="text-align: center;">✓</td> </tr> </tbody> </table> <ul style="list-style-type: none"> • All three correct (2) • Any two correct (1) 	salt	soluble	insoluble	ammonium chloride	✓		lithium sulfate	✓		magnesium carbonate		✓	(2)
salt	soluble	insoluble												
ammonium chloride	✓													
lithium sulfate	✓													
magnesium carbonate		✓												

Q50.

Question Number	Answer	Mark
	D calcium carbonate (1)	(1)

Q51.

Question Number	Answer	Mark
	An answer that combines knowledge (1 mark) and understanding (2 marks) to provide a logical description <ul style="list-style-type: none">• use of a pH (probe and) meter / suitable universal indicator paper (1)• (after each addition of calcium oxide) stir (1)• record pH after each addition (1)	(3)

Q52.

Question Number	Answer	Mark
	$H^+ + OH^- \rightarrow H_2O$ (2) left hand side (1) right hand side (1)	(2)

Q53.

Question Number	Answer	Mark
	{sodium/ potassium / ammonium} carbonate (solution) / any soluble sulfate (solution) / sulfuric acid	(1)

Q54.

Question Number	Answer	Additional guidance	Mark
	<p>A description to include</p> <ul style="list-style-type: none"> • filter (1) <p>and two in a logical order from</p> <ul style="list-style-type: none"> • crystallisation (1) • heat solution (to concentrate) (1) • allow to cool (1) • dry crystals between filter papers (1) 	<p>if filtration not first stage, ignore it and give maximum 2 marks</p> <p>allow description of filtration ignore filtration to obtain nickel sulfate (crystals)</p> <p>allow 'leave until water evaporates' / use of water bath / evaporate {water/the solution}</p> <p>allow leave {until crystals form / for a few hours / in a warm place / on a window sill}</p> <p>allow 'dry crystals in (warm) oven'</p> <p>if alternative methods of making nickel sulfate solution described, max 1 mark from last four marking points</p>	<p>(3)</p> <p>AO 2 2</p>

Q55.

Question Number	Answer	Additional guidance	Mark
	<p>A description to include</p> <ul style="list-style-type: none"> • filter (1) <p>and two in a logical order from</p> <ul style="list-style-type: none"> • crystallisation (1) • heat solution (to concentrate) (1) • allow to cool (1) • dry crystals between filter papers (1) 	<p>if filtration not first stage, ignore it and give maximum 2 marks</p> <p>allow description of filtration ignore filtration to obtain nickel sulfate (crystals)</p> <p>allow 'leave until water evaporates' / use of water bath / evaporate {water/the solution}</p> <p>allow leave {until crystals form / for a few hours / in a warm place / on a window sill}</p> <p>allow 'dry crystals in (warm) oven'</p> <p>if alternative methods of making nickel sulfate solution described, max 1 mark from last four marking points</p>	<p>(3)</p> <p>AO 2 2</p>

Q56.

Question Number	Indicative content
	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;">AO2 (3 marks)</p> <ul style="list-style-type: none">• suitable acid: sulfuric acid• suitable substance : magnesium oxide / magnesium carbonate / magnesium hydroxide / magnesium• equation for reaction: $\text{MgO} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2\text{O}/$$\text{Mg}(\text{OH})_2 + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + 2\text{H}_2\text{O}/$$\text{MgCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2\text{O} + \text{CO}_2/$$\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$ <p style="text-align: center;">AO3 (3 marks)</p> <ul style="list-style-type: none">• add solid to warmed acid until in excess solid remains (oxide and hydroxide) / add solid a little at a time until no more bubbles (carbonate/metal)• filter off the excess solid, pour remaining solution into an evaporating basin• {heat solution / leave the water to evaporate}• until pure salt crystals form and then dry salt crystals with absorbent paper/leave to dry.

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	<ul style="list-style-type: none"> The plan attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2) Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	<ul style="list-style-type: none"> The explanation is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO2) Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5–6	<ul style="list-style-type: none"> The explanation is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO2) Analyses the scientific information and provide logical connections between scientific concepts throughout. A well-developed plan that synthesises relevant understanding coherently. (AO3)

Q57.

Question number	Answer	Mark
(i)	C	(1)

Question number	Answer	Mark
(ii)	C	(1)

Q58.

Question Number	Answer	Mark
(i)	chlorine (1)	(1)

Question Number	Answer	Mark
(ii)	A description to include <ul style="list-style-type: none"> • lighted splint / ignite gas (1) • gas burns / (squeaky) pop (if air is present) (1) 	(2)

Q59.

Question number	Answer	Additional Guidance	Mark
(i)	use <u>pH meter</u> / <u>pH probe</u> (1)	allow <u>pH paper</u> / <u>Universal indicator</u> reject other named indicators / 'just 'indicator'	(1)

Question number	Answer	Mark
(ii)	D ten times higher A is incorrect because a pH difference in 1 reflects a 10 fold difference in $[H^+]$ B is incorrect because a pH difference in 1 reflects a 10 fold difference in $[H^+]$ C is incorrect because a lower pH means a higher $[H^+]$	(1)

Q60.

Question number	Answer	Additional guidance	Mark
(i)	neutralisation OR exothermic	allow exothermic	(1)

Question number	Answer	Mark
(ii)	D ammonium nitrate is the only correct answer A is incorrect because the cation is ammonium and the anion is nitrate B is incorrect because the cation is ammonium C is incorrect because anion is nitrate	(1)

Q61.

Question number	Answer	Additional guidance	Mark
	Any TWO from <ul style="list-style-type: none"> • no more bubbles / fizzing (1) • no further change in colour (1) • {solid / copper carbonate} remains at bottom of flask / no more {solid / copper carbonate} dissolves (1) 	ignore references to pH allow cloudy/opaque liquid ignore no more copper carbonate will react	(2)

Q62.

Question number	Answer	Additional guidance	Mark
	Any TWO from <ul style="list-style-type: none"> no more bubbles / fizzing (1) no further change in colour (1) {solid / copper carbonate} remains at bottom of flask / no more {solid / copper carbonate} dissolves (1) 	ignore references to pH allow cloudy/opaque liquid ignore no more copper carbonate will react	(2)

Q63.

Question number	Answer	Additional Guidance	Mark
(i)	use <u>pH meter</u> / <u>pH probe</u> (1)	allow <u>pH paper</u> / <u>Universal indicator</u> reject other named indicators / 'just 'indicator'	(1)

Question number	Answer	Mark
(ii)	D ten times higher A is incorrect because a pH difference in 1 reflects a 10 fold difference in $[H^+]$ B is incorrect because a pH difference in 1 reflects a 10 fold difference in $[H^+]$ C is incorrect because a lower pH means a higher $[H^+]$	(1)

Q64.

Question number	Answer	Additional guidance	Mark
(i)	(squeaky) pop / gas burns / water forms	allow explosion / bang / flame / fire / energy released ignore reaction occurs / ignites / set alight ignore references to splints (glowing or lit)	(1)
(ii)	A description to include <ul style="list-style-type: none"> <i>volumes going up:</i> (oxygen/ hydrogen/ gas) increase (with time) / volume (directly) proportional to time (1) <i>quantitative comparing hydrogen and oxygen:</i> (volume of) hydrogen double (volume of) oxygen / ORA / 2:1 ratio (1) 	allow hydrogen goes up by 4 (cm ³) each time / by 2 cm ³ per minute / equivalent for oxygen for MP1 explicit reference needed to a ratio and not just quoting 2 figures allow amount in place of volume throughout twice as much hydrogen produced as oxygen (1) rate of hydrogen production double that of oxygen (2)	(2)

Q65.

Question number	Answer	Additional guidance	Mark
(i)	(squeaky) pop / gas burns / water forms	allow explosion / bang / flame / fire / energy released ignore reaction occurs / ignites / set alight ignore references to splints (glowing or lit)	(1)

Question number	Answer	Mark	
(ii)	<p>A description to include</p> <ul style="list-style-type: none"> <i>volumes going up:</i> (oxygen/ hydrogen/ gas) increase (with time) / volume (directly) proportional to time (1) <i>quantitative comparing hydrogen and oxygen:</i> (volume of) hydrogen double (volume of) oxygen / ORA / 2:1 ratio (1) 	<p>allow hydrogen goes up by 4 (cm³) each time / by 2 cm³ per minute / equivalent for oxygen for MP1</p> <p>explicit reference needed to a ratio and not just quoting 2 figures</p> <p>allow amount in place of volume throughout</p> <p>allow twice as much hydrogen produced as oxygen (1)</p> <p>allow rate of hydrogen production double that of oxygen (2)</p>	(2)

Q66.

Question number	Answer	Mark
(i)	<p>An explanation that makes reference to: identification – knowledge (1 mark) and reasoning /justification – knowledge (1 mark):</p> <ul style="list-style-type: none"> a strong acid is completely ionised in solution/exists completely as ions (1) but a weak acid is only partly ionised/exists mainly as molecules with very few ions present (1) 	(2)
Question number	Answer	Mark
(ii)	hydroxide ions react with hydrogen ions and reduce the hydrogen ion concentration therefore increase pH (1)	(1)

Q67.

Question Number	Answer	Mark
	{sodium/ potassium / ammonium} carbonate (solution) / any soluble sulfate (solution) / sulfuric acid	(1)

Q68.

Question Number	Answer	Additional guidance	Mark
(i)	A description including <ul style="list-style-type: none"> • apply lighted splint (1) • (squeaky) pop (1) 	allow flame / ignite gas / fire ignore 'squeaky pop test' / glowing splint second mark is dependent on first	(2) AO 2 2

Question Number	Answer		Mark
(ii)	An explanation linking <ul style="list-style-type: none"> • loss of electron(s) (1) • two electrons (1) 	allow gains two electrons for 1 mark zero marks overall if sharing of electrons / gain or loss of protons / positive electrons marks can be awarded for suitably drawn diagram / half equation	(2) AO 1 1

Q69.

Question Number	Answer	Additional guidance	Mark
(i)	A description including <ul style="list-style-type: none"> • apply lighted splint (1) • (squeaky) pop (1) 	allow flame / ignite gas / fire ignore 'squeaky pop test' / glowing splint second mark is dependent on first	(2) AO 2 2

Question Number	Answer		Mark
(ii)	An explanation linking <ul style="list-style-type: none"> • loss of electron(s) (1) • two electrons (1) 	allow gains two electrons for 1 mark zero marks overall if sharing of electrons / gain or loss of protons / positive electrons marks can be awarded for suitably drawn diagram / half equation	(2) AO 1 1

Q70.

Question Number	Answer	Mark
	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark) <ul style="list-style-type: none"> • acid is diluted 10 times (1) • causes increase in pH by 1 / pH of diluted solution is 2 (1) 	(2)

Q71.

Question Number	Answer	Acceptable answers	Mark
(i)	A description linking <ul style="list-style-type: none"> • pipette (1) • one practical point eg draw liquid <u>up to line</u>/ use pipette filler/ rinse first / read at eye level (1) 	ignore burette etc for 1 st mpt if using measuring cylinder/ burette allow suitable practical point eg read at eye level/ add dropwise from burette near 25 cm ³ (1) ignore as 2 nd point: transfer liquid to flask / safety precautions	(2)

Question Number	Answer	Acceptable answers	Mark
(ii)	D 25.20 cm ³		(1)

Q72.

Question Number	Answer	Acceptable answers	Mark
(i)	A description linking <ul style="list-style-type: none"> • pipette (1) • one practical point eg draw liquid <u>up to line</u>/ use pipette filler/ rinse first / read at eye level (1) 	ignore burette etc for 1 st mpt if using measuring cylinder/ burette allow suitable practical point eg read at eye level/ add dropwise from burette near 25 cm ³ (1) ignore as 2 nd point: transfer liquid to flask / safety precautions	(2)

Question Number	Answer	Acceptable answers	Mark
(ii)	D 25.20 cm ³		(1)

Q73.

Question Number	Answer	Mark
	<p>An explanation that combines identification - application of knowledge (2 marks) and reasoning/justification - application of understanding (2 marks)</p> <ul style="list-style-type: none">• hydrochloric acid is (almost) fully dissociated into ions (1)• ethanoic acid is only slightly dissociated into ions (1)• but the concentration of acid in the hydrochloric acid is lower (1)• so the concentration of hydrogen ions in the hydrochloric acid is lower (1)	(4)

Q74.

Question Number	Answer	Mark
	<p>An explanation that combines identification via a judgment (1 mark) to reach a conclusion via justification/reasoning (1 mark)</p> <ul style="list-style-type: none">• solution is alkaline (1)• excess hydroxide ions are present / sodium and hydroxide ions in solution / sodium hydroxide solution formed (1)	(2)

Q75.

Question Number	Answer	Mark
	<p>An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark):</p> <ul style="list-style-type: none">• sodium and chloride ions present (1)• these ions can move (in solution) (1)	(2)

Q76.

Question number	Answer	Additional guidance	Mark
	$\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$ <ul style="list-style-type: none">• all formulae on correct side (2)• balancing (1)	Allow 3/4 formulae (1)	(3)

Q77.

Question number	Answer	Mark
	$\text{ZnO} + 2\text{HNO}_3 \rightarrow \text{Zn}(\text{NO}_3)_2 + 2\text{H}_2\text{O}$ <ul style="list-style-type: none">• zinc nitrate formula (1)• full, balanced equation (1)	(2)

Q78.

Question number	Answer	Mark
	$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ <ul style="list-style-type: none">• all species (1)• balancing (1)	(2)

Q79.

Question number	Answer	Additional guidance	Mark
	$\text{Zn}^{2+} + 2\text{e}^{(-)} \rightarrow \text{Zn}$ (2)	if not fully correct, allow 1 for $\text{Zn}^{2+} + (\text{any number}) \text{e}^{(-)} \rightarrow (\text{anything})$ allow ZN, zn allow multiples reverse reaction scores (0) ignore state symbols $\text{Zn}^{2+} \rightarrow \text{Zn} - 2\text{e}^{(-)}$ (0)	(2)

Q80.

Question number	Answer	Additional guidance	Mark
	$\text{Zn}^{2+} + 2\text{e}^{(-)} \rightarrow \text{Zn}$ (2)	if not fully correct, allow 1 for $\text{Zn}^{2+} + (\text{any number}) \text{e}^{(-)} \rightarrow (\text{anything})$ allow ZN, zn allow multiples reverse reaction scores (0) ignore state symbols $\text{Zn}^{2+} \rightarrow \text{Zn} - 2\text{e}^{(-)}$ (0)	(2)

Q81.

Question number	Answer	Additional guidance	Mark
	$\text{MgO} + 2\text{H}^{+} \rightarrow \text{Mg}^{2+} + \text{H}_2\text{O}$ LHS (1) RHS (1) balancing of correct formulae (1)	allow two marks for $\text{O}^{2-} + 2\text{H}^{+} \rightarrow \text{H}_2\text{O}$	(3)

Q82.

Question number	Answer	Additional guidance	Mark
	$\text{MgO} + 2\text{H}^+ \rightarrow \text{Mg}^{2+} + \text{H}_2\text{O}$ LHS (1) RHS (1) balancing of correct formulae (1)	allow two marks for $\text{O}^{2-} + 2\text{H}^+ \rightarrow \text{H}_2\text{O}$	(3)

Q83.

Question Number	Answer	Mark
	$\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$ (2) left hand side (1) right hand side (1)	(2)

Name: _____

Paper 1 Core Practical 2022 Exam

Date:

Time:

Total marks available:

Total marks achieved: _____

Mark Scheme

Q1.

	Answer	Acceptable answers	Mark
	yellow / orange / red (1)	Combinations of yellow/orange/red pink	(1)

Q2.

	Answer	Acceptable answers	Mark
	yellow / orange / red (1)	Combinations of yellow/orange/red pink	(1)

Q3.

Question Number	Answer	Mark
(i)	hydrochloric acid	(1)

Question Number	Answer	Mark
(ii)	C pink-red	(1)

Q4.

Question Number	Answer	Mark
	<p>Any two linked explanations</p> <p>Any two suitable precautions to make use of pipette or burette as accurate as possible or to carry out the titration as accurate as possible (1) linked explanation (1)</p> <p>e.g.</p> <p>read bottom of the meniscus on the burette/pipette scale / read burette/pipette at eye-level (1) to obtain accurate volume of sodium hydroxide solution / sulfuric acid added (1)</p> <p>add {solution from burette / alkali} one drop at a time near end point (1) to identify exactly when colour change of indicator takes place (1)</p> <p>use a white tile (1) to make it easier to see exactly when colour change of indicator takes place (1)</p> <p>make sure no air bubbles in burette or pipette when measuring volumes (1) so exact volumes are recorded (1)</p> <p>continually swirl flask (1) to ensure complete mixing of acid with alkali (1)</p> <p>wash inside of conical flask with a little deionised/distilled water (1) to wash reactants into reaction mixture (1)</p> <p>wash burette / pipette with appropriate solution before titration (1) to ensure burette / pipette is not contaminated (1)</p> <p>do not award marks for concordancy / reliability / changes of indicator</p>	<p>(4)</p> <p>AO 1 2</p>

Q5.

Question number	Answer	Mark
(a)	<p>any one precaution from:</p> <ul style="list-style-type: none"> • wear gloves to prevent contact with skin/safety (1) • spectacles to prevent contact with eyes (1) 	(1)

Question number	Answer	Additional guidance	Mark
(b)	1000 cm ³ contain $\frac{4.3 \times 1000}{250}$ (1) 1 dm ³ contains 17.1 (g dm ⁻³) (1)	Award full marks for correct numerical answer without working.	(2)
Question number	Answer	Additional guidance	Mark
(c)	2NaOH + H ₂ SO ₄ → Na ₂ SO ₄ + 2H ₂ O • correct formulae (1) • balancing (1)	Do not award 2 if incorrect balancing added.	(2)
Question number	Answer	Additional guidance	Mark
(d)	• {titration 1/27 cm ³ } should not be used because burette readings {not precise/not accurate/not read to 2 d.p.} (1) • {titration 4/25.80 cm ³ } should not be used because volume of used (25.80 cm ³) not concordant with other two (1)		(2)

Q6.

Question number	Answer	Additional guidance	Mark
(i)	ACID use measuring cylinder / pipette / burette (1) BASE balance / scales / weigh out amount (1)	must name apparatus ignore weigh the liquid allow use portion of known mass / use measured amount in g / specific mass given [from 0.1 to 10g] allow weight for mass	(2)
(ii)	START colourless END pink / magenta	both START and END required for mark ignore clear	(1)
(iii)	An explanation linking • {hydrogen ions / H ⁺ } {reacted / neutralised} (1) • {concentration falls/ fewer} H ⁺ / {concentration rises/ more} OH ⁻ (1)	allow H ⁺ + OH ⁻ H ₂ O (1) for MP1	(2)

Q7.

Question number	Answer	Additional guidance	Mark
(i)	ACID use measuring cylinder / pipette / burette (1) BASE balance / scales / weigh out amount (1)	must name apparatus ignore weigh the liquid allow use portion of known mass / use measured amount in g / specific mass given [from 0.1 to 10g] allow weight for mass	(2)
Question number	Answer	Additional guidance	Mark
(ii)	START colourless END pink / magenta	ignore clear	(1)
Question number	Answer	Additional guidance	Mark
(iii)	An explanation linking <ul style="list-style-type: none"> {hydrogen ions/ H⁺} {reacted / neutralised} (1) {concentration falls/ fewer} H⁺ / {concentration rises/ more} OH⁻ (1) 	allow H ⁺ + OH ⁻ → H ₂ O for MP1	(2)

Q8.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking <ul style="list-style-type: none"> stainless steel resistant to {corrosion/ rusting/ oxidation} / corrosion rate slower / does not react with {air/oxygen} and water neither rod would rust/ react (in a few days) / there would be no {rusting / reaction}/ no change would occur / it would take a long time for any result (1) 	Ignore iron corrodes but ALLOW iron corrodes faster than stainless steel / iron rusts but stainless steel does not (1)	(2)
(ii)	measuring cylinder accurate enough / accuracy of pipette not needed / no need to be (more) accurate / the volume of water is not critical	allow exact/ precise for accurate allow pipettes only used for accurate/ precise/ exact volumes	(1)
(iii)	An explanation linking <ul style="list-style-type: none"> (A) the magnesium has {corroded/ reacted/ oxidised} / (B) {rusting / corrosion / oxidation} has occurred (1) because magnesium is more reactive than iron / (magnesium has reacted) instead of the iron (1) 	MP1 describes reaction that occurs MP2 reason – ignore 'sacrificial protection' etc.	(2)

Q9.

Question Number	Answer	Acceptable answers	Mark
(a)	$\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$ M1 correct formulae on LHS and RHS (1) M2 correctly balanced (1)	In M1 do not allow incorrect use of upper/lower case/subscripts but M2 can be awarded for correct balancing dependent on M1 being awarded (but note special case above) accept multiples	(2)

Question Number	Answer	Acceptable answers	Mark
(b)	<p>M1 shared pair of electrons between one H and one Cl (1)</p> <p>M2 remaining outer electrons correct (1)</p>	<p>Accept all permutations of dots and crosses for electrons If any indication of ionic bonding including charges 0/2 symbols not required ignore incorrect symbols eg C/CL</p> <p>M2 dependent on M1 electrons do not need to be in pairs ignore inner shells electrons can be on/in ring or no ring</p>	(2)

Q10.

Question Number	Answer	Mark
	<p>An answer that combines knowledge (1 mark) and understanding (2 marks) to provide a logical description</p> <ul style="list-style-type: none"> • use of a pH (probe and) meter / suitable universal indicator paper (1) • (after each addition of calcium oxide) stir (1) • record pH after each addition (1) 	(3)

Q11.

Question Number	Answer	Additional guidance	Mark
	<p>23.65 with or without working scores 2</p> <p>OR</p> $\frac{23.60+23.70}{2} \text{ (1)}$ <p>= 23.65 (1)</p>	<p>allow 1 mark for all 3 averaged (24.35)</p>	<p>(2)</p> <p>AO 3 2a AO 3 2b</p>

Q12.

Question Number	Answer	Mark
	from pink / red to orange / yellow	(1) AO 1 2

Q13.

Question number	Indicative content	Mark
*	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>A01 (3 marks) A02 (3 marks)</p> <ul style="list-style-type: none"> • pipette to measure out the ammonia solution (25 cm³) • into a suitable container, e.g. conical flask • add few drops of methyl orange indicator • put flask on a white tile • fill burette with sulfuric acid solution • read level of liquid in burette • add acid from the burette • swirl flask gently / mix • add drop-wise near end-point • until {indicator just changes colour} • read level on burette • repeat experiment until concordant results owtte • mix the same volumes of sulfuric acid and ammonia solution (determined from the titration experiment) • but leaving out the indicator/methyl orange • pour solution into an evaporating dish • heat the solution to point of crystallisation • leave to cool • filter off crystals • leave to dry 	EXP (6)

Level	Mark	Descriptor
	0	<ul style="list-style-type: none">No awardable content
Level 1	1-2	<ul style="list-style-type: none">Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1)The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3-4	<ul style="list-style-type: none">Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1)The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5-6	<ul style="list-style-type: none">Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1)The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels
			Eg - At each level, as well as content, the scientific coherency of what is stated backed up by planning detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1-2	<u>Additional guidance</u> Describes at least two steps of any of the three stages in the preparation of the ammonium sulfate crystals	<u>Possible candidate responses</u> <ul style="list-style-type: none"> add sulfuric acid using a burette to ammonium solution use a pipette to measure out the ammonium solution and fill a burette with sulfuric acid mix correct volumes of sulfuric acid and ammonia solution together without indicator heat the ammonium solution until crystals start to form
Level 2	3-4	<u>Additional guidance</u> Describes at least two of the three stages in some detail, at least three steps, OR all three stages but lacking detail	<u>Possible candidate responses</u> <ul style="list-style-type: none"> use a pipette to measure out the ammonium solution into a conical flask add few drops of indicator, add acid from a burette to ammonia solution. Crystallise the ammonium sulfate solution. use a pipette to measure out the ammonium solution. Add sulfuric acid using a burette to ammonia solution. Mix correct volumes of sulfuric acid and ammonia solution together without indicator to produce ammonium sulfate solution. carry out a titration adding acid to ammonia to find amounts of acid and ammonia solution needed. Mix correct amounts of sulfuric acid and ammonia solution together without indicator. Crystallise the ammonium sulfate solution
Level 3	5-6	<u>Additional guidance</u> Describes all three stages in the preparation of the ammonium sulfate crystals in some detail to include without use of indicator (6 marks) OR two stages in detail to include repeating without indicator (5 marks)	<u>Possible candidate responses</u> <ul style="list-style-type: none"> use a pipette to measure out the ammonium solution into a conical flask. Add a few drops of indicator. Add acid from a burette to ammonia solution, swirling flask, until indicator just changes colour. Mix correct volumes of sulfuric acid and ammonia solution together without indicator to produce ammonium sulfate solution. Heat the ammonium sulfate solution until crystals start to form. Leave to cool and filter off crystals. use a pipette to measure out the ammonium solution into a conical flask. Add a few drops of indicator. Place flask on white tile. Fill a burette with sulfuric acid and read level on burette. Add acid to ammonia solution, swirling flask, until indicator just changes colour. Read level on burette. Use the results of titration, mixing the correct volumes of sulfuric acid and ammonia leaving out indicator.

Q14.

Question number	Indicative content
	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;">AO1 (6 marks)</p> <ul style="list-style-type: none">• rinse pipette with alkali and burette with acid• measure alkali using a pipette into suitable container e.g. flask/beaker and place flask on a white tile• add a few drops of indicator/suitable named indicator (eg methyl orange/phenolphthalein)• fill burette with acid and read volume of acid in burette• add acid from burette to the flask slowly swirling the flask until {indicator just changes colour/correct colour change for named indicator (eg methyl orange yellow to peach/orange, phenolphthalein pink to colourless)/solution is neutral}• read volume of acid in burette at end of titration• repeat experiment until concordant results• mix the same volume of alkali with the volume of acid determined from the titration but do not add indicator• pour solution into an evaporating basin then {heat solution/leave the water to evaporate} until pure salt crystals are left• dry crystals using absorbent paper

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	<ul style="list-style-type: none">• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1)• Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	<ul style="list-style-type: none">• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1)• Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	<ul style="list-style-type: none">• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1)• Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Q15.

Question Number	Answer	Acceptable answers	Mark
(a)	improves resistance to corrosion	ignore rusting	(1)

Question Number	Answer	Acceptable answers	Mark
(b)	<p>An explanation to include</p> <ul style="list-style-type: none"> • anode dissolves / half equation given / atoms lose electrons /copper becomes ions/copper (atoms) oxidised (1) • copper ions moving from anode to cathode (1) • copper plated on cathode / half equation given / ions gain electrons/copper ions reduced/copper ions form atoms (1) • {difference/0.2g} is impurities (1) <p>• would expect same decrease in mass (as increase) (1)</p>	<p>ignore references to mass increase of cathode and mass decrease of anode</p> <p>ignore 'impure copper (ions)' for the second marking point</p> <p>allow difference is metal around it eaten away/ impurities/sludge fallen to bottom of container /under anode (1) (there needs to be a reference to the difference in electrode masses for this point)</p>	(3)

Question Number	Answer	Acceptable answers	Mark
(c)	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^{(-)}$ (2) OR $\text{O}^{2-} \rightarrow \text{O} + 2\text{e}^{(-)}$ (1) $2\text{O} \rightarrow \text{O}_2$ (1)	Unbalanced equation (1)	(2)

Question Number		Indicative Content	Mark
QWC	* (d)	<p>A description including some of the following points</p> <ul style="list-style-type: none"> sodium chloride is melted and ions are free to move <p>at cathode</p> <ul style="list-style-type: none"> {sodium / positive} ions move to cathode (sodium) metal forms at cathode sodium ions gain electrons ... to form atoms this is reduction $\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$ <p>at anode</p> <ul style="list-style-type: none"> {chloride / negative} ions move to anode (chlorine) gas forms at anode chloride ions lose electrons ... to form atoms this is oxidation two chlorine atoms combine to form a chlorine molecule / share electrons $\text{Cl}^- \rightarrow \text{Cl} + \text{e}^- / 2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$ $2 \text{Cl} \rightarrow \text{Cl}_2$ 	(6)
Level	0	No rewardable content	
1	1 - 2	<ul style="list-style-type: none"> a limited description e.g. gives at least one relevant description or explanation the answer communicates ideas using simple language and uses limited scientific terminology spelling, punctuation and grammar are used with limited accuracy 	
2	3 - 4	<ul style="list-style-type: none"> a simple description e.g. for anode or cathode gives at least three descriptions or relevant explanations the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately spelling, punctuation and grammar are used with some accuracy 	
3	5 - 6	<ul style="list-style-type: none"> a detailed description e.g. for both anode and cathode gives a total of at least five descriptions or relevant explanations the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately spelling, punctuation and grammar are used with few errors 	

Q16.

Question Number	Answer	Acceptable answers	Mark
(a)	improves resistance to corrosion	ignore rusting	(1)

Question Number	Answer	Acceptable answers	Mark
(b)	<p>An explanation to include</p> <ul style="list-style-type: none"> • anode dissolves / half equation given / atoms lose electrons /copper becomes ions/copper (atoms) oxidised (1) • copper ions moving from anode to cathode (1) • copper plated on cathode / half equation given / ions gain electrons/copper ions reduced/copper ions form atoms (1) • {difference/0.2g} is impurities (1) <p>• would expect same decrease in mass (as increase) (1)</p>	<p>ignore references to mass increase of cathode and mass decrease of anode</p> <p>ignore 'impure copper (ions)' for the second marking point</p> <p>allow difference is metal around it eaten away/ impurities/sludge fallen to bottom of container /under anode (1) (there needs to be a reference to the difference in electrode masses for this point)</p>	(3)

Question Number	Answer	Acceptable answers	Mark
(c)	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^{(-)}$ (2) OR $\text{O}^{2-} \rightarrow \text{O} + 2\text{e}^{(-)}$ (1) $2\text{O} \rightarrow \text{O}_2$ (1)	Unbalanced equation (1)	(2)

Question Number		Indicative Content	Mark
QWC	* (d)	<p>A description including some of the following points</p> <ul style="list-style-type: none"> sodium chloride is melted and ions are free to move <p>at cathode</p> <ul style="list-style-type: none"> {sodium / positive} ions move to cathode (sodium) metal forms at cathode sodium ions gain electrons ... to form atoms this is reduction $\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$ <p>at anode</p> <ul style="list-style-type: none"> {chloride / negative} ions move to anode (chlorine) gas forms at anode chloride ions lose electrons ... to form atoms this is oxidation two chlorine atoms combine to form a chlorine molecule / share electrons $\text{Cl}^- \rightarrow \text{Cl} + \text{e}^- / 2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$ $2 \text{Cl} \rightarrow \text{Cl}_2$ 	(6)
Level	0	No rewardable content	
1	1 - 2	<ul style="list-style-type: none"> a limited description e.g. gives at least one relevant description or explanation the answer communicates ideas using simple language and uses limited scientific terminology spelling, punctuation and grammar are used with limited accuracy 	
2	3 - 4	<ul style="list-style-type: none"> a simple description e.g. for anode or cathode gives at least three descriptions or relevant explanations the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately spelling, punctuation and grammar are used with some accuracy 	
3	5 - 6	<ul style="list-style-type: none"> a detailed description e.g. for both anode and cathode gives a total of at least five descriptions or relevant explanations the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately spelling, punctuation and grammar are used with few errors 	

Q17.

	Answer	Acceptable answers	Mark
(a)	C oxidised		(1)
(b)	D preservative		(1)
(c)	yellow / orange / red (1)	Combinations of yellow/orange/red pink	(1)

(d)	(CH ₃ COOH +) NaOH (1) (→ CH ₃ COONa +) H ₂ O (1)	NaHO ignore attempts to balance	(2)
(e)	hydrogen	H ₂ ignore H	(1)
(f)(i)	ethanoic acid + ethanol → ethyl ethanoate + water (2)	correct spellings only left hand side (1) right hand side (1)	(2)
(f)(ii)	An explanation linking use (1) property (1) eg perfumes /cosmetics (1) pleasant smelling (1) other uses include flavourings / solvents	property dependent on use ignore 'sweet smelling' use – nail varnish remover property – acts as solvent for polyester: use – (polyester) to make clothing property – can be made into fibres	(2)

Q18.

	Answer	Acceptable answers	Mark
(a)	C oxidised		(1)
(b)	D preservative		(1)
(c)	yellow / orange / red (1)	Combinations of yellow/orange/red pink	(1)
(d)	(CH ₃ COOH +) NaOH (1) (→ CH ₃ COONa +) H ₂ O (1)	NaHO ignore attempts to balance	(2)
(e)	hydrogen	H ₂ ignore H	(1)
(f)(i)	ethanoic acid + ethanol → ethyl ethanoate + water (2)	correct spellings only left hand side (1) right hand side (1)	(2)
(f)(ii)	An explanation linking use (1) property (1) eg perfumes /cosmetics (1) pleasant smelling (1) other uses include flavourings / solvents	property dependent on use ignore 'sweet smelling' use – nail varnish remover property – acts as solvent for polyester: use – (polyester) to make clothing property – can be made into fibres	(2)

Q19.

Question number	Answer	Additional guidance	Mark
(i)	$25 \div 1000 \times 0.1 = 0.0025$ (1) $35 \div 1000 \times 0.075 = 0.002625$ (1) The acid is in excess (1)	Third mark only awarded as conclusion from calculated data.	(3)

Question number	Answer	Mark
(ii)	$\frac{36.20 + 36.30}{2} = 36.25$ (1)	(1)

Question number	Answer	Mark
(iii)	D	(1)

Q20.

Question Number	Answer	Mark
	An explanation that combines identification via a judgment (1 mark) to reach a conclusion via justification/reasoning (1 mark) <ul style="list-style-type: none"> • solution is alkaline (1) • excess hydroxide ions are present / sodium and hydroxide ions in solution / sodium hydroxide solution formed (1) 	(2)

Q21.

Question number	Answer	Additional guidance	Mark
(i)	pH meter/ pH probe	ignore data logger alone reject litmus / phenolphthalein / universal indicator solution / pH paper	(1)

Question number	Answer	Additional guidance	Mark
(ii)	<ul style="list-style-type: none"> increases pH (1) until pH above 7 (1) and an explanation linking REACTION <ul style="list-style-type: none"> {magnesium hydroxide / base / alkali / OH⁻ ions} {reacts with / neutralises} {the acid / the H⁺ ions} IONS REMAINING <ul style="list-style-type: none"> so the hydrogen ions concentration is reduced / all hydrogen ions reacted / there is an excess of hydroxide ions (1) 	allow until pH = 7 ignore until neutral ignore there is an excess of magnesium hydroxide	(4)

Q22.

Question number	Answer	Additional guidance	Mark
(i)	pH meter/ pH probe	ignore data logger alone reject litmus / phenolphthalein / universal indicator solution / pH paper	(1)

Question number	Answer	Additional guidance	Mark
(ii)	<ul style="list-style-type: none"> increases pH (1) until pH above 7 (1) and an explanation linking REACTION <ul style="list-style-type: none"> {magnesium hydroxide / base / alkali / OH⁻ ions} {reacts with / neutralises} {the acid / the H⁺ ions} IONS REMAINING <ul style="list-style-type: none"> so the hydrogen ions concentration is reduced / all hydrogen ions reacted / there is an excess of hydroxide ions (1) 	allow until pH = 7 ignore until neutral ignore there is an excess of magnesium hydroxide	(4)

Q23.

Question Number	Answer	Mark
(i)	hydrochloric acid	(1)

Question Number	Answer	Mark
(ii)	C pink-red	(1)

Q24.

		Indicative Content	Mark
QWC	*	A description / explanation including some of the following points anode <ul style="list-style-type: none"> the anode decreases in mass / size copper atoms 	(6)

		<p>form ions by losing electrons</p> <ul style="list-style-type: none"> • copper ions pass into electrolyte • oxidation takes place at the anode • (anode) sludge forms as • impurities are left behind / fall to the bottom (under electrode) <p>cathode</p> <ul style="list-style-type: none"> • the cathode increases in mass / size • copper ions gain electrons to form copper • pure copper deposits on the cathode • reduction takes place at the cathode • copper sulfate solution does not change in colour • no change in concentration of copper ions • copper ions in the electrolyte move toward the cathode 	
Level	0	No rewardable content	
1	1 - 2	<ul style="list-style-type: none"> • a limited description e.g. copper leaves the anode and deposits on the cathode. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy 	
2	3 - 4	<ul style="list-style-type: none"> • a simple description e.g. copper leaves the anode and deposits on the cathode and impurities fall to the bottom of the beaker. • the answer communicates ideas showing some evidence of clarity and 	

		<p>organisation and uses scientific terminology appropriately</p> <ul style="list-style-type: none"> spelling, punctuation and grammar are used with some accuracy
3	5 - 6	<ul style="list-style-type: none"> a detailed description and explanation e.g. copper atoms from the anode lose electrons to form copper ions; copper ions are attracted to the cathode where they gain electrons to form pure copper. the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately spelling, punctuation and grammar are used with few errors

Q25.

Question Number	Answer	Mark
	<p>An answer that combines knowledge (1 mark) and understanding (2 marks) to provide a logical description</p> <ul style="list-style-type: none"> use of a pH (probe and) meter / suitable universal indicator paper (1) (after each addition of calcium oxide) stir (1) record pH after each addition (1) 	(3)

Q26.

Question Number	Answer	Acceptable answers	Mark
(a)	D aq l		(1)

Question Number	Answer	acceptable answers	Mark
(b)	$\text{H}^+ + \text{OH}^- (1) \rightarrow \text{H}_2\text{O} (1)$	LHS (1) RHS (1) ignore state symbols, even if incorrect. allow inclusion of spectator ions, Na^+ and Cl^- , if shown on both sides for one mark max	(2)

Question Number	Answer	Acceptable answers	Mark
(c)(i)	suitable acid-base indicator eg methyl orange, phenolphthalein	litmus reject universal indicator allow recognisable phonetic spelling	(1)

Question Number	Answer	Acceptable answers	Mark
(c)(ii)	correct colour change for suitable indicator in 4(c)(i): methyl orange : yellow \rightarrow orange/pink/red phenolphthalein : magenta/pink \rightarrow colourless	litmus : blue \rightarrow red ignore clear	(1)

Question Number	Answer	Acceptable answers	Mark
(d)	rel mass NaOH = 23.0 + 16.0 + 1.00 (1) concentration = $\frac{20.0}{\text{formula mass}} \times 1 (1)$	(= 40.0) (1) 0.5 (mol dm ⁻³) without working (2)	(2)

Question Number	Answer	Acceptable answers	Mark
(e)	moles of NaOH = $\frac{25.0 \times 1.50}{1000}$ (1) (= 0.0375 moles) ratio 1 : 1 / moles NaOH = moles HCl (1) conc of HCl = $\frac{0.0375 \times 1000}{30.0}$ (1) (= 1.25 (mol dm ⁻³)) OR 25.0 x 1.50 = 30.0 x conc acid (2) conc of HCl = $\frac{25.0 \times 1.50}{30.0}$ (1) (=1.25 (mol dm ⁻³))	0.0375 (1) – without working shown conc of HCl = 1.25 (mol dm ⁻³)(3) without any working shown allow ecf conc = $\frac{30.0 \times 1.50}{25.0} = 1.80$ (2) (mol dm ⁻³) allow 0.00125 / 0.125 / 12.5 max 2	(3)

Q27.

Question Number	Answer	Acceptable answers	Mark
(a)	C preservative		(1)

Question Number	Answer	Acceptable answers	Mark
(b)	M1 named indicator (1) M2 correct colour (1) M2 dependent on M1	universal Indicator – yellow/orange/red methyl orange – red phenolphthalein – colourless (red/blue) litmus - red	(2)

Question Number	Answer	Acceptable answers	Mark
(c) (i)	oxygen (1)	O ₂ reject O	(1)

Question Number	Answer	Acceptable answers	Mark
(c)(ii)	hydrogen (1)	H ₂ reject H	(1)

Question Number	Answer	Acceptable answers	Mark
(c)(iii)	carbon dioxide (1)	CO ₂	(1)

Question Number	Answer	Acceptable answers	Mark
(d)	ethanoic acid + ethanol → ethyl ethanoate + water (2) left hand side (1) right hand side (1)	allow recognisable misspellings allow reactants and products in either order allow = for → allow correct formulae if formulae are used do not allow incorrect use of the subscripts / upper / lower case	(2)

Q28.

Question Number	Answer	Acceptable answers	Mark
(a)	C preservative		(1)

Question Number	Answer	Acceptable answers	Mark
(b)	M1 named indicator (1) M2 correct colour (1) M2 dependent on M1	universal Indicator – yellow/orange/red methyl orange – red phenolphthalein – colourless (red/blue) litmus - red	(2)

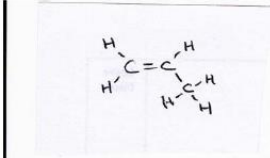
Question Number	Answer	Acceptable answers	Mark
(c) (i)	oxygen (1)	O ₂ reject O	(1)

Question Number	Answer	Acceptable answers	Mark
(c)(ii)	hydrogen (1)	H ₂ reject H	(1)

Question Number	Answer	Acceptable answers	Mark
(c)(iii)	carbon dioxide (1)	CO ₂	(1)

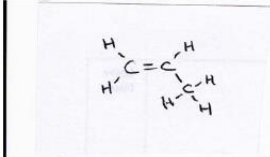
Question Number	Answer	Acceptable answers	Mark
(d)	ethanoic acid + ethanol → ethyl ethanoate + water (2) left hand side (1) right hand side (1)	allow recognisable misspellings allow reactants and products in either order allow = for → allow correct formulae if formulae are used do not allow incorrect use of the subscripts / upper / lower case	(2)

Q29.

	Answer	Acceptable answers	Mark
(a)(i)	D C ₄ H ₁₀		(1)
(a)(ii)	 <p>one C=C in a molecule with three consecutive carbon atoms (1) rest of structure correct, ignore bond angles, conditional on first marking point(1)</p>	allow -CH ₃ do not allow two C=C in a molecule allow (1) for completely correct dot and cross diagram	(2)
(b)	C oxidised		(1)
(c)(i)	A description including two from <ul style="list-style-type: none"> effervescence / fizzing / bubbles of gas (1) solid disappears/clears / (colourless) solution formed (1) 	ignore cloudy/white ppt / gas formed / colour change / name of gas / changes to a liquid (solid/sodium carbonate/it) dissolves (1)	(2)
(c)(ii)	CH ₃ COOC ₂ H ₅ /CH ₃ COOCH ₂ CH ₃ / CH ₃ CO ₂ C ₂ H ₅ / CH ₃ CO ₂ CH ₂ CH ₃ / C ₂ H ₅ O ₂ CCH ₃ / CH ₃ CH ₂ OOCCH ₃ (1) H ₂ O (1)	allow displayed formulae/ C ₄ H ₈ O ₂ do not allow formulae ending in – COOH/-COO or any formula that does not show an ester do not allow H ₂ O / H ² O / lower case h/HOH	(2)

		maximum (1) if additional incorrect balancing ignore state symbols	
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Q30.

	Answer	Acceptable answers	Mark
(a)(i)	D C ₄ H ₁₀		(1)
(a)(ii)	 <p>one C=C in a molecule with three consecutive carbon atoms (1) rest of structure correct, ignore bond angles, conditional on first marking point(1)</p>	<p>allow -CH₃</p> <p>do not allow two C=C in a molecule allow (1) for completely correct dot and cross diagram</p>	(2)
(b)	C oxidised		(1)
(c)(i)	<p>A description including two from</p> <ul style="list-style-type: none"> effervescence / fizzing / bubbles of gas (1) solid disappears/clears / (colourless) solution formed (1) 	<p>ignore cloudy/white ppt / gas formed / colour change / name of gas / changes to a liquid (solid/sodium carbonate/it) dissolves (1)</p>	(2)
(c)(ii)	<p>CH₃COOC₂H₅/CH₃COOCH₂CH₃ / CH₃CO₂C₂H₅ / CH₃CO₂CH₂CH₃ / C₂H₅O₂CCH₃ / CH₃CH₂OOCCH₃ (1) H₂O (1)</p>	<p>allow displayed formulae/ C₄H₈O₂ do not allow formulae ending in – COOH/COO or any formula that does not show an ester do not allow H₂O / H²O / lower case h/HOH maximum (1) if additional incorrect balancing ignore state symbols</p>	(2)

Q31.

Question Number	Answer	Additional guidance	Mark
(i)	phenolphthalein /methyl orange	allow litmus / screened methyl orange / methyl red ignore litmus paper ignore pH meter/probe	(1) AO 2 2

Question Number	Answer	Additional guidance	Mark
(ii)	it does not show sharp colour change at end point / not known which colour change gives correct end point	ignore goes through a series of gradual colour changes allow does not have a definite end point	(1) AO 3 1b

Q32.

Question Number	Indicative Content	Mark
QWC *	<p>A description including some of the following points</p> <p>Stage 1</p> <ul style="list-style-type: none">identifies pipettepipette / measuring cylinder to measure out the ammonia solution (25 cm³)into a suitable container, e.g. conical flask <p>Stage 2</p> <ul style="list-style-type: none">add few drops of indicator / suitable named indicatorput flask on a white tileidentifies burettefill burette with sulfuric acid solutionclamp burette / burette holder/standread level of buretteadd acid from the buretteswirl flask (gently)add drop-wise near end-pointuntil {indicator just changes colour / correct colour change for chosen indicator}read level on buretterepeat experiment until concordant results owtte <p>Stage 3</p> <ul style="list-style-type: none">mix the same volumes of sulfuric acid and ammonia solution (determined from the titration experiment)but leaving out the indicator <p>Stage 4</p> <ul style="list-style-type: none">pour into an evaporating dish{heat the solution / leave to evaporate} to dryness, until pure salt crystals formedto point of crystallisation/ concentrate solutionleave to coolfilter off crystalswash with waterleave to dry	(6)

Level	0	No rewardable content
1	1 - 2	<ul style="list-style-type: none"> a limited description e.g. limited description of one stage / add one solution to the other the answer communicates ideas using simple language and uses limited scientific terminology spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	<ul style="list-style-type: none"> a simple description e.g. one stage in detail / attempt to describe more than one stage the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately spelling, punctuation and grammar are used with some accuracy
3	5 - 6	<ul style="list-style-type: none"> a detailed description e.g. add sulphuric acid to ammonia using indicator appropriately, good detail of equipment and of titration technique and some mention of producing crystals / detail description of producing crystals with some mention of titration the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately spelling, punctuation and grammar are used with few errors

Q33.

	Answer	Acceptable answers	Mark
(i)	A description including two from <ul style="list-style-type: none"> effervescence / fizzing / bubbles of gas (1) solid disappears/clears / (colourless) solution formed (1) 	ignore cloudy/white ppt / gas formed / colour change / name of gas / changes to a liquid (solid/sodium carbonate/it) dissolves (1)	(2)
(ii)	$\text{CH}_3\text{COOC}_2\text{H}_5/\text{CH}_3\text{COOCH}_2\text{CH}_3/$ $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5/$ $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_3/$ $\text{C}_2\text{H}_5\text{O}_2\text{CCH}_3/$ $\text{CH}_3\text{CH}_2\text{OOCCH}_3$ (1) H_2O (1)	allow displayed formulae/ $\text{C}_4\text{H}_8\text{O}_2$ do not allow formulae ending in $-\text{COOH}/-\text{COO}$ or any formula that does not show an ester do not allow $\text{H}_2\text{O}/\text{H}^2\text{O}$ /lower case h/HOH maximum (1) if additional incorrect balancing ignore state symbols	(2)

Q34.

	Answer	Acceptable answers	Mark
(i)	A description including two from <ul style="list-style-type: none"> effervescence / fizzing / bubbles of gas (1) solid disappears/clears / (colourless) solution formed (1) 	ignore cloudy/white ppt / gas formed / colour change / name of gas / changes to a liquid (solid/sodium carbonate/it) dissolves (1)	(2)
(ii)	CH ₃ COOC ₂ H ₅ /CH ₃ COOCH ₂ CH ₃ / CH ₃ CO ₂ C ₂ H ₅ / CH ₃ CO ₂ CH ₂ CH ₃ / C ₂ H ₅ O ₂ CCH ₃ / CH ₃ CH ₂ OOCCH ₃ (1) H ₂ O (1)	allow displayed formulae/ C ₄ H ₈ O ₂ do not allow formulae ending in – COOH/-COO or any formula that does not show an ester do not allow H ₂ O / H ² O / lower case h/HOH maximum (1) if additional incorrect balancing ignore state symbols	(2)

Q35.

Question number	Answer	Additional Guidance	Mark
(i)	use <u>pH meter</u> / <u>pH probe</u> (1)	allow <u>pH paper</u> / <u>Universal indicator</u> reject other named indicators / 'just indicator'	(1)

Question number	Answer	Mark
(ii)	D ten times higher A is incorrect because a pH difference in 1 reflects a 10 fold difference in [H ⁺] B is incorrect because a pH difference in 1 reflects a 10 fold difference in [H ⁺] C is incorrect because a lower pH means a higher [H ⁺]	(1)

Q36.

Question number	Answer	Additional guidance	Mark
(i)	neutralisation OR exothermic	allow exothermic	(1)

Question number	Answer	Mark
(ii)	D ammonium nitrate is the only correct answer A is incorrect because the cation is ammonium and the anion is nitrate B is incorrect because the cation is ammonium C is incorrect because anion is nitrate	(1)

Q37.

Question number	Answer	Additional Guidance	Mark
(i)	use <u>pH meter/ pH probe</u> (1)	allow <u>pH paper / Universal indicator</u> reject other named indicators / 'just 'indicator'	(1)

Question number	Answer	Mark
(ii)	D ten times higher A is incorrect because a pH difference in 1 reflects a 10 fold difference in $[H^+]$ B is incorrect because a pH difference in 1 reflects a 10 fold difference in $[H^+]$ C is incorrect because a lower pH means a higher $[H^+]$	(1)

Q38.

Question number	Answer	Additional guidance	Mark
(i)	pH meter	allow universal indicator / pH paper ignore datalogger alone ignore pH scale / pH strip ignore indicator alone	(1)
Question number	Answer	Additional guidance	Mark
(ii)	7 / seven	allow pH7 / PH7	(1)

Q39.

Question number	Answer	Additional guidance	Mark
(i)	pH meter	allow universal indicator / pH paper ignore datalogger alone ignore pH scale / pH strip ignore indicator alone	1
Question number	Answer	Additional guidance	Mark
(ii)	7 / seven	allow pH7 / PH7	1

Q40.

Question Number	Answer	Mark
(i)	pipette	(1)
Question Number	Answer	Mark
(ii)	<ul style="list-style-type: none"> name of indicator: suitable indicator e.g. methyl orange / phenolphthalein (1) colour change: correct colour change of indicator eg yellow to orange / pink (magenta) to colourless (1) 	(2)

Question Number	Answer	Additional guidance	Mark
(iii)	<ul style="list-style-type: none"> swirl flask (1) add acid drop by drop near end point (1) 	allow any suitable practical technique that improves the accuracy	(2)

Q41.

		Indicative Content	Mark
QWC	*	<p>A description including some of the following points</p> <p>titration experiment</p> <ul style="list-style-type: none"> rinse pipette with alkali and burette with acid measure alkali using a pipette into suitable container e.g. flask/beaker add a few drops of indicator / suitable named indicator (eg methyl orange/phenolphthal ein) flask on a white tile fill burette with acid read level/volume (of acid) in burette add acid from burette to the flask slowly / swirl the flask until indicator just changes colour/correct colour change for named indicator (eg methyl orange yellow to peach/orange, phenolphthalein pink to colourless)/solution 	(6)

		<p>is neutral</p> <ul style="list-style-type: none"> • read level/volume (of acid) in burette • repeat experiment • until concordant results <p>salt preparation</p> <ul style="list-style-type: none"> • mix the same volume of alkali with the volume of acid determined from the first experiment but do not add indicator (or add (activated) charcoal to remove indicator, then filter) • pour solution into an evaporating basin • heat solution/leave the water to evaporate until pure salt crystals are left 	
Level	0	No rewardable content	
1	1 - 2	<ul style="list-style-type: none"> • a limited description of titration and/or salt preparation e.g. add hydrochloric acid to sodium hydroxide solution in a flask, then evaporate the water from solution. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy 	
2	3 - 4	<ul style="list-style-type: none"> • a simple description of titration and/or salt preparation e.g. pipette sodium hydroxide solution into flask, add indicator, place hydrochloric acid in burette, add acid to alkali until colour change. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy 	
3	5 - 6	<ul style="list-style-type: none"> • a detailed description including titration and salt preparation e.g. pipette 	

		<p>sodium hydroxide solution into flask, add indicator, hydrochloric acid in burette, add acid to alkali until colour change, repeat until concordant results, evaporate water.</p> <ul style="list-style-type: none"> the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately spelling, punctuation and grammar are used with few errors
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Q42.

	Answer	Acceptable answers	Mark
	Any one from <ul style="list-style-type: none"> no sharp/clear/distinct change in colour gradual colour change there are too many different colours 	ignore not as accurate/reliable allow too difficult to see when it is neutral/reaction is complete ignore speed of colour change	(1)

Q43.

Question Number	Answer	Additional guidance	Mark
(i)	A description including any two from : <ul style="list-style-type: none"> use a pipette filler (1) wash pipette with sodium hydroxide solution (1) draw the liquid up so (the bottom of the meniscus) touches the line (1) 		(2) AO 1 2

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation linking any two from : <ul style="list-style-type: none"> to remove water from the burette (1) because this would dilute the original acid (1) this will give an inaccurate result / ORA (1) 	ignore to avoid contamination ignore to kill bacteria	(2) AO 1 2

Q44.

Question Number	Answer	Acceptable answers	Mark
(i)	A description linking <ul style="list-style-type: none"> pipette (1) one practical point eg draw liquid <u>up to line</u>/ use pipette filler/ rinse first / read at eye level (1) 	ignore burette etc for 1 st mpt if using measuring cylinder/ burette allow suitable practical point eg read at eye level/ add dropwise from burette near 25 cm ³ (1) ignore as 2 nd point: transfer liquid to flask / safety precautions	(2)

Question Number	Answer	Acceptable answers	Mark
(ii)	D 25.20 cm ³		(1)

Q45.

	Answer	Acceptable answers	Mark
(a)	A neutralisation		(1)
(b)	Any one from <ul style="list-style-type: none"> no sharp/clear/distinct change in colour gradual colour change there are too 	ignore not as accurate/reliable allow too difficult to see when it is neutral/reaction is complete ignore speed of colour	(1)

	many different colours	change	
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		Indicative Content	Mark
QWC	*(c)	<p>A description including some of the following points</p> <p>titration experiment</p> <ul style="list-style-type: none"> • rinse pipette with alkali and burette with acid • measure alkali using a pipette • into suitable container e.g. flask/beaker • add a few drops of indicator / suitable named indicator (eg methyl orange/phenolphthal ein) • flask on a white tile • fill burette with acid • read level/volume (of acid) in burette • add acid from burette to the flask slowly / swirl the flask • until indicator just changes colour/correct colour change for named indicator (eg methyl orange yellow to peach/orange, phenolphthalein pink to colourless)/solution is neutral • read level/volume (of acid) in burette • repeat experiment • until concordant results <p>salt preparation</p>	(6)

		<ul style="list-style-type: none"> • mix the same volume of alkali with the volume of acid determined from the first experiment but do not add indicator (or add (activated) charcoal to remove indicator, then filter) • pour solution into an evaporating basin • heat solution/leave the water to evaporate until pure salt crystals are left 	
Level	0	No rewardable content	
1	1 - 2	<ul style="list-style-type: none"> • a limited description of titration and/or salt preparation e.g. add hydrochloric acid to sodium hydroxide solution in a flask, then evaporate the water from solution. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy 	
2	3 - 4	<ul style="list-style-type: none"> • a simple description of titration and/or salt preparation e.g. pipette sodium hydroxide solution into flask, add indicator, place hydrochloric acid in burette, add acid to alkali until colour change. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy 	
3	5 - 6	<ul style="list-style-type: none"> • a detailed description including titration and salt preparation e.g. pipette sodium hydroxide solution into flask, add indicator, hydrochloric acid in burette, add acid to alkali until colour change, repeat until concordant results, evaporate water. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors 	

	Answer	Acceptable answers	Mark
(d)(i)	$\frac{22.6 + 22.8}{2}$ (1) (= 22.7)		(1)
(d)(ii)	marks are for the working no. moles HCl = $\frac{23.2 \times 0.1}{1000}$ (1) (= 2.32×10^{-3}) no. moles NaOH = no. moles HCl (1) no. moles NaOH = no. moles HCl (1) conc NaOH = $\frac{2.32 \times 10^{-3} \times 1000}{25.0}$ (1) (= $0.0928 \text{ mol dm}^{-3}$) mark consequentially OR no. moles NaOH reacting = $\frac{1}{1}$ (1) no. moles HCl reacting $\frac{25.0 \times \text{conc}}{23.2 \times 0.1} = \frac{1}{1}$ (1) conc NaOH = $\frac{0.1 \times 23.2}{25.0}$ (1) (= $0.0928 \text{ mol dm}^{-3}$) OR use of $c_1V_1 = c_2V_2$ (1) $0.1 \times 23.2 = \text{conc} \times 25.0$ (1) conc NaOH = $\frac{0.1 \times 23.2}{25.0}$ (1) (= $0.0928 \text{ mol dm}^{-3}$)	0.0928/0.093 with or without working (3) 0.09 with no working (2) common incorrect answers with working 0.108/0.1077 (2) – used 1:1 ratio but $25 \times 0.1 / 23.2$ 0.928 (2) – used 1:1 ratio but missed out 0.1	(3)

Q46.

Question Number	Answer	Mark
	An explanation that combines identification via a judgment (1 mark) to reach a conclusion via justification/reasoning (1 mark) <ul style="list-style-type: none"> • solution is alkaline (1) • excess hydroxide ions are present / sodium and hydroxide ions in solution / sodium hydroxide solution formed (1) 	(2)

Q47.

Question number	Answer	Additional guidance	Mark
(i)	K, L, J, N, M		(1)

Question number	Answer	Additional guidance	Mark
(ii)	(volumetric) pipette	allow burette reject dropping pipette ignore balance	(1)

Q48.

Question number	Answer	Additional guidance	Mark
(i)	K, L, J, N, M		(1)

Question number	Answer	Additional guidance	Mark
(ii)	(volumetric) pipette	allow burette reject dropping pipette ignore balance	(1)

Name: _____

Topic 5 Chemistry 2022 Exam

Date:

Time:

Total marks available:

Total marks achieved: _____

Mark Scheme

Q1.

Question Number	Answer	Mark
	<p>Any two linked explanations</p> <p>Any two suitable precautions to make use of pipette or burette as accurate as possible or to carry out the titration as accurate as possible (1) linked explanation (1)</p> <p>e.g.</p> <p>read bottom of the meniscus on the burette/pipette scale / read burette/pipette at eye-level (1) to obtain accurate volume of sodium hydroxide solution / sulfuric acid added (1)</p> <p>add {solution from burette / alkali} one drop at a time near end point (1) to identify exactly when colour change of indicator takes place (1)</p> <p>use a white tile (1) to make it easier to see exactly when colour change of indicator takes place (1)</p> <p>make sure no air bubbles in burette or pipette when measuring volumes (1) so exact volumes are recorded (1)</p> <p>continually swirl flask (1) to ensure complete mixing of acid with alkali (1)</p> <p>wash inside of conical flask with a little deionised/distilled water (1) to wash reactants into reaction mixture (1)</p> <p>wash burette / pipette with appropriate solution before titration (1) to ensure burette / pipette is not contaminated (1)</p> <p>do not award marks for concordancy / reliability / changes of indicator</p>	<p>(4)</p> <p>AO 1 2</p>

Q2.

Question Number	Indicative content	Mark
*	<p>An explanation that combines identification via a judgment (3 marks) to reach a conclusion via justification/reasoning (3 marks)</p> <ul style="list-style-type: none"> raw materials: fermentation uses plants which can be regrown / hydration uses crude oil which is finite resource temperature: fermentation low therefore low energy cost / hydration high therefore high energy cost atom economy: fermentation lower / hydration of ethene 100% production rate: fermentation slow / hydration fast purification: fermentation needs energy for fractional distillation / hydration product pure carbon dioxide produced by fermentation could be useful product high pressure needed for hydration means more expensive plant 	(6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	<ul style="list-style-type: none"> Deconstructs scientific information but understanding and connections are flawed. An unbalanced or incomplete argument that provides limited synthesis of understanding. Judgements are supported by limited evidence. (AO3)
Level 2	3-4	<ul style="list-style-type: none"> Deconstructs scientific information and provides some logical connections between scientific concepts. An imbalanced argument that synthesises mostly relevant understanding, but not entirely coherently. Judgements are supported by evidence occasionally. (AO3)
Level 3	5-6	<ul style="list-style-type: none"> Deconstructs scientific information and provide logical connections between scientific concepts throughout. A balanced, well-developed argument that synthesises relevant understanding coherently. Judgements are supported by evidence throughout. (AO3)

Q3.

Question number	Answer	Additional guidance	Mark
(i)	<p>An explanation linking</p> <ul style="list-style-type: none"> stainless steel resistant to {corrosion/ rusting/ oxidation} / corrosion rate slower / does not react with {air/oxygen} and water neither rod would rust/ react (in a few days) / there would be no {rusting / reaction}/ no change would occur / it would take a long time for any result (1) 	<p>Ignore iron corrodes but ALLOW iron corrodes faster than stainless steel / iron rusts but stainless steel does not (1)</p>	(2)
(ii)	<p>measuring cylinder accurate enough / accuracy of pipette not needed / no need to be (more) accurate / the volume of water is not critical</p>	<p>allow exact/ precise for accurate allow pipettes only used for accurate/ precise/ exact volumes</p>	(1)
(iii)	<p>An explanation linking</p> <ul style="list-style-type: none"> (A) the magnesium has {corroded/ reacted/ oxidised} / (B) {rusting / corrosion / oxidation} has occurred (1) because magnesium is more reactive than iron / (magnesium has reacted) instead of the iron (1) 	<p>MP1 describes reaction that occurs</p> <p>MP2 reason – ignore 'sacrificial protection' etc.</p>	(2)

Q4.

Question Number	Answer	Additional guidance	Mark
	final answer of 90 with or without working (4) OR total mass : $2 \times 223 + 12 / (2 \times 207) + 44 (= 458)$ (1) mass of useful products : $2 \times 207 = 414$ $\frac{414}{458} (1) \times 100 (1) (= 90.39)$ $= 90 (1)$	allow ECF throughout 458 seen (1) 90.39 / 90.4 for 3 marks 110.628... / 111 (2) 110 (3) correct rounding of an answer with working to 2 sig fig (1)	(4) AO 2 1

Q5.

Question number	Answer	Additional guidance	Mark
	<ul style="list-style-type: none"> mass values in correct places (1) multiplication by 100 (1) correct final answer to two significant figures (1) 	$\frac{2.53}{2.85} \times 100 = 88.8\%$ 89% (to 2 s.f.) Award full marks for correct numerical answer without working.	(3)

Q6.

Question number	Answer	Additional guidance	Mark
	$8.000 - 6.213 = (1.787)$ (g)	allow 1.8, 1.79	(1)

Q7.

Question number	Answer	Additional guidance	Mark
	Formula mass ammonium chloride $= 14.0 + 4.00 + 35.5 = 53.5$ moles of ammonium chloride $= \frac{10.0}{53.5} = 0.187 \text{ (1)}$ volume ammonia $= 0.187 \times 24$ $= 4.49 \text{ dm}^3 \text{ (1)}$ or <ul style="list-style-type: none"> $2 \times 53.5 = 107 \text{ g}$ ammonium chloride produces $2 \times 24 = 48 \text{ dm}^3$ ammonia (1) 10.0 g ammonium chloride produces $\frac{10.0}{2 \times 53.5} \times 2 \times 24 = 4.49 \text{ dm}^3$ ammonia (1) 	Award full marks for correct numerical answer without working.	(2)

Q8.

Question number	Answer	Additional guidance	Mark
	2000 dm ³ with or without working scores 4 moles NO = 1000/30 (1) (= 33.3...) moles O ₂ = moles NO / 2 (1) (= 16.666...) volume O ₂ = moles x 24 = 16.666... x 24 (1) (=400 dm ³) volume air = volume O ₂ x 100/20 (1) (=2000 dm ³) OR 2 mol NO = 60 g (1) 60 g NO : 24 dm ³ oxygen (1) 1000 g NO reacts with 24 x 1000/60 (1) (=400 dm ³) volume air = volume O ₂ x 100/20 (1) (=2000 dm ³)	ecf on all stages 3 marks all working up to $400 \times 20/100 = 80$	(4)

Q9.

Question number	Answer	Additional guidance	Mark
(i)	97.3(%) with or without working scores 2 $\frac{5.450}{5.600} (1) \times 100$ $= 97.3214\dots$ $= 97.3(\%) (1)$	if fraction inverted then $\times 100 = 102.75\dots$ (3 or more sig fig) allow (1) for 0.973 allow (1) MP2 only for correctly $\times 100$ some figure derived from the data given allow any sig fig except 1	(2)

Question number	Answer	Mark
(ii)	A some solid was lost from the crucible is the only correct answer B is incorrect because this would increase mass C is incorrect because this would not alter mass D is incorrect because this would increase mass	(1)

Q10.

Question number	Answer	Additional guidance	Mark
(i)	100 with or without working scores 2 $40 + 12 + 3 \times 16 (1)$ $= 100 (1)$	ignore any units ecf for MP2 if using 12, 16 and 40, using addition and multiplication only	(2)
(ii)	56% without working scores 0 $\frac{56}{100} (1)$ $(\times 100) = 56 (\%) (1)$	56/answer to 4(d)(i) (1) $\times 100 (1)$ MP2 only for correctly $\times 100$ some figure derived from the data given 100% scores 0	(2)

Q11.

Question Number	Answer	Mark
	<ul style="list-style-type: none"> • $17.73/24.60$ (0.7207) (1) • $(17.73/24.60) \times 100$ (72.07) (1) • = 72.1% (1) 	(3)

Q12.

Question Number	Answer	Mark
	<p>amount of sodium hydroxide = $\frac{25.00 \times 0.50}{1000}$ (1)</p> <p>amount of hydrochloric acid = amount of sodium hydroxide (1) = $\frac{25.00 \times 0.50}{1000}$</p> <p>concentration of hydrochloric acid = $\frac{25.00 \times 0.50 \times 1000}{1000 \times 22.85}$ (1) = 0.547 (mol dm⁻³) (3 sf) (1)</p> <p>OR</p> <p>$25.00 \times 0.50 = \text{conc HCl} \times 22.85$ (2) $\text{conc HCl} = \frac{25.00 \times 0.50}{22.85}$ (1) = 0.547 (mol dm⁻³) (3 sf) (1)</p>	(4)

Q13.

Question Number	Answer	Mark
	<p>relative formula mass KOH = 39+16+1 (=56) (1)</p> <p>concentration = 0.625×56 (= 35 g dm⁻³) (1)</p>	(2)

Q14.

Question Number	Answer	Mark
	180 g glucose produces $2 \times 24 \text{ dm}^3$ carbon dioxide (1) 75 kg glucose produces $2 \times 24 \times \frac{75000}{180} \text{ dm}^3$ carbon dioxide (1) $= 20000 \text{ dm}^3$ (1)	(3)

Q15.

Question Number	Answer	Mark
	0.097 (mol dm^{-3}) with or without working (4) OR moles of NaOH = $\frac{24.25 \times 0.200}{1000}$ (1) (= 4.85×10^{-3}) from reaction equation moles acid = $\frac{1}{2} \times$ moles alkali $= \frac{1}{2} \times 4.85 \times 10^{-3}$ (1) $(= 2.425 \times 10^{-3})$ concentration of $\text{H}_2\text{SO}_4 = \frac{2.425 \times 10^{-3} \times 1000}{25.00}$ (1) $= 0.097$ (1) (mol dm^{-3}) OR $\frac{1}{2} (1) \times 24.25 \times 0.200 = 25.00 \times \text{conc H}_2\text{SO}_4$ (1) $\text{conc H}_2\text{SO}_4 = \frac{1}{2} \times \frac{24.25 \times 0.200}{25.00}$ (1) $= 0.097(1)$ (mol dm^{-3}) on answer line 0.388 / 0.39 (3) [$\times 2$ instead of $\times \frac{1}{2}$] 0.194 / 0.19 (3) [not $\times \frac{1}{2}$] Ignore sig figs except for 1	(4) AO 3 2a AO 3 2b

Q16.

Question Number	Answer	Mark
	from pink / red to orange / yellow	(1) AO 1 2

Q20.

Question Number	Answer	Mark
(i)	$2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$	(2) AO 3 1a AO 3 1b

Question Number	Answer	Additional guidance	Mark
(ii)	all <u>atoms</u> in the reactants are present in the product / only one product is formed	<p>allow no atoms are wasted (in the reaction) / no waste products / nothing is wasted</p> <p>allow total mass of reactants = mass of useful products</p> <p>allow complete calculation to show that atom economy is 100%</p> <p>ignore equation is balanced / same number of atoms on both sides</p>	(1) AO 1 1

Q21.

Question Number	Indicative content	Mark
	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <ul style="list-style-type: none">• equilibrium reached faster because of higher temperature in set A / equilibrium reached slower because of lower temperature in set B• higher temperature means more frequent collisions because molecules have more energy / ORA for lower temperature in set B• decrease in temperature increases equilibrium yield but system takes longer to reach equilibrium• temperature chosen for optimum conditions• yield lower as forward reaction is exothermic• high temperature favours back reaction which is endothermic• equilibrium reached faster because of higher pressure in set B / equilibrium reached slower because of lower pressure in set A • higher pressure causes molecules to be closer together so more frequent collisions / ORA for lower pressure in set A• yield higher because products occupy smaller volume than reactants for set B • catalyst in set B causes equilibrium to be reached faster• catalyst increases rate of both forward and back reactions• equilibrium position not affected so catalyst does not affect yield• catalyst reduces the need for the higher temperature	(6) AO 2 1 AO 3 1 AO 3 1

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	<ul style="list-style-type: none"> Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3–4	<ul style="list-style-type: none"> Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5–6	<ul style="list-style-type: none"> Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Q22.

Question number	Answer	Additional guidance	Mark
(i)	both are {soluble/will dissolve} (in water)		(1)

Question number	Answer	Additional guidance	Mark
(ii)	$\text{NH}_3 + \text{HNO}_3 \rightarrow \text{NH}_4\text{NO}_3$ LHS (1) RHS (1)	allow multiples	(2)

Question number	Answer		Mark
(iii)	<p>a similarity from :</p> <p>both use sulfuric acid (1)</p> <p>both (are examples of) neutralisation (1)</p> <p>and a difference from :</p> <p>the industrial process is on a much larger scale than the laboratory process / ORA (1)</p> <p>the industrial process involves more stages than the laboratory process / ORA (1)</p> <p>ammonia is a gas in the industrial process but a solution in the laboratory process (1)</p> <p>laboratory preparation uses titration and crystallisation (1)</p>	<p>ignore both produce ammonium sulfate</p> <p>allow both use same reactants</p> <p>allow both give out heat energy / exothermic (1)</p> <p>allow laboratory preparation is a batch process, industrial preparation is continuous process (1)</p> <p>ignore industrial is more dangerous</p>	(2)

Q23.

Question number	Answer	Additional guidance	Mark
(i)	$25 \div 1000 \times 0.1 = 0.0025$ (1) $35 \div 1000 \times 0.075 = 0.002625$ (1) The acid is in excess (1)	Third mark only awarded as conclusion from calculated data.	(3)
Question number	Answer		Mark
(ii)	$\frac{36.20 + 36.30}{2} = 36.25$ (1)		(1)

Question number	Answer	Mark
(iii)	D	(1)

Q24.

Question Number	Indicative content
	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;">AO1 (6 marks)</p> <p>The effect of the temperature rise on the rate of attainment of equilibrium and on the equilibrium yield are considered by:</p> <ul style="list-style-type: none">• higher temperature reaches equilibrium faster because molecules move faster• therefore there are more frequent collisions because molecules have more energy• therefore more collisions have required energy but yield will be lower• because higher temperature favours endothermic reaction and so equilibrium shifts to left hand side• which is decomposition of ammonia / ammonia reforms elements• catalyst causes reaction to reach equilibrium faster / catalyst increases rates (of both forward and back reactions)• lowers the activation energy (of both forward and back reactions) but does not affect yield• equilibrium position not affected.

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	<ul style="list-style-type: none"> • Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	<ul style="list-style-type: none"> • Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	<ul style="list-style-type: none"> • Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Q25.

Question number	Answer	Additional guidance	Mark
(i)	an explanation linking <ul style="list-style-type: none"> • shift equilibrium to right / in forward direction (1) • increase yield of {product / hydrogen / carbon monoxide} (1) 	allow favours forward/endothermic reaction ignore references to decreasing amounts of reactants. marks are independent	(2)

Question number	Answer	Additional guidance	Mark
(ii)	final answer of 2.4 with or without working (3) OR $\frac{0.4}{16} = 0.025$ (1) $0.025 \times 4 = 0.1$ (1) $0.1 \times 24 = 2.4$ (1)		(3)

Q26.

Question number	Answer	Mark
(i)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): <ul style="list-style-type: none">• rate increased/time to reach equilibrium reduced (1)• because gas molecules closer/more concentrated (1)• so increased collision rate/more frequent collisions(1)	(3)
Question number	Answer	Mark
(ii)	A	(1)

Q27.

Question number	Indicative content	Mark
*	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;">AO1 & AO2 (6 marks)</p> <p>EXCESS AIR</p> <ul style="list-style-type: none">• increases oxygen concentration• so excess air favours right hand side• and gives higher yield <ul style="list-style-type: none">• excess air increases concentration of oxygen• equilibrium reached faster <p>PRESSURE</p> <ul style="list-style-type: none">• 9 molecules on left and 10 on right• so higher pressure favours left hand side• and gives lower yield <ul style="list-style-type: none">• higher pressure increases concentration of gases• more frequent collisions• equilibrium reached faster <p>TEMPERATURE</p> <ul style="list-style-type: none">• heat energy given out in forward reaction• higher temperature favours reaction that takes in heat energy• so higher temperature favours left hand side• hence lower yield <ul style="list-style-type: none">• molecules move faster at higher temperature• more frequent collisions• therefore more reactions in given time• equilibrium reached faster	(6)

Level	Mark	Descriptor
	0	<ul style="list-style-type: none">No awardable content
Level 1	1-2	<ul style="list-style-type: none">Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1)The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3-4	<ul style="list-style-type: none">Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1)The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5-6	<ul style="list-style-type: none">Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1)The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Level	Mark	Descriptor	Additional guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1–2	<p><u>Additional guidance</u> One factor is discussed with a statement of effect on yield and/or rate (1)</p> <p>One factor is discussed with explanation of yield and/or rate (2)</p> <p>Two or three factors are discussed with statement of effect on yield and/or rate (2)</p>	<p><u>Possible candidate responses</u> A higher pressure gives a lower yield because there are more gas molecules on the right hand side. Factor and reason – 2 marks</p>
Level 2	3–4	<p><u>Additional guidance</u> One factor is fully discussed with explanation of yield and rate. (3)</p> <p>Two factors are discussed with explanation of yield and/or rate in one case and just statement of yield and/or rate in one case(3)</p> <p>Two factors are discussed with explanation of yield and/or rate in each case (4)</p> <p>Three factors are discussed with statement of effect on yield and/or rate with explanation for at least one (4)</p>	<p><u>Possible candidate responses</u> A higher pressure gives a lower yield because there are more gas molecules on the right hand side. A higher temperature gives a lower yield because the forward reaction is exothermic. 2 factors both with reasons – 4 marks</p>
Level 3	5–6	<p><u>Additional guidance</u> All three factors are discussed, with explanation of yield and/or rate in each case (6)</p> <p>All three factors are discussed, with explanation of yield and/or rate in two cases (5)</p>	<p><u>Possible candidate responses</u> Excess air gives a higher yield. A higher pressure gives a higher rate because the gas molecules are closer and collide more frequently. A higher temperature gives a higher rate because more molecules have the activation energy. 3 factors, 2 have reasons, 1 statement (air) – 5 marks</p>

Q28.

Question number	Answer	Additional guidance	Mark
(i)	<p>An explanation linking</p> <ul style="list-style-type: none"> • solution from titration contains an indicator (1) • therefore second solution used with no indicator / indicator would contaminate salt (1) 	<p>MP2 dependant on MP1</p> <p>allow original mixture was contaminated by indicator so doesn't form a pure salt (2)</p>	(2)

Question number	Answer	Additional guidance	Mark
(ii)	<p>final answer of 120% with or without working (2)</p> <p>OR</p> $\frac{0.84}{0.70} (=1.2) (1)$ $\frac{0.84}{0.70} \times 100 (=120\%) (1)$	<p>allow any fraction x100 (1)</p>	(2)

Question number	Answer	Additional guidance	Mark
(iii)	<p>{the salt/solid/potassium chloride} was still wet/ not all of the water had been evaporated off</p>		(1)

Question number	Answer	Additional guidance	Mark
(iv)	final answer of 80.5 with or without working (4) OR total mass: $56 + 36.5 (=92.5) /$ $74.5 + 18 (=92.5) (1)$ $\frac{74.5}{92.5} (= 0.8054) (1)$ $\frac{74.5}{92.5} \times 100 (=80.540) (1)$ $= 80.5 (1)$	allow ECF throughout 92.5 seen (1) incorrect answer with working to 1 decimal place (1) 50.0/100.0 does not score MP4	(4)

Q29.

Question Number	Answer	Acceptable answers	Mark
(i)	A 333 dm ³		(1)

Question Number	Answer	Acceptable answers	Mark
(ii)	An explanation linking <ul style="list-style-type: none"> • <u>all / three</u> gases present/<u>nitrogen, hydrogen and ammonia</u> (1) • ammonia decomposes/<u>ammonia</u> turns back to reactants/ reaction goes both ways / reversible (1) 	reject ammonium ignore incomplete reaction assume that "both reactions" refer to forward and backward reaction allow <u>dynamic</u> equilibrium	(2)

Question Number	Answer	Acceptable answers	Mark
(iii)	An explanation linking <ul style="list-style-type: none"> • increased / higher {yield / amount of ammonia} (1) • because fewer (gas) molecules/ moles on RHS/ 4 mole(cule)s on left and 2 on right/ decreased volume on RHS/equilibrium shifts to RHS/ equilibrium shifts in forward direction (1) 	mark independently ignore "high yield" reject answers referring to exothermic or endothermic ignore any references to rate	(2)

Question Number	Answer	Acceptable answers	Mark
(iv)	An explanation to include <ul style="list-style-type: none"> • <u>rate</u> increased/ time to reach equilibrium reduced (1) • because gas molecules closer / more concentrated (1) • so increased <u>collision rate</u> / more <u>collisions</u> <u>in a given time</u> / more <u>frequent collisions</u>(1) 	mark independently ignore any refs to equilibrium ignore 'time is faster'/ allow 'quicker' allow atoms/ particles instead of molecules; allow more molecules present (in same container) do not allow 'more collisions'	(3)

Question number	Answer	Mark	
(i)	D increases does not change A, B, C are incorrect because catalysts increase rate of attainment of equilibrium and do not change equilibrium yield	(1)	
Question number	Answer	Mark	
(ii)	C the amounts of nitrogen, hydrogen and ammonia become constant A, B, D are incorrect because when the reaction reaches equilibrium the amount of nitrogen, hydrogen and ammonia remain constant	(1)	
Question number	Answer	Additional guidance	Mark
(iii)	an explanation linking <ul style="list-style-type: none"> • equilibrium attained in a shorter period of time / rate of attainment of equilibrium {faster/ increases} (1) • equilibrium yield increases (1) • equilibrium shifts to the {right / forward / to products side} (1) • decrease in number of molecules (1) 	allow moves to fewer molecules	(4)

Q31.

Question number	Answer	Mark
	<ul style="list-style-type: none"> • volumes of solution too large for titration method (1) • large volumes of liquid need to be heated and then allowed to crystallise (1) 	(2)

Q32.

Question number	Answer	Mark
	<p>An explanation that combines identification – improvement of the experimental procedure (maximum 2 marks) and justification/reasoning, which must be linked to the improvement (maximum 2 marks):</p> <ul style="list-style-type: none"> • add excess sodium sulfate solution rather than a few drops (1) • so more reaction occurs to form more lead sulfate (1) • filter the reaction mixture rather than pour off the liquid(1) • so none of the lead sulfate is lost on separation(1) • wash the lead sulfate (1) • so the impurities are removed (1) • place the lead sulfate in an oven/warm place (1) • so the lead sulfate is dry (1) 	(4)

Q33.

Question Number	Answer	Additional guidance	Mark
(i)	<p>final answer of 65(%) with or without working (2)</p> <p>OR</p> <p>$\frac{7.67}{11.80}$ (= 0.65) (1)</p> <p>$\frac{7.67}{11.80} \times 100$ (=65(%)) (1)</p>	<p>allow any fraction x 100 (1)</p> <p>153.84.... scores 1</p>	<p>(2)</p> <p>AO 2 1</p>

Question Number	Answer	Additional guidance	Mark
(ii)	<p>any two from</p> <ul style="list-style-type: none"> • incomplete / reversible reactions • competing/unwanted/side reactions • practical losses during the experiment / loss on transfer from one piece of equipment to another 	<p>ignore</p> <p>gases formed / impure substances / losses through incompetence / products not used up</p>	<p>(2)</p> <p>AO 1 1</p>

Q34.

Question Number	Answer	Mark
	<p>An answer that combines three of the following points of application of knowledge and understanding to provide a logical description</p> <ul style="list-style-type: none"> • add some ammonia solution/ hydrochloric acid (to a beaker/flask) (1) • add an indicator (1) • add the other reagent until the indicator just changes colour (1) • repeat using same volumes but without indicator (to obtain pure solution) (1) 	(3)

Q35.

Question Number	Answer	Acceptable answers	Mark
	$\text{CaCl}_2 = 40 + 35.5 + 35.5$ (=111) (1) <p>THEN</p> moles = $11.1 / 111$ (= 0.1) (1) conc = moles x 1000/500 (=0.2) (1) <p>OR</p> mass conc = $11.1 \times 1000/500$ (=22.2) (1) conc = mass conc /111 (= 0.2) (1)	<u>0.2 scores 3</u> ecf: 11.1 / Mr ecf: mass conc / 111	(3)

Q36.

Question number	Answer	Mark
	equilibrium position/usefulness of by-products	(1)

Q37.

Question number	Answer	Additional guidance	Mark
(i)	Haber process (1)	accept phonetically correct spellings e.g Harber	(1)

Question number	Answer	Mark
(ii)	rate increased / speeded up / quicker / faster (1)	(1)
(iii)	yield unchanged/ stays same / none (1)	(1)

Q38.

Question number	Answer	Additional guidance	Mark
(i)	neutralisation OR exothermic	allow exothermic	(1)

Question number	Answer	Mark
(ii)	D ammonium nitrate is the only correct answer A is incorrect because the cation is ammonium and the anion is nitrate B is incorrect because the cation is ammonium C is incorrect because anion is nitrate	(1)

Q39.

Question Number	Answer	Mark
	<p>An explanation that combines identification - knowledge (1 mark) and reasoning/justification - understanding (2 marks)</p> <ul style="list-style-type: none"> • rate increased / time to reach equilibrium reduced (1) • (because) gas molecules closer together (1) • (so) increased collision rate / more frequent collisions (1) 	(3)

Q40.

Question Number	Answer	Acceptable answers	Mark
(i)	<p>A description linking</p> <ul style="list-style-type: none"> • pipette (1) • one practical point eg draw liquid <u>up to line</u>/ use pipette filler/ rinse first / read at eye level (1) 	<p>ignore burette etc for 1st mpt if using measuring cylinder/ burette allow suitable practical point eg read at eye level/ add dropwise from burette near 25 cm³ (1)</p> <p>ignore as 2nd point: transfer liquid to flask / safety precautions</p>	(2)

Question Number	Answer	Acceptable answers	Mark
(ii)	D 25.20 cm ³		(1)

Q41.

Question Number	Answer	Mark
(i)	pipette	(1)

Question Number	Answer	Mark
(ii)	<ul style="list-style-type: none"> name of indicator: suitable indicator e.g. methyl orange / phenolphthalein (1) colour change: correct colour change of indicator eg yellow to orange / pink (magenta) to colourless (1) 	(2)

Question Number	Answer	Additional guidance	Mark
(iii)	<ul style="list-style-type: none"> swirl flask (1) add acid drop by drop near end point (1) 	allow any suitable practical technique that improves the accuracy	(2)

Q42.

Question Number	Answer	Mark
	<p>B 750</p> <p>The only correct answer is B</p> <p><i>A is not correct because 375.5 dm³ is half the actual volume formed</i></p> <p><i>C is not correct because 1125.5 dm³ is one and a half times the actual volume formed</i></p> <p><i>D is not correct because 1500 dm³ is double the actual volume formed</i></p>	<p>(1)</p> <p>AO 2 1</p>

Q43.

Question number	Answer	Additional guidance	Mark
(i)	K, L, J, N, M		(1)

Question number	Answer	Additional guidance	Mark
(ii)	(volumetric) pipette	allow burette reject dropping pipette ignore balance	(1)

Name: _____

Topic 4 Chemistry 2022 Exam

Date:

Time:

Total marks available:

Total marks achieved: _____

Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
	$2\text{Al} + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2$ (2)	Al and H ₂ (1) balancing of correct species (1) allow multiples	(2) AO 2 1

Q2.

Question Number	Answer	Additional guidance	Mark
	$2\text{Al} + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2$ (2)	Al and H ₂ (1) balancing of correct species (1) allow multiples	(2) AO 2 1

Q3.

Question number	Answer	Additional guidance	Mark
(i)	14(.2) with or without working scores 3 1kg = 1000g (1) $\frac{142}{1000}$ (1) x 100% = 14(.2) (1)	If the percentage of non nickel compounds is calculated to give 85.8%/86% score 2 $\frac{142}{1000}$ or 0.142 will score MP1 and MP2 $\frac{142}{1} \times 100 = 14200$ scores (1)	(3)
(ii)	decontaminates ground / conserves {nickel / nickel ores / ores} / allows use of low-grade ore / specified environmental reason: e.g. less noise due to mining / carbon neutral / less carbon dioxide	Ignore any reference to cost/ better for environment etc. / time / energy	(1)

Q4.

Question number	Answer	Additional guidance	Mark
(i)	14(.2) with or without working scores 3 1kg = 1000g (1) $\frac{142}{1000}$ (1) $\times 100\% = 14(.2)$ (1)	If the percentage of non nickel compounds is calculated to give 85.8%/86% score 2 $\frac{142}{1000}$ or 0.142 will score MP1 and MP2 $\frac{142 \times 100}{1} = 14200$ scores (1)	(3)
Question number	Answer	Additional guidance	Mark
(ii)	decontaminates ground / conserves {nickel / nickel ores / ores} / allows use of low-grade ore / specified environmental reason: e.g. less noise due to mining / carbon neutral / less carbon dioxide	Ignore any reference to cost/ better for environment etc. / time / energy	(1) XP

Q5.

Question number	Answer	Additional guidance	Mark
	Any two from: <ul style="list-style-type: none"> • {(red-)brown / orange / pink} solid formed (1) • (some) {grey/silver} solid remains (1) • (blue solution) becomes colourless (1) 	Ignore substance names – descriptions are required allow {grey/silver} solid disappears / reduces / dissolves Answers that include fizzing/ effervescence/ bubbles in addition to correct response have max score of 1.	(2)

Q6.

Question number	Answer	Additional guidance	Mark
	Any two from: <ul style="list-style-type: none"> • {(red-)brown / orange / pink} solid formed (1) • (some) {grey/silver} solid remains (1) • (blue solution) becomes colourless (1) 	ignore substance names – descriptions are required allow {grey/silver} solid disappears / reduces / dissolves Answers that include fizzing/ effervescence/ bubbles in addition to correct response have max score of 1.	(2)

Q7.

Question number	Answer	Additional guidance	Mark
	An explanation linking <ul style="list-style-type: none"> • zinc oxidised (1) • because (zinc) lose electrons/ half equation (1) • copper (ions) reduced (1) • because copper (ions) gained electrons/ half equation (1) 	ignore copper sulfate is reduced ignore copper sulfate gains electrons marks are independent e.g zinc is reduced because it loses electrons = 1 zinc is oxidised because it gains electrons = 1 If no other mark scored allow one mark for oxidation is the loss of electrons and reduction is the gain of electrons	(4)

Q8.

Question number	Answer	Additional guidance	Mark
	An explanation linking <ul style="list-style-type: none"> zinc oxidised (1) because (zinc) lose electrons/ half equation (1) copper (ions) reduced (1) because copper (ions) gained electrons/ half equation (1) 	ignore copper sulfate is reduced ignore copper sulfate gains electrons marks are independent e.g zinc is reduced because it loses electrons = 1 zinc is oxidised because it gains electrons = 1 If no other mark scored allow one mark for oxidation is the loss of electrons and reduction is the gain of electrons	(4)

Q9.

Question Number	Answer	Additional guidance	Mark
	An explanation linking the following points <ul style="list-style-type: none"> aluminium is high in reactivity / aluminium oxide is (very) stable (1) aluminium (oxide) cannot be reduced by carbon (1) 	allow carbon is less reactive than aluminium / ORA / aluminium is very reactive ignore 'aluminium is more reactive' (alone) allow carbon cannot displace aluminium / aluminium oxide does not react with carbon ignore aluminium extracted by electrolysis	(2) AO 1 1

Q10.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation linking the following points</p> <ul style="list-style-type: none"> aluminium is high in reactivity / aluminium oxide is (very) stable (1) aluminium (oxide) cannot be reduced by carbon (1) 	<p>allow carbon is less reactive than aluminium / ORA / aluminium is very reactive ignore 'aluminium is more reactive' (alone)</p> <p>allow carbon cannot displace aluminium / aluminium oxide does not react with carbon</p> <p>ignore aluminium extracted by electrolysis</p>	<p>(2)</p> <p>AO 1 1</p>

Q11.

Question Number	Answer	Mark
(i)	<p>C iron oxide is reduced</p> <p>The only correct answer is C</p> <p><i>A is not correct because carbon gains oxygen</i></p> <p><i>B is not correct because it is not an acid-base reaction</i></p> <p><i>D is not correct because iron oxide loses oxygen</i></p>	<p>(1)</p> <p>AO 1 1</p>

Question Number	Answer	Additional guidance	Mark
(ii)	<p>final answer of 168 (tonnes) with or without working (3)</p> <p>OR</p> <p>relative formula mass $\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)$ (1)</p> <p>160 tonnes Fe_2O_3 produces $\{2 \times 56 / 112\}$ tonnes Fe (1)</p> <p>240 tonnes Fe_2O_3 produces $\frac{2 \times 56}{160} \times 240$ (1) = 168 (tonnes)</p> <p>OR</p> <p>relative formula mass $\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)$ (1)</p> <p>$\frac{240}{160}$ (1) = 1.5</p> <p>1.5×112 (1) = 168 (tonnes)</p> <p>OR</p> <p>relative formula mass $\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)$ (1)</p> <p>$\frac{112}{160}$ (1) = 0.7</p> <p>0.7×240 (1) = 168 (tonnes)</p>	<p>allow ECF throughout</p> <p>$M_r [\text{Fe}_2\text{O}_3] = 160$ seen without working (1)</p> <p>allow 320 tonnes : 224 tonnes (1)</p> <p>final answer 84 (tonnes) with or without working (2)</p> <p>Note : final answer 1.5 scores 2 overall</p>	<p>(3)</p> <p>AO 2 1</p>

Q12.

Question Number	Answer	Mark
(i)	<p>C iron oxide is reduced</p> <p>The only correct answer is C</p> <p><i>A is not correct because carbon gains oxygen</i></p> <p><i>B is not correct because it is not an acid-base reaction</i></p> <p><i>D is not correct because iron oxide loses oxygen</i></p>	<p>(1)</p> <p>AO 1 1</p>

Question Number	Answer	Additional guidance	Mark
(ii)	<p>final answer of 168 (tonnes) with or without working (3)</p> <p>OR</p> <p>relative formula mass $\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)$ (1)</p> <p>160 tonnes Fe_2O_3 produces $\{2 \times 56 / 112\}$ tonnes Fe (1)</p> <p>240 tonnes Fe_2O_3 produces $\frac{2 \times 56}{160} \times 240$ (1) = 168 (tonnes)</p> <p>OR</p> <p>relative formula mass $\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)$ (1)</p> <p>$\frac{240}{160}$ (1) = 1.5</p> <p>1.5 x 112 (1) = 168 (tonnes)</p> <p>OR</p> <p>relative formula mass $\text{Fe}_2\text{O}_3 = 2 \times 56 + 3 \times 16 (= 160)$ (1)</p> <p>$\frac{112}{160}$ (1) = 0.7</p> <p>0.7 x 240 (1) = 168 (tonnes)</p>	<p>allow ECF throughout</p> <p>$M_r [\text{Fe}_2\text{O}_3] = 160$ seen without working (1)</p> <p>allow 320 tonnes : 224 tonnes (1)</p> <p>final answer 84 (tonnes) with or without working (2)</p> <p>Note : final answer 1.5 scores 2 overall</p>	(3) AO 2 1

Q13.

Question Number	Answer	Acceptable answers	Mark
	$2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$ (3) lhs (1) rhs (1) balancing correct formulae (1)		(3)

Q14.

Question Number	Answer	Acceptable answers	Mark
	$2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$ (3) lhs (1) rhs (1) balancing correct formulae (1)		(3)

Q15.

Question Number	Answer	Acceptable answers	Mark
(a)	loss of oxygen	gain of electrons	(1)

Question Number	Answer	Acceptable answers	Mark
(b)	An explanation to include <ul style="list-style-type: none"> aluminium high in reactivity series / aluminium more reactive than {carbon / iron} (1) (aluminium reduction) needs more energy / electrolysis is {more / very} powerful (means of reduction) / carbon cannot displace aluminium (from aluminium oxide) (1) 	aluminium compounds are stable aluminium is more reactive ignore just 'very reactive'/highly reactive allow stronger (method of reduction)	(2)

Q16.

Question Number	Answer	Acceptable answers	Mark
(a)	loss of oxygen	gain of electrons	(1)

Question Number	Answer	Acceptable answers	Mark
(b)	An explanation to include <ul style="list-style-type: none"> aluminium high in reactivity series / aluminium more reactive than {carbon / iron} (1) (aluminium reduction) needs more energy / electrolysis is {more / very} powerful (means of reduction) / carbon cannot displace aluminium (from aluminium oxide) (1) 	aluminium compounds are stable aluminium is more reactive ignore just 'very reactive'/highly reactive allow stronger (method of reduction)	(2)

Q17.

Question Number	Answer	Additional guidance	Mark
	An explanation linking <ul style="list-style-type: none"> zinc corrodes {easier than / in preference to / OWTTE} iron / zinc reacts with air and water instead (1) zinc is more reactive than iron / zinc is sacrificial / zinc has a higher tendency to form ions (1) 	reject zinc rusts	(2) AO 1 1 AO 2 1

Q18.

Question number	Answer	Mark
(i)	electrolysis (1)	(1)

Question number	Answer	Mark
(ii)	<p>An answer that combines identification- knowledge (1 mark) and understanding (1 mark) and reasoning/justification- understanding (1 mark)</p> <ul style="list-style-type: none"> aluminium compounds are more stable than iron compounds (1) so carbon is not a strong enough reducing agent to produce aluminium from its ore (1) 	(2)

Q19.

Question number	Answer	Additional guidance	Mark
(i)	<p>D oxidation</p> <p>Answers A and B are physical processes rather than chemical reactions.</p> <p>C is wrong because it is not neutralisation.</p>		(1)

Question number	Answer	Additional guidance	Mark
(ii)	<p>A description linking any three from:</p> <ul style="list-style-type: none"> lift lid from time to time/ leave small gap between crucible and lid (1) find mass (of crucible, lid and product) (1) {repeat / heat} to constant mass (1) final mass – start mass = mass of oxygen (1) 	<p>allow 'weigh'</p> <p>allow find the change in mass</p>	(3)

Q20.

Question number	Answer	Additional guidance	Mark
(i)	<p>D oxidation</p> <p>Answers A and B are physical processes rather than chemical reactions.</p> <p>C is wrong because it is not neutralisation.</p>		(1)

Question number	Answer	Additional guidance	Mark
(ii)	<p>A description linking any three from:</p> <ul style="list-style-type: none"> lift lid from time to time/ leave small gap between crucible and lid (1) find mass (of crucible, lid and product) (1) {repeat / heat} to constant mass (1) final mass – start mass = mass of oxygen (1) 	<p>allow 'weigh'</p> <p>allow find the change in mass</p>	(3)

Q21.

Question Number	Answer	Mark
	electrolysis	(1) AO 3 2a

Q22.

Question Number	Answer	Mark
	electrolysis	(1) AO 3 2a

Q23.


Question Number	Answer	Additional guidance	Mark
	A description to include <ul style="list-style-type: none"> plants absorb {copper/metal} (ions) from the {soil/ores} / plants concentrate copper ions (1) plants (harvested and) burned (to leave copper/metal compound) (1) 	ignore plants absorb copper from solid metal ignore copper {atoms/metal/compounds} ignore plants heated mark independently	(2) AO 1 1

Q24.

Question Number	Answer	Additional guidance	Mark
	A description to include <ul style="list-style-type: none"> plants absorb {copper/metal} (ions) from the {soil/ores} / plants concentrate copper ions (1) plants (harvested and) burned (to leave copper/metal compound) (1) 	ignore plants absorb copper from solid metal ignore copper {atoms/metal/compounds} ignore plants heated mark independently	(2) AO 1 1


Q25.

Question Number	Answer	Additional guidance	Mark
(i)	P R Q S (2)	two in correct order (1)	(2) AO 3 2a AO 3 2b

Question Number	Answer		Mark
(ii)	<p>A workable diagram showing a method to measure the volume of the gas</p> <ul style="list-style-type: none"> • delivery tube between test-tube and (1) • gas syringe / (graduated tube / inverted burette / measuring cylinder) over water bath (1) 	<p>if diagram is not workable (eg no bung at top of test tube), max 1 mark</p> <p>allow connection shown as</p>  <p>if collection vessel not labelled, graduations must be shown for the second mark</p>	<p>(2)</p> <p>AO 3 3a AO 3 3b</p>

Q26.

Question Number	Answer	Additional guidance	Mark
(i)	P R Q S (2)	two in correct order (1)	<p>(2)</p> <p>AO 3 2a AO 3 2b</p>

Question Number	Answer		Mark
(ii)	<p>A workable diagram showing a method to measure the volume of the gas</p> <ul style="list-style-type: none"> • delivery tube between test-tube and (1) • gas syringe / (graduated tube / inverted burette / measuring cylinder) over water bath (1) 	<p>if diagram is not workable (eg no bung at top of test tube), max 1 mark</p> <p>allow connection shown as</p>  <p>if collection vessel not labelled, graduations must be shown for the second mark</p>	<p>(2)</p> <p>AO 3 3a AO 3 3b</p>

Q27.

Question number	Answer	Additional guidance	Mark
(i)	both form a hydroxide	allow formulae ignore observations	(1)

Question number	Answer	Additional guidance	Mark
(ii)	potassium {forms cations / loses (outer) electron} more easily ORA	ignore speed of electron loss / sizes of atoms / number of shells / distance of electrons from nucleus / number of electrons in outer shell	(1)

Q28.

Question number	Answer	Additional guidance	Mark
(i)	both form a hydroxide	allow formulae ignore observations	(1)

Question number	Answer	Additional guidance	Mark
(ii)	potassium {forms cations / loses (outer) electron} more easily ORA	ignore speed of electron loss / sizes of atoms / number of shells / distance of electrons from nucleus / number of electrons in outer shell	(1)

Q29.

Question number	Answer	Additional guidance	Mark
(i)	$2\text{NiS} + 3\text{O}_2 \rightarrow 2\text{NiO} + 2\text{SO}_2$ (2) all four formulae (1) balancing correct formulae only (1)	allow = for \rightarrow allow multiples if wrong subscript or misuse of capital/small letter e.g. O2, O ² , niO, NIS, allow MP1 but cannot score MP2 if more than 4 formulae, can score MP1 but not MP2 ignore state symbols	(2)

Question number	Answer	Mark
(ii)	B the metal produced by electrolysis is very pure is the only correct answer A is incorrect because this is a disadvantage C is incorrect because electrolysis is expensive D is incorrect because heating with carbon can be used	(1)

Q30.

Question number	Answer	Additional guidance	Mark
(i)	$2\text{NiS} + 3\text{O}_2 \rightarrow 2\text{NiO} + 2\text{SO}_2$ (2) all four formulae (1) balancing correct formulae only (1)	allow = for \rightarrow allow multiples if wrong subscript or misuse of capital/small letter e.g. O2, O ² , niO, NIS, allow MP1 but cannot score MP2 if more than 4 formulae, can score MP1 but not MP2 ignore state symbols	(2)

Question number	Answer	Mark
(ii)	B the metal produced by electrolysis is very pure is the only correct answer A is incorrect because this is a disadvantage C is incorrect because electrolysis is expensive D is incorrect because heating with carbon can be used	(1)

Name: _____

Chemistry Paper 1 Low Tariff Topics

Date:

Time:

Total marks available:

Total marks achieved: _____

Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
	$2\text{Al} + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2$ (2)	Al and H ₂ (1) balancing of correct species (1) allow multiples	(2) AO 2 1

Q2.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking <ul style="list-style-type: none"> stainless steel resistant to {corrosion/ rusting/ oxidation} / corrosion rate slower / does not react with {air/oxygen} and water neither rod would rust/ react (in a few days) / there would be no {rusting / reaction}/ no change would occur / it would take a long time for any result (1) 	Ignore iron corrodes but ALLOW iron corrodes faster than stainless steel / iron rusts but stainless steel does not (1)	(2)
(ii)	measuring cylinder accurate enough / accuracy of pipette not needed / no need to be (more) accurate / the volume of water is not critical	allow exact/ precise for accurate allow pipettes only used for accurate/ precise/ exact volumes	(1)
(iii)	An explanation linking <ul style="list-style-type: none"> (A) the magnesium has {corroded/ reacted/ oxidised} / (B) {rusting / corrosion / oxidation} has occurred (1) because magnesium is more reactive than iron / (magnesium has reacted) instead of the iron (1) 	MP1 describes reaction that occurs MP2 reason – ignore 'sacrificial protection' etc.	(2)

Q3.

Question Number	Answer	Additional guidance	Mark
(i)	C neutral (1)		(1)

Question Number	Answer	Mark
(ii)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark) <ul style="list-style-type: none">• to react all the (nitric) acid in the solution (1)• so that the calcium nitrate solution is pure (1)	(2)

Question Number	Answer	Mark
(iii)	$\text{CaCO}_3 + 2\text{HNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{H}_2\text{O} + \text{CO}_2$ (3) left hand side formulae (1) right hand side formulae (1) balancing correct formulae (1)	(3)

Q4.

Question number	Answer	Additional guidance	Mark
	mol of acid = $24.80 \div 1000 \times 0.200$ (= 0.004 96 mol) (1) mol NaOH = $2 \times 0.004 96$ (= 0.009 92) (1) conc. of NaOH = $0.009 92 \div 25.0 \times 1000$ (1) = 0.3968/0.397 (mol dm ⁻³) (1) or $(25.00 \times \text{conc NaOH}) \div 2 = 24.80 \times 0.200$ (2) conc NaOH = $2 \times 24.80 \times 0.200 \div 25.00$ (1) = 0.3968/0.397 (mol dm ⁻³) (1)	Award full marks for correct numerical answer without working. Allow max 3 marks if missing '2 ×' in step 2.	(4)

Q5.

Question number	Answer	Additional guidance	Mark
	proportion gold = $9 \div 24$ (= 0.375) (1) mass = $0.375 \times 12 = 4.5$ (g) (1)	Award full marks for correct numerical answer without working.	(2)

Q6.

Question Number	Answer	Mark
(i)	$2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$	(2) AO 3 1a AO 3 1b

Question Number	Answer	Additional guidance	Mark
(ii)	all <u>atoms</u> in the reactants are present in the product / only one product is formed	<p>allow no atoms are wasted (in the reaction) / no waste products / nothing is wasted</p> <p>allow total mass of reactants = mass of useful products</p> <p>allow complete calculation to show that atom economy is 100%</p> <p>ignore equation is balanced / same number of atoms on both sides</p>	(1) AO 1 1

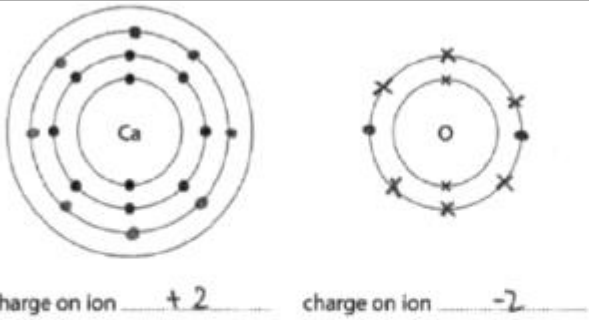
Q7.

Question number	Answer	Additional guidance	Mark
(i)	Left : H ₂ SO ₄ (1) Right : CuSO ₄ (1)	<p>reject superscript numbers</p> <p>reject superscript numbers</p> <p>incorrect balancing max 1</p>	(2)

Question number	Answer	Mark
(ii)	63.5 + 12 + 3x16 (1) = 123.5 (1)	(2)

Question number	Answer	Mark
(iii)	<p>A bubble the gas through limewater, limewater turns cloudy</p> <p>The only correct answer is A</p> <p>B is not correct because test shows only an acidic gas</p> <p>C is not correct because test shows only that the gas does not support combustion</p> <p>D is not correct because test shows only an acidic gas</p>	(1)

Q8.

Question number	Answer	Additional guidance	Mark
	 <p>charge on ion $+2$ charge on ion -2</p> <p>(3)</p> <ul style="list-style-type: none"> • correct dots for calcium ion (1) • correct 2 dots and 6 crosses for the oxide ion (1) • correct charges $2+/+2$ and $2-/-2$ (1) 	ignore arrows showing movement of electrons	(3) EXP

Q9.

Question number	Answer	Mark
	<p>D the metal is oxidised</p> <p>A is incorrect because the reaction is with oxygen</p> <p>B is incorrect because the reaction is with oxygen</p> <p>C is incorrect because the metal does not decompose</p>	(1)

Q10.

Question number	Indicative content	Additional guidance	Mark
	An answer that provides a description by making reference to: <ul style="list-style-type: none"> shared electrons (1) {a pair of / two} (electrons) (1) 	allow one electron from each allow more than one shared pair any idea of ionic bonding / ions = 0	(2)

Q11.

Question number	Answer	Additional guidance	Mark
	$\frac{2.24}{56.0} = 0.04$ and $\frac{0.96}{16.0} = 0.06$ (1) $1 : 1.5 / 2 : 3$ (1) Fe_2O_3 (1) $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$ (1)	allow ECF for MP2 and MP3 only. allow $\frac{2.24}{56.0} = 0.04$ and $\frac{0.96}{32.0} = 0.03$ (1) $1.33 : 1 / 4 : 3$ (1) Fe_2O_3 (1) $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$ (1) NOTE: equation alone gains no marks.	(4)

Q12.

Question number	Answer	Additional guidance	Mark
	final answer of 14 with or without working (3) OR $\frac{2.9}{5.0} = 0.58$ (1) $0.58 \times 100 = 58\%$ (1) 14 (1)	allow ECF allow 13.8-14.0	(3)

Q13.

Question number	Answer	Additional guidance	Mark
(i)	both are {soluble/will dissolve} (in water)		(1)

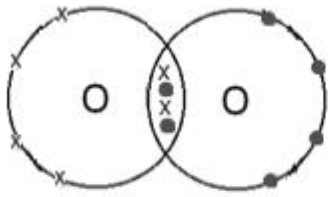
Question number	Answer	Additional guidance	Mark
(ii)	$\text{NH}_3 + \text{HNO}_3 \rightarrow \text{NH}_4\text{NO}_3$ LHS (1) RHS (1)	allow multiples	(2)

Question number	Answer		Mark
(iii)	<p>a similarity from :</p> <p>both use sulfuric acid (1)</p> <p>both (are examples of) neutralisation (1)</p> <p>and a difference from :</p> <p>the industrial process is on a much larger scale than the laboratory process / ORA (1)</p> <p>the industrial process involves more stages than the laboratory process / ORA (1)</p> <p>ammonia is a gas in the industrial process but a solution in the laboratory process (1)</p> <p>laboratory preparation uses titration and crystallisation (1)</p>	<p>ignore both produce ammonium sulfate</p> <p>allow both use same reactants</p> <p>allow both give out heat energy / exothermic (1)</p> <p>allow laboratory preparation is a batch process, industrial preparation is continuous process (1)</p> <p>ignore industrial is more dangerous</p>	(2)

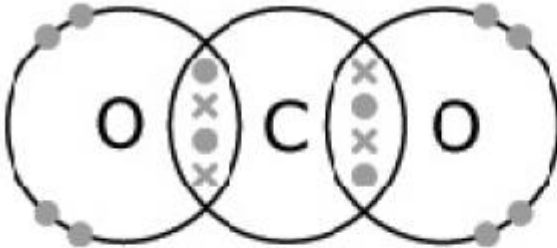
Q14.

Question number	Answer	Mark
(i)	B $\text{H} \times \overset{\cdot\cdot}{\underset{\cdot\cdot}{\text{S}}} \times \text{H}$	(1)
Question number	Answer	Mark
(ii)	C low low poor conductor	(1)

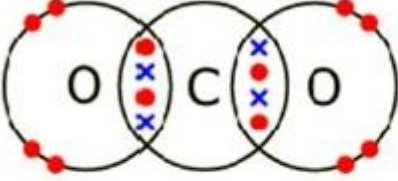
Q15.

Question Number	Answer	Additional guidance	Mark
	 <p>(2)</p>	double bond (1) rest of molecule (1) (dependent on correct double bond) ignore atomic symbol allow all x or ● ignore inner shells of electrons even if incorrect	(2) AO 1 1

Q16.

Question number	Answer	Additional guidance	Mark
	 <p>(2)</p> <p>or</p> <ul style="list-style-type: none"> • CO₂ with one correct double bond (1) • rest of structure correct (1) 	ignore any inner electrons shown remaining electrons on oxygen either singly or paired allow all dots or all crosses 2 nd mark dependent on 1st	(2)

Q17.

Question number	Answer	Additional guidance	Mark
(i)	 <ul style="list-style-type: none"> • {2 pairs of/four} electrons shared between an oxygen atom and the carbon atom (1) • rest of structure correct (1) 	ignore any inner electrons shown remaining electrons on oxygen either singly or paired allow all dots or all crosses 2 nd mark dependent on 1st	(2) EXP
Question number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to identification – knowledge (1 mark) and reasoning /justification – knowledge (1 mark): <ul style="list-style-type: none"> • diamond has a giant (covalent) structure / strong (covalent) bonds / each carbon atom is bonded to four other carbon atoms / all carbon atoms in diamond are bonded together (1) • large amount of (heat) energy is needed to {separate the carbon atoms / break the bonds / break up lattice} (1) 	reject ionic lattice reject layers reject bonds between molecules reject intermolecular forces being broken ignore just high heat mark independently	(2) GRAD

Q18.

Question Number	Answer	Acceptable answers	Mark
(a)	Cl ⁻ and OH ⁻	Reject if any other ions given Allow names / chloride and hydroxide	(1)
Question Number	Answer	Acceptable answers	Mark
(b)	D lead and bromine		(1)

Question Number	Answer	Acceptable answers	Mark
(c)	<p>A explanation to include:</p> <p>oxidation is the loss of electrons (1)</p> <p>reduction is the gain of electrons (1)</p>	<p>oxidation is the gain of electrons AND reduction is the loss of electrons (1)</p>	(2)

Question Number	Answer	Acceptable answers	Mark
(d)	<p>A explanation to include any two from:</p> <p>to put a layer of one metal onto another metal (1)</p> <p>change / improve the appearance (of metal objects) (1)</p> <p>improve the resistance to corrosion (of metal objects) (1)</p> <p>qualified reference to cost eg thin layer of expensive metal on cheaper metal (1)</p>	<p>allow to give shiny appearance / look nicer</p> <p>allow prevents corrosion ignore rusting unless linked to iron/steel</p>	(2)

Q19.

Question Number	Answer	Acceptable answers	Mark
(i)	A description including two of the following <ul style="list-style-type: none"> dissolve the sugar/aqueous solution (1) warm/ 25-40°C (1) in absence of air / no oxygen/ anaerobic / attach airlock (1) pH neutral / slightly acidic /4-7 sterile conditions ignore any mention of pressure	ignore incorrect answers ignore heat / hot allow any temperature or range within 25-40 allowed ignore clean etc ignore 'optimum' {temp/pressure/pH}	(2)

Question Number	Answer	Acceptable answers	Mark
(ii)	B fractional distillation		(1)

Question Number	Answer	Acceptable answers	Mark
(iii)	$\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2 \text{C}_2\text{H}_5\text{OH} + 2 \text{CO}_2$ (2) correct formulae (<u>with no others</u>) (1) balancing <u>the three</u> formulae (1) ignore state symbols	allow C ₂ H ₆ O/ CH ₃ CH ₂ OH for C ₂ H ₅ OH reject CO ₂ / CO ² allow multiples	(2)

Q20.

Question number	Answer	Mark
	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): <ul style="list-style-type: none"> aluminium and copper have different size atoms (1) and so this prevents the layers of metal atoms from sliding over one another (1) 	(2)

Q21.

Question number	Answer	Additional guidance	Mark
	An explanation linking <ul style="list-style-type: none"> (18 carat gold) contains atoms of different sizes/ORAs (1) disrupts structure of metal / prevents layers from {slipping / sliding /moving} over one another (1) 	reject molecules once allow particles/ions for atoms allow particles / atoms / sheets / rows for layers	(2)

Q22.

Question Number	Answer	Acceptable answers	Mark
	$2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$ (3) lhs (1) rhs (1) balancing correct formulae (1)		(3)

Q23.

Question Number	Answer	Additional guidance	Mark
	$2\text{H}^+ + 2\text{e}^{-} \rightarrow \text{H}_2$ / $2\text{H}^+ \rightarrow \text{H}_2 - 2\text{e}^{-}$ (2) species in correct place as shown above (1) balancing of correct species in correct place (1)	allow use of = or \rightleftharpoons in place of \rightarrow allow multiples reject h2 / h ₂ / H2 / H ²	(2) AO 1 1

Q24.

Question Number	Answer	Mark
	<ul style="list-style-type: none"> • Ca^{2+} (1) • NO_3^- (1) 	(2)

Q25.

Question Number	Answer	Additional guidance	Mark
	An explanation linking <ul style="list-style-type: none"> • zinc corrodes {easier than / in preference to / OWTTE} iron / zinc reacts with air and water instead (1) • zinc is more reactive than iron / zinc is sacrificial / zinc has a higher tendency to form ions (1) 	reject zinc rusts	(2) AO 1 1 AO 2 1

Q26.

Question number	Answer	Mark
	reactants are being used up (1)	(1)

Q27.

Question number	Answer	Additional guidance	Mark
(i)	any two from E, G and X	allow mark if all three given for E allow B / boron for G allow O / O ₂ / oxygen for X allow Ar / argon allow use of lower case letters reject answers with any other letters / element names	(1)
(ii)	any two from A, E and G	allow mark if all three given for A allow Li / lithium for E allow B / boron for G allow O / O ₂ / oxygen allow use of lower case letters reject answers with any other letters / element names	(1)
(iii)	A / J	allow mark if both given for A allow Li / lithium for J allow Na / sodium allow use of lower case letters reject answers with any other letters / element names reject answers with + or - charges	(1)

Q28.

Question Number	Answer	Mark
	An explanation that combines identification - knowledge (1 mark) and reasoning/justification - understanding (1 mark): <ul style="list-style-type: none"> • magnesium more reactive (than iron in steel) (1) • magnesium has a greater tendency to form ions/reacts instead of the iron (1) 	(2)

Q29.

Question number	Answer	Mark
(i)	C	(1)

Question number	Answer	Mark
(ii)	C	(1)

Q30.

Question number	Answer	Mark
	D SO_4^{2-}	(1) comp

Q31.

Question number	Answer	Mark
	D 12 protons, 12 neutrons, 10 electrons	(1) comp

Q32.

Question Number	Answer	Acceptable answers	Mark
(i)	A description linking <ul style="list-style-type: none"> • blue (1) • precipitate / solid (1) Marked independently. If further, incorrect observations given, use list principle	allow appropriate qualifiers: e.g. 'light blue' but not other colours eg green-blue allow ppt	(2)

Question Number	Answer	Acceptable answers	Mark
(ii)	$\text{Cu}^{2+} + 2\text{OH}^- \rightarrow \text{Cu}(\text{OH})_2$ (3) Identifies Cu^{2+} on LHS <u>and</u> $\text{Cu}(\text{OH})_2$ on RHS in equation format (1) OH^- formula on LHS (1) These two marks are independent and can be scored even if additional ions, correct or incorrect, are given balancing correct symbols (1) This mark is only awarded for a fully correct ionic equation with no additional ions	allow multiples accept $\text{Cu}^{2+}(\text{OH}^-)_2$ allow $\text{Cu}^{++}/\text{Cu}^{+2}$ reject incorrect symbols such as cu^{2+} , Oh^- etc. ignore: state symbols allow = instead of \rightarrow	(3)

Q33.

Question Number	Answer	Mark
	C oxidised	(1)

Q34.

Question Number	Answer	Mark
	<p>C yes high coloured</p> <p>The only correct answer is C</p> <p><i>A is not correct because transition metal chlorides are coloured</i></p> <p><i>B is not correct because all properties are incorrect</i></p> <p><i>D is not correct because transition metals are used as catalysts and have a high density</i></p>	<p>(1)</p> <p>AO 1 1</p>

Q35.

Question number	Answer	Additional guidance	Mark
	<p>Any two from:</p> <ul style="list-style-type: none"> improves the appearance/ shiny (1) improves resistance to corrosion/ does not corrode/ prevents reaction with {air/oxygen/water}/ prevents oxidation (1) can make e.g. 'gold' object more cheaply using a gold layer on a cheaper base / looks more expensive than it is (1) 	<p>allow does not rust ignore durable/ protects unqualified etc.</p> <p>ignore 'makes more valuable'</p>	(2)

Q36.

Question Number	Answer	Mark
(i)	<p>B -78 -33 does not conduct</p> <p>The only correct answer is B</p> <p><i>A is not correct because simple molecular, covalent substances do not have high mpt and bpt</i></p> <p><i>C is not correct because ammonia is a gas at room temperature and does not conduct</i></p> <p><i>D is not correct because simple molecular, covalent substances do not have these properties</i></p>	<p>(1)</p> <p>AO 2 1</p>

Question Number	Answer	Additional guidance	Mark
(ii)	<p>$N_2 + 3H_2 \rightarrow 2NH_3$ (2)</p> <p>left hand side formulae (1) balancing of correct formulae (1)</p>	<p>accept multiples allow = or \rightleftharpoons in place of \rightarrow ignore state symbols even if incorrect do not allow N2, n2, etc</p>	<p>(2)</p> <p>AO 2 1</p>

Q37.

Question number	Answer	Additional guidance	Mark
(i)	iron rusts/ corrodes/ reacts {with oxygen/ water} / iron oxidises / forms iron oxide	ignore erodes/ corrosive	(1)

Question number	Answer	Additional guidance	Mark
(ii)	platinum is a transition { <u>metal/ element</u> }	ignore 'in the middle' etc. ignore any irrelevant/ additional information	(1)

Q38.

Question Number	Answer	Additional guidance	Mark
(i)	A description including <ul style="list-style-type: none"> • apply lighted splint (1) • (squeaky) pop (1) 	allow flame / ignite gas / fire ignore 'squeaky pop test' / glowing splint second mark is dependent on first	(2) AO 2 2

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation linking <ul style="list-style-type: none"> • loss of electron(s) (1) • two electrons (1) 	allow gains two electrons for 1 mark zero marks overall if sharing of electrons / gain or loss of protons / positive electrons marks can be awarded for suitably drawn diagram / half equation	(2) AO 1 1

Q39.

Question number	Answer	Additional guidance	Mark
	An explanation linking <ul style="list-style-type: none"> • {less oxygen / no oxygen / oxygen is removed} by the hydrazine (1) • oxygen is needed for {rusting / reaction} / corrosion/so oxidation prevented (1) 	For MP1 allow 'oxygen reacts with hydrazine instead of the metal' (1) ignore hydrazine {displaces/ more reactive than} oxygen no oxygen so no rusting scores 2	(2)

Q40.

Question Number	Answer	Mark
	<p>An explanation that combines identification - application of knowledge (2 marks) and reasoning/justification - application of understanding (2 marks)</p> <ul style="list-style-type: none"> hydrochloric acid is (almost) fully dissociated into ions (1) ethanoic acid is only slightly dissociated into ions (1) but the concentration of acid in the hydrochloric acid is lower (1) so the concentration of hydrogen ions in the hydrochloric acid is lower (1) 	(4)

Q41.

Question number	Answer	Additional guidance	Mark
	$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ (2) fully correct balanced equation (2) If not (2), then H_2O as product in an equation format, regardless of any other errors (1)	Allow =, \rightleftharpoons for \rightarrow Ignore all words and state symbols Allow multiples reject formulae with charges Do not penalise small letters e.g allow h_2O If H_2O or H^2O in otherwise fully correct equation, allow (1)	(2)

Q42.

Question Number	Answer	Mark
	<p>An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark)</p> <ul style="list-style-type: none"> high density (1) (so that) Bunsen does not tip over (1) 	(2)

Q43.

Question number	Answer	Additional guidance	Mark
(i)	$2\text{NiS} + 3\text{O}_2 \rightarrow 2\text{NiO} + 2\text{SO}_2$ (2) all four formulae (1) balancing correct formulae only (1)	allow = for \rightarrow allow multiples if wrong subscript or misuse of capital/small letter e.g. O2, O ² , niO, NiS, allow MP1 but cannot score MP2 if more than 4 formulae, can score MP1 but not MP2 ignore state symbols	(2)

Question number	Answer	Mark
(ii)	B the metal produced by electrolysis is very pure is the only correct answer A is incorrect because this is a disadvantage C is incorrect because electrolysis is expensive D is incorrect because heating with carbon can be used	(1)

Q44.

Question number	Answer	Additional guidance	Mark
	Na ₂ SO ₄	allow SO ₄ Na ₂ allow upper case A ignore any charges on ions reject non-subscript 2 & 4	(1)

Q45.

Question number	Answer	Additional guidance	Mark
	$\text{Cu}^{2+} + 2 \text{OH}^- \rightarrow \text{Cu}(\text{OH})_2$ (2) $\text{OH}^- / \text{Cu}(\text{OH})_2$ (1) balancing of correct formulae (1)	allow reactants in any order ignore state symbols	(2) GRAD

Q46.

Question number	Answer	Additional guidance	Mark
	$\text{MgO} + 2\text{H}^+ \rightarrow \text{Mg}^{2+} + \text{H}_2\text{O}$ LHS (1) RHS (1) balancing of correct formulae (1)	allow two marks for $\text{O}^{2-} + 2\text{H}^+ \rightarrow \text{H}_2\text{O}$	(3)