OCR GCSE GATEWAY CHEMISTRY A · J248

CHEMISTRY



MARK SCHEME

C3.3 TYPES OF CHEMICAL REACTIONS

SCORE	PERCENTAGE
/224	%

STEMUP

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1</td><td></td><td></td><td>Hydrogen, chloride and sulfate are present (1)

Hydrogen ions because pH is 3 (1)

Sulfate because white precipitate with barium chloride (1)

Chloride because white precipitate with silver nitrate (1)</td><td>4</td><td>ALLOW H^+, Cl^- and SO_4^{2-}
ALLOW (1) for the three correct ions
ALLOW(1) for each correct explanation (must be linked to correct ion)</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
<tr><td>2</td><td>a</td><td></td><td>When one drop makes the litmus change colour (1)

Correct colour change blue to red (1)</td><td>2</td><td>ALLOW use a pH probe = 1 mark

ALLOW gives a pH value of 7 when neutral = 1 mark</td></tr>
<tr><td></td><td>b</td><td>i</td><td><table><tr><th>Titration number</th><th>1</th><th>2</th><th>3</th></tr><tr><td>final reading in cm^3</td><td>17.8</td><td>37.5</td><td>32.1</td></tr><tr><td>initial reading in cm^3</td><td>0.0</td><td>20.4</td><td>15.0</td></tr><tr><td>titre (volume of acid added) in cm^3</td><td>17.8</td><td>17.1</td><td>17.1</td></tr></table></td><td>2</td><td>Correct burette readings = 1 mark

Correct titre = 1 mark

DO NOT ALLOW 0</td></tr>
<tr><td></td><td></td><td>ii</td><td>Yes

Titration 1 is a rough estimate / titration 1 is an outlier / titrations 2 and 3 are identical (1)</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>5</td><td></td></tr>
<tr><td>3</td><td></td><td></td><td>Neutralisation (1)</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr><td>4</td><td></td><td></td><td>B</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr><td>5</td><td></td><td></td><td>B</td><td>1</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
			Total	1	
6			B	1	
			Total	1	
7	a		**Any four from:** idea that an excess of zinc oxide must be added (1) so reaction is complete / all nitric acid is reacted (1) filter off excess zinc oxide (1) evaporate off some of the water (1) allow to crystallise (1)	4	
	b		reaction between nitric acid (HNO_3), an acid and zinc oxide (ZnO), a base (1) to make zinc nitrate ($Zn(NO_3)_2$, a salt and water (only) (1)	2	Only award marks if reactions and products are named in the answer **ALLOW** the use of just chemical formulae
			Total	6	
8			The oxidising agent is **oxygen** and the reducing agent is **magnesium** (1)	1	
			Total	1	
9			$Ca + 2HCl \rightarrow CaCl_2 + H_2$	2	1 mark for both correct reactants 1 mark for both correct products
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
10	a		Mean titre = 17.1 (1) Because titration 1 is a rough estimate / titration 1 is an outlier / titrations 2 and 3 are identical (1)	2	**IGNORE** anything in the titration table
	b		Moles of acid = 0.00171 (1) Concentration of KOH = 0.0684 (1)	2	**ALLOW ECF** from incorrect titre / 0.100 × titre × 10^{-3} **ALLOW ECF** from incorrect moles providing answer is to 3 sig figs / moles÷volume
	c		M_r of KOH = 56.1 (1) Concentration of KOH = 3.84 (1)	2	**ALLOW** correct answer without working **ALLOW** 3.837 **ALLOW ECF** from incorrect M_r and / or incorrect concentration from (b) / M_r × conc
			Total	6	
11		i	Titrate ammonia against sulfuric acid to obtain volumes needed for complete neutralisation (1) Add these volumes without the use of indicator (1) Slow evaporation of reaction mixture / heat reaction mixture over a steam bath (1) Burette and other chemical apparatus not suitable for using large quantities / very difficult to use a steam bath in the large scale (1)	4	**ALLOW** heat neutral mixture with carbon or charcoal and then filter off carbon **ALLOW** Slow evaporation of filtrate / heat filtrate over a steam bath if method involving carbon is used
		ii	34 (g or tonnes) of ammonia makes 132.1 (g or tonnes) of ammonium sulfate / 17 (g or tonnes) of ammonia makes 66 (g or tonnes) of ammonium sulfate (1) So 51 tonnes makes 198.1 tonnes of ammonium sulfate (1)	2	**ALLOW** one mark for correct calculation of M_r for ammonia **AND** ammonium sulfate **IGNORE** units for the first marking point **ALLOW** one mark for 2 moles of ammonia makes 1 mole of ammonium sulfate
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
12			A is exothermic as the temperature increases (1) B is neither exothermic nor endothermic as the temperature stays the same (1) C is endothermic as the temperature drops (1) D is exothermic as the temperature increases (1)	4	ALLOW no energy change
			Total	8	
13			add universal indicator solution / pH paper (1) identify colour produced (1) match to colour chart to determine pH (1)	3	
			Total	1	
14		i	$ZnO + 2HNO_3 \rightarrow Zn(NO_3)_2 + H_2O$ correct formulae in correct position (1) balancing (1)	2	balancing mark is conditional on correct formulae ALLOW any correct multiple, e.g. $2ZnO + 4HNO_3 \rightarrow 2Zn(NO_3)_2 + 2H_2O$ (2) **ALLOW** = or Δ or $\rightleftharpoons$ for arrow DO NOT ALLOW 'and' or & for + ALLOW one mark for correct balanced equation with minor errors in case, subscript and superscript e.g. $ZnO + 2HNO^3 \rightarrow Zn(NO_3)_2 + H_2$
		ii	any four from: idea that an excess of zinc oxide must be added (1) so reaction is complete / all nitric acid is reacted (1) filter off excess zinc oxide (1) evaporate off some of the water (1) allow to crystallise (1)	4	
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
15	a		C_4H_{10} / $H_{10}C_4$ (1)	1	DO NOT ALLOW C^4H^{10} / $H^{10}C^4$ / C4H10 / H10C4
	b	i	both points correctly plotted (1) reasonable line of best fit (1)	2	
		ii	–4 to –10 °C dependent on line of best fit (1)	1	
		iii	as the number of carbon atoms increases the boiling point increases (1) idea that larger molecules have greater intermolecular forces (1)	2	
			Total	7	
16			copper **and** iron(II) sulfate (1) only reaction in which there is no change in observation (1)		**allow** Cu **and** $FeSO_4$ (1) **allow** solution stays green / solution does not change colour (1) **Examiner's Comments** Good responses identified that copper and iron (II) sulfate do not react because the solution does not change colour.
			Total	2	
17			**any two from:** medicines ? idea of avoiding overdose / avoiding harm (1) idea of getting correct concentration (1) baby milk – idea of (to get correct concentration) to avoid harming the baby (1)	2	**ignore** can have too many chemicals or preservatives **ignore** progressively dilute heroin to wean addicts off the drug **allow** idea that doses are weaker or could be harmful if left undiluted (1) **Examiner's Comments** Good responses described the ideas of diluting medicines to avoid an overdose and diluting baby milk to avoid harming the baby.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
18			Level 3 Interprets graph to make at least two deductions one of which correctly identifies end-point AND correctly calculates the concentration of NaOH. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) Level 2 Interprets graph to make at least two deductions one of which correctly identifies end-point AND attempts calculation OR correctly calculates the concentration of NaOH from the wrong end-point. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) Level 1 Candidate interprets graph to make a simple deduction e.g. volume at end-point. Quality of written communication impedes communication of the science at this level. (1 – 2 marks) Level 0 Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to A / A*. Indicative scientific points may include: Deductions • neutralised at or end-point is 20 cm^3 • pH at start, of NaOH, is any value between 12.8 to 13.2 • range for rapid rate of change of pH is about 12 to 3 • correctly reads pH for a stated volume of acid • correctly reads volume of acid for a stated pH • strong acid / strong base Calculation • no of moles of acid = $\frac{\text{volume}}{1000} \times 0.1$ • no of moles of acid = $\frac{20}{1000} \times 0.1$ or $0.020 \times 10^{-3} = 0.002$ • $25cm^3$ of NaOH contains 0.002 moles • concentration of NaOH = $\frac{\text{moles}}{\text{volume}} \times 1000$ or $\frac{\text{moles}}{\text{volume in dm3}}$ • concentration of NaOH = $\frac{0.002}{25} \times 1000$ or $\frac{0.002}{0.025}$ • concentration = 0.08 mol/dm^3 allow ecf from incorrect end-point an attempt at a calculation is one of the partial steps in the calculation e.g. working out moles of acid or working out a

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Question			Answer/Indicative content	Marks	Guidance
					concentration of NaOH **Use the L1, L2, L3 annotations in Scoris; do not use ticks.** **Examiner's Comments** This six mark question involved the interpretation of a pH titration curve and the calculation of an unknown concentration. Many candidates achieved level 1 by stating one simple deduction from the graph for example 'as the volume of acid is added the pH went down.' Other candidates gave more detailed answers that described what happens to the pH at neutralisation. The term ‘end-point’ was not well understood and some candidates thought it was the value at the end of the titration rather than at neutralisation. Most candidates either did not attempt the calculation or just wrote down some random numbers. Centres should advise candidates to write down the equation they are using, then substitute in the appropriate numbers and finally do a calculation. Either the use of moles = volume x concentration or concentration = moles/volume was considered an attempt at the calculation. A significant proportion of the candidates who attempted the calculation was not able to convert cm^3 into dm^3 and vice-versa. To get level 3 the calculation had to be complete with a concentration of 0.08 mol/dm^3 or a calculation that had been completed but used the wrong volume (typically 40 cm^3 rather than 20 cm^3) along with one other deduction from the graph.
			Total	**6**	

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Question			Answer/Indicative content	Marks	Guidance
19		i	**any one from** idea that there are more hydrogen ions in the hydrochloric acid / hydrogen ions more concentrated / hydrogen ions more crowded / hydrogen ions are closer together (1) idea that there are more collisions (between hydrogen ions and calcium carbonate) (1)	1	**ignore** references to particles for marking point 1 **ignore** hydrochloric acid is more ionising / references to kinetic energy **allow** greater collision frequency / collisions more likely / more chance of collision **Examiner's Comments** This question was about chlorine and fluorine. Targeted at grade C so that an answer that mentioned more collisions was sufficient to be awarded a mark, although many candidates gave higher level answers referring to an increased collision frequency. Answers that did not refer to collisions had to refer to hydrogen ions in their answer and it was sufficient to refer to more hydrogen ions present (since the volume was constant).
		ii	idea that both acids have the same concentration / amount of gas is determined by amounts of acids and calcium carbonate (not strength of acid) (1)	1	**allow** same amount of acid / both give same amount of H^+ (eventually) / same amount of calcium carbonate / same amount of reactants (1) **allow** calcium carbonate is limiting reactant / acid is limiting reactant **ignore** same volume of acid **not** same concentration of H^+ **not** same mass of acid **Examiner's Comments** This question was about chlorine and fluorine. Many candidates appreciated that the same amount of reactants was used and this was given credit in the mark scheme, however the same mass of acid and same volume were ignored.

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Question			Answer/Indicative content	Marks	Guidance
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
20		i	zinc has a greater gradient / iron has a smaller gradient (1) less gas is made with zinc / more gas is made with iron (1)	2	**allow** reaction with zinc is faster / reaction with iron is slower / takes less time to react Examiner's Comments This question was about the reactions of zinc and iron with hydrochloric acid. Candidates in (i) had little difficulty interpreting the two graphs and could describe two differences focusing on the difference in the rate of reaction and the total volume of gas being made at the end of the reaction.
		ii	Powder has more surface area / more collisions (per second) / more exposed particles (1)	1	assume answers refer to powder unless lump is specified **allow** or a lump has less surface area / less collisions (per second) / less exposed particles Examiner's Comments This question was about the reactions of zinc and iron with hydrochloric acid. The idea that a powder has a larger surface area was well understood in (ii) and some candidates also referred to more collisions.
		iii	**any three from:** higher temperature / heat (1) greater concentration (1) add a catalyst (1) use a finer powder (1) shake or stir (1)	3	**ignore** increase pressure Examiner's Comments This question was about the reactions of zinc and iron with hydrochloric acid. In (iii) candidates often gave at least two ways of speeding up the reaction. The most common answers were adding a catalyst or having a higher temperature. Candidates sometimes explained the factor but there were no marks available in the mark scheme for explanations.
			Total	**6**	

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Question			Answer/Indicative content	Marks	Guidance
21		i	potassium hydroxide + nitric acid → potassium nitrate + water one correct product: potassium nitrate / water (1) remainder of word equation correct(1)	2	equation must be totally correct for 2 marks **allow** correct formulae or mix of names and formulae i.e. KOH + HNO_3 ? KNO_3 + H_2O **allow** hydrogen oxide Examiner's Comments This question was about fertilisers. Candidates found writing the word equation challenging and often could write the left hand side but could not name the correct products.
		ii	add a few drops of universal indicator to solution (1) check against colour chart / idea that colour indicates pH (1)	2	**allow** use pH paper / pH indicator **not** litmus **allow** specific reference to colour and pH e.g. green is pH 7 **allow** second marking point even if incorrect indicator is used Examiner's Comments This question was about fertilisers. The use of Universal Indicator was well known and candidates often appreciated the need to check against a colour chart. Some candidates described the use of litmus or methyl orange indicators rather than Universal Indicator.
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
22	a	i	does not rust in boiled water / no rusting in tube **A** (1) does not rust in dry air / no rusting in tube **D** (1)	2	**allow** tube with no air no rusting **allow** tube with no water no rusting **A** and **D** rust slower is **not** sufficient Examiner's Comments This question was about rusting and corrosion. Candidates had to evaluate the results of an investigation on rusting. In part (i) Many candidates did not appreciate the importance of the experiments where rusting did not take place. Instead they often just stated the results from experiments **B** and **C**.
		ii	salt (water) (1)	1	**allow** sea water **not** sodium Examiner's Comments Most candidates in (ii) were able to conclude that salt speeds up rusting.

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Question			Answer/Indicative content	Marks	Guidance
	b		$4A? + 3O_2$? $2A?_2O_3$ formulae (1) balancing - conditional on correct formulae (1)	2	**allow** any correct multiple e.g. $2A? + {}^3/_2O_2$? $A?_2O_3$ **allow** = or ? for arrow **not** 'and' or & for + **allow** one mark for correct balanced equation with minor errors of case, subscript and superscript e.g. $4AL + 3O^2$? entity $2A?2o_3$ (1) Examiner's Comments This question was about rusting and corrosion. Some candidates could balance the equation but a common misconception was to change the formula of the aluminium oxide. Almost all correct answers had equations balanced with integers rather than fractions.
			Total	**5**	
23			(copper oxide has had) oxygen removed (1)	1	**allow** copper is made (1) **allow** (copper ions have) gained electrons (1) **allow** hydrogen gains oxygen (1) Examiner's Comments This question was about metals and alloys. The idea that reduction involves the loss of oxygen was often used to explain why copper oxide was reduced. Only a very small proportion of the candidates gave answers that used the gain of electrons.
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
24			any two from: lack of oxygen (1) incomplete combustion (1) forms soot / forms carbon (1)	2	**allow** ora if specified just 'amount of oxygen' is insufficient **allow** flame not hot enough (1) **allow** sodium (ions) injected into flame (1) Examiner's Comments This question used the context of the London Olympic flame to assess aspects of combustion. Many candidates thought that the flame was yellow because there was too much oxygen rather than a shortage of oxygen. Only a very small proportion of candidates gave an answer that referred to incomplete combustion.
			Total	2	
25			idea that (metal A) does not corrode in damp air (1)	1	**allow** the result in damp air (1) **allow** idea that (metal **A**) **only** corrodes in damp acidic air **allow** ORA ie all the other metals corrode in damp air **ignore** references to dry air **ignore** references to rusting Examiner's Comments This question focused on the corrosion of metals. Good responses to this question used the information from the table to identify that metal A does not corrode in damp air. Candidates who failed to gain credit gave responses that were not specific enough such as 'it needs acidic conditions'.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
26		i	iron + water + oxygen ? hydrated iron(III) oxide (1)	1	order of reactants is unimportant **allow** hydrated iron oxide **not** iron(III) oxide / iron oxide **ignore** incorrect oxidation state **allow** $Fe + H_2O + O_2$? $Fe_2O_3.xH_2O$ (1) **allow** mix of correct formulae and words Examiner's Comments This question focused on the corrosion of metals. The word equation in part (i) was completed well by most candidates, with most incorrect responses failing to include one of the reactants.
		ii	involves reaction with oxygen / forms an oxide (1)	1	**allow** addition of oxygen (1) **allow** (iron) loses electrons / (iron) loses an electron (1) **allow** oxidation number (of iron) increases (1) Examiner's Comments This question focused on the corrosion of metals. In part (ii) the most common correct response made reference to iron losing electrons. The mnemonic ‘OILRIG’ is well known.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
27			$CH_4 + O_2$? $2H_2O + C$ correct reactants and products (1) balancing dependent on correct formulae (1)	2	**allow** correct multiples correct products must include H_2O and C **allow** equations making carbon, carbon monoxide and carbon dioxide so long as carbon is made e.g. $3CH_4 + 4½O_2$? $6H_2O + C + CO + CO_2$ $2CH_4 + 2½O_2$? $4H_2O + C + CO$ $3CH_4 + 4O_2$? $6H_2O + C + 2CO$ **allow** one mark for correctly balanced equations with minor errors of case and subscript e.g. CH4 + O2 ? 2H2o + C Examiner's Comments This question focused on incomplete combustion and required candidates to construct a balanced symbol equation to show the incomplete combustion of methane to make carbon. One mark was awarded for the correct reactants and products and 1 mark for the correct balancing. The balancing mark was dependent on the correct formulae, but 1 mark was allowed for a balanced equation with a minor error in subscripts or formulae. When candidates did not gain marks it was usually because they failed to include carbon as a product; many just had carbon monoxide and water.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
28	a		$CaCO_3$ + 2HC*l* ? $CaCl_2$ + CO_2 + H_2O formulae correct (1) balancing (1)	2	balancing mark is dependent on correct formulae **but** **allow** one mark for balanced equation with minor errors of subscripts, superscripts, etc eg $CACO_3$ + 2HC*l* ? $CaCl^2$ + CO_2 + H2O **not** and or & for + **allow** = instead of ? **allow** correct multiples eg $2CaCO_3$ + 4HC*l* ? $2CaCl_2$ + $2CO_2$ + $2H_2O$ **Examiner's Comments** Candidates were able to balance the symbol equation, given the formulae. They found balancing the ionic equation.
	b		H^+ + OH^- ? H_2O (1)	1	order of reactants unimportant **allow** OH_2 / HOH **allow** correct multiples subscripts and superscripts must be correct eg H^2O scores 0 **Examiner's Comments** They found balancing the ionic equation more challenging. Candidates often gave good answers.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
29			$2NaHCO_3$? $Na_2CO_3 + CO_2 + H_2O$ formulae correct (1) balancing (1)	2	balancing mark is dependent on correct formulae **allow** = instead of ? **allow** any correct multiples of this equation **allow** one mark for correct balanced equation with minor errors of superscripts, subscript or case. eg $2NAHCO_3$? $Na_2CO_3 + CO^2 + H2O$ **Examiner's Comments** Candidates found a challenging question, and few candidates could recall the formula $NaHCO_3$, which made balancing the equation impossible.
			Total	2	

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<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>30</td><td>a</td><td></td><td>add universal indicator (paper or solution) (1)

match colour to test card (1)</td><td>2</td><td>allow pH paper
allow use a pH meter (2)

2nd mark is dependent on 1st being awarded
allow colour corresponds to a pH value (1)
allow correct colours in acid and / or alkali (1)
ignore to see what colour it goes

Examiner's Comments

A number of candidates quoted the use of litmus rather than universal indicator and failed to score. Only the best candidates scored both marks.</td></tr>
<tr><td></td><td>b</td><td></td><td><table><tr><th>acid</th><th>base</th><th>salt</th></tr><tr><td>sulfuric acid</td><td>copper oxide</td><td>copper sulfate</td></tr><tr><td>nitric acid</td><td>sodium carbonate</td><td>sodium nitrate (1)</td></tr><tr><td>hydrochloric acid (1)</td><td>zinc oxide</td><td>zinc chloride</td></tr><tr><td>sulfuric acid</td><td>magnesium oxide / magnesium hydroxide / magnesium carbonate (1)</td><td>magnesium sulfate</td></tr></table></td><td>3</td><td>allow correct formulae i.e.
$NaNO_3$ (1)

HCl (1)

MgO / $Mg(OH)_2$ / $MgCO_3$ (1)

Examiner's Comments

This question produced a spread of marks and differentiated well. Most candidates correctly deduced magnesium oxide as the base. The production of sodium nitrate was less well known and the hydrochloric acid least well known. ‘Chloric acid’ was a common misconception.</td></tr>
<tr><td></td><td>c</td><td></td><td>$CuCl_2$ or H_2O (1)</td><td>1</td><td>allow $CuCl_2$ and H_2O (1)

Examiner's Comments

The words ‘formula’ and ‘product’ were both emboldened in the question. In spite of this there were a number of names rather than formulae given and only a minority of candidates understood what was meant by a product.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>6</td><td></td></tr>
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Question			Answer/Indicative content	Marks	Guidance
31			carbon dioxide (1)	1	**allow** CO_2 (1) **allow** correct answer circled, underlined or ticked in list if answer line is blank Examiner's Comments The most common incorrect answer was 'carbon monoxide'. 'Nitrogen' and 'propane' also featured regularly.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
32			Level 3 Describes the difference between strong and weak acids AND explains the different shapes of the graphs in terms of collision frequency and hydrogen ions Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) Level 2 EITHER Describes the difference between strong and weak acids and explains the different shapes of the graphs in terms of rate of reaction and strength of acid OR explains the different shapes of the graphs in terms of collision frequency or hydrogen ions Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) Level 1 EITHER Describes the difference between strong and weak acids OR explains the different shapes of the graphs in terms of rate of reaction and strength of acid Quality of written communication impedes communication of the science at this level. (1 – 2 marks) Level 0 Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to A. Indicative scientific points at level 3 must include: Shapes of graph • reference to hydrogen ions e.g. nitric acid has more hydrogen ions / greater concentration of hydrogen ions • reference to collision frequency e.g. nitric acid has more collisions per second / collisions more often / greater collision frequency **allow** references to increased chance of collision, collisions more often, collisions more likely, as alternatives to increased collision frequency **allow** ora for propanoic acid Indicative scientific points at all levels may include: Strength of acid • strong acid completely dissociates / ionises completely • weak acid partially dissociates / does not completely ionise Shapes of graph • nitric acid faster than propanoic acid • nitric acid has more reacting particles / greater concentration of reacting particles • nitric acid has more collisions • nitric acid has particles closer together **allow** ora for propanoic acid **ignore** comments about similarities of the graph Use the L1, L2, L3 annotations in Scoris; **do not use** ticks. Examiner's Comments

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Question			Answer/Indicative content	Marks	Guidance
					This question which assessed the quality of written communication was very demanding and many candidates used poor and imprecise chemical terminology. Candidates rarely described the difference between a strong and a weak acid in terms of the dissociation to form hydrogen ions. Most candidates could describe why the shapes of the graphs were different in terms of strong and weak acids using simple ideas such as 'the graph for nitric acid was steeper because the acid was stronger and reacted faster'. This type of comment allowed the award of level 1. To go beyond level 1 candidates had to describe the difference between a strong and weak acid or to explain their answer in terms of collision theory. Only the very best answers referred to both collision frequency and hydrogen ions.
			Total	6	
33			**any one from:** fewer collisions (1) less crowded particles (1) fewer hydrogen ions / less concentrated H^+ (1)	1	**ignore** any extra qualification about collisions **but not** particles have more energy fewer ions / fewer particles is **not** sufficient **not** atoms or molecules as particles if particles are named **allow** weak acids do not fully ionise (but strong acids do) / weak acids do not completely dissociate (but strong acids do) / weak acids are less ionised **allow** ora if strong acid specifide **Examiner's Comments** Candidates often referred to ethanoic acid being only partially dissociated. Other candidates referred to the lower concentration of hydrogen ions or less collisions.
			Total	1	

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Question	Answer/Indicative content	Marks	Guidance
34	mass of water calculated (1) prediction supported because as more copper hydroxide is used the mass of water increases (1) **but** prediction supported illustrated by examples showing the direct proportionality e.g. mass of $Cu(OH)_2$ doubles in expt 1 and expt 2 and so does the mass of water (2)	3	Maximum of **two** marks if no comment about whether data supports prediction **allow** both explanation marks if answer based on mass of copper oxide rather than water **allow** prediction not supported because the result for experiment 5 does not fit the pattern (2) **Examiner's Comments** Many candidates could calculate the missing column in the data table. However a common error was to quote the mass of water as 0.9 rather than 0.09 in experiment 1. Candidates could either state that the data supported the prediction or that it did not. The best answers used data from the table to support their answers for example from experiment 1 to 2 the mass of copper hydroxide doubled and so did the mass of water. Alternatively candidates could compare results with experiment 5 to show that the prediction was not supported. Other candidates calculated the constant of proportionality that linked the mass of copper hydroxide and the mass of water and compared this value for different experiments. Some candidates only described that the

experiment number	Mass of water made in g
1	**0.09**
2	**0.18**
3	**0.28**
4	**0.37**
5	**0.60**

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Question			Answer/Indicative content	Marks	Guidance
					mass of water increased as the mass of copper hydroxide increased without reference to specific data.
			Total	3	
35			strong acid is fully ionised (in water) (1) weak acid is only partially ionised (1)	2	**allow** dissociated for ionised **Examiner's Comments** Some candidates gave good definitions based in comparing the degree of ionisation. Good answers stated that hydrochloric acid fully dissociated and ethanoic acid only partially dissociated. Marks were not awarded for candidates who only referred to the number of hydrogen ions present or to differences in pH.
			Total	2	
36			iron or top reaction loses **electrons** which is oxidation (1) oxygen or bottom reaction gains **electrons** which is reduction (1)	2	no mark for identifying which reaction is oxidation and which is reduction **allow** water gains electrons which is reduction **Examiner's Comments** Most candidates used the concept of Oil Rig and were able to identify that iron is oxidised and oxygen is reduced. Only a small proportion of candidates did not give a reason for their choice.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
37		i	ethanoic acid contains a lower concentration of hydrogen ions (than hydrochloric acid) (1) so lower collision frequency (1)	2	**allow** ethanoic acid contains less crowded hydrogen ions / hydrogen ions in ethanoic acid are further apart / ora **allow** ethanoic acid has a higher pH / ora **allow** collisions less often / less chance of a collision / fewer collisions per second / ora if specified for hydrochloric acid Examiner's Comments Candidates often failed to include sufficient collision theory to be awarded a mark. Candidates were more likely to state that there are fewer collisions with ethanoic acid but did not state that it was the decreased collision frequency that was important. The idea that the hydrogen ions were less crowded or that the pH was higher was seldom mentioned.
		ii	both contain the same number of moles of magnesium (1)	1	**allow** both contain the same amount of magnesium / both contain same mass of magnesium (1) **ignore** magnesium is the limiting reagent **not** same number of moles of acid Examiner's Comments Candidates often appreciated that the limiting reagent would run out but missed the idea that it was because there was the same mass of magnesium that was important. A significant proportion of candidates did not appreciate that magnesium was the limiting reagent and gave answers that stated there was the same amount of acid.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
38	a		(chlorine molecule) gains electron(s) (1)	1	**Examiner's Comments** The concept of Oil Rig was well understood so many candidates referred to chlorine gaining electrons.
	b		Cl_2 + 2KI ? 2KC*l* + I_2 **OR** Cl_2 + 2$I^?$? I_2 + 2C*l*$^?$ correct formulae (1) correct balancing – dependent on correct formulae (1)	2	**ignore** state symbols **allow** = instead of ? **allow** any correct multiple including fractions **not** & or and instead of + **allow** one mark for correct equation with minor errors of subscript, superscript and case eg c*l*2 + 2KI ? 2KCl + I^2 **Examiner's Comments** Candidates found the balanced symbol equation very challenging. Many candidates were not able to recall the formula of potassium chloride or iodine. A typical error was to give the formula of iodine as I and of potassium chloride as KCl2. A small number of candidates gave the ionic equation for this reaction which was given full credit in the mark scheme.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
39	a		reading decreases (1) (because) a gas is made / carbon dioxide is made (1)	2	2nd mark is dependent on decreases **not** the name of an incorrect gas Examiner's Comments Only better candidates realised that the mass would decrease as a gas was given off which could escape from the flask. Many candidates thought that the mass would increase as the gas would not escape. The ideas around conservation of mass are not well understood by a significant number of candidates.
	b		reaction is slower / reading on balance decreases more slowly (1) ethanoic acid is a weak acid / fewer collisions / fewer hydrogen ions (1)	2	**allow** idea that reaction takes longer (1) **allow** has not decreased as much (in the same time) (1) **ignore** a longer rate of reaction **allow** ethanoic acid is not as strong as hydrochloric acid (1) Examiner's Comments This question was poorly answered by all but the best candidates. Better candidates recognised that the reaction with ethanoic acid would be slower because ethanoic acid is a weak acid. Many thought that ethanoic acid would react faster as it would react more strongly. Others just said that the reaction would be different because the reactants are different.
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
40	a		$2Br^{?} - 2e^{?}$? Br_2(1)	1	**allow** any correct multiple, including fractions **not** any additional symbols, other than balancing **Examiner's Comments** Most candidates correctly balanced the equation.
	b		(oxidation because) electrons are lost (from $Br^{?}$) (1)	1	**allow** oxidation number of Br increases (1) **not** bromine (atoms) lose electrons **but allow** ions lose electrons (1) **Examiner's Comments** Most candidates explained that oxidation is loss of electrons. Candidates who did not gain credit either stated that electrons were gained, or suggested that the wrong species was losing electrons, e.g. bromine loses electrons.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
41	a	i	(copper carbonate is) broken down (using heat) (1)	1	**allow** two or more substances are produced from one substance (by heating) (1) **allow** break up of (copper carbonate) (with heat) (1) **ignore** breaks up bonds **not** heat particles broken down **ignore** decay / dissolve **Examiner's Comments** Candidates displayed a good understanding of thermal decomposition.
		ii	$2CuO + C$? $2Cu + CO_2$ formulae correct (1) balancing (1)	2	**allow** any correct multiple, including fractions **allow** = / ? instead of ? **not** and / & not '+ heat' in equation balancing mark is dependent on the correct formula **but** **allow** 1 mark for a balanced equation with minor errors of case, subscripts, superscripts, etc 2CuO + C ? 2CU + CO2 **Examiner's Comments** This question required candidates to write a balanced symbol equation for the reaction of copper oxide with carbon. One mark was awarded for the correct reactants and products and 1 mark for the correct balancing. The balancing mark was dependent on the correct formulae, but 1 mark was allowed for a balanced equation with a minor error in subscripts or formulae. The majority of candidates gained both marks. When candidates did not gain marks it was often because they tried to balance the equation by altering the formula for copper oxide, i.e. CuO_2.

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Question			Answer/Indicative content	Marks	Guidance
	b		**advantages any one from:** saves resources (because the ore does not have to be extracted) (1) uses less energy (1) idea of less environmental damage (due to quarrying) (1) **problems any one from:** copper has to be collected (1) copper has to be sorted from other metals (1)	2	must be **one** advantage and **one** problem for 2 marks **allow** copper is in short supply (1) **ignore** saves landfill space **allow** loss of jobs mining or extracting copper ore (1) **Examiner's Comments** Good responses to this question described an advantage and a disadvantage of recycling copper, with candidates usually stating that recycling saves natural resources but that copper is difficult to sort from other metals. Credit was not given for vague references to the environment or reducing pollution.
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
42			Level 3 (5–6 marks) Names both the reagents needed AND Describes a neutralisation experiment, including how both a neutral solution and solid ammonium sulfate is obtained. Quality of written communication does not impede communication of the science at this level. Level 2 (3–4 marks) Names both the reagents needed AND Attempts to describe a neutralisation experiment. Quality of written communication partly impedes communication of the science at this level. Level 1 (1–2 marks) Names one of the reagents needed OR Attempts to describe a neutralisation experiment. Quality of written communication impedes communication of the science at this level. Level 0 (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted at grades up to A*. Indicative scientific points may include: names of reagents • acid is sulfuric acid • alkali is (a solution of) ammonia or ammonium hydroxide or ammonium carbonate. method • sulfuric acid is added to ammonia solution until a neutral solution is formed • neutral solution obtained by use of pH meter / indicator solution / indicator paper / universal indicator solution • the neutral solution is evaporated until saturated • solution is allowed to stand and crystallise • crystals are filtered off and dried. **allow** idea of 'evaporation to dryness' as an alternative to crystallisation **N.B.** It is not necessary to describe a titration method to get Level 3. Use the L1, L2, L3 annotations in scoris; do not use ticks. Examiner's Comments This question was about fertilisers. The number of atoms in the formula was usually correct. Where candidates did not gain the mark it was often because they gave an answer of 132, being the relative formula mass of ammonium sulfate.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
43		i	oxygen / O_2 (1)	1	**ignore** O ?Examiner's Comments??? Some candidates recognised oxygen as the gas needed for combustion but a significant proportion of the candidates chose carbon dioxide. Candidates found the word equation
		ii	hexane + oxygen ? carbon + water **or** hexane + oxygen ? carbon monoxide + water **or** hexane + oxygen ? carbon + carbon monoxide + water (1) **AND** carbon monoxide (made is a dangerous gas) / makes a poisonous gas / makes a toxic gas / makes black smoke / makes soot / dirty flame / less energy produced (1)	2	**ignore** carbon dioxide as an extra product **allow** correct formula instead of names C_6H_{14}, O_2, C, H_2O and CO **allow** idea that energy (in fuel) is wasted ?Examiner's Comments?? Very challenging and rarely included water as one of the products. The toxic nature of carbon monoxide was well known. The idea that incomplete combustion releases less energy was not often mentioned by candidates. A significant proportion of the candidates did not attempt.
			Total	**3**	
44			magnesium + hydrochloric acid ? magnesium chloride + hydrogen (1)	1	**allow** = for ? **not** and or & for + **allow** mix of correct formulae and words in an unbalanced equation eg Mg + HC*l* ? $MgCl_2 + H_2$ **Examiner's Comments** Word equation was correctly written down by most candidates.
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
45		i	$2Cl^- \rightarrow 2e^- + Cl_2$ (1)	1	**allow** any correct multiple, including fractions Examiner's Comments The majority of candidates correctly balanced the equation. The most common errors were balancing with the number '4' or completing the gaps with 'Na' and 'Cl'.
		ii	oxidation because electrons are lost (1)	1	**allow** oxidation number of Cl increases / oxidation number of Cl goes from −1 to 0 (1) **not** chlor**ine** loses electrons or chlor**ine** ions lose electrons Examiner's Comments Most candidates explained that the reaction was oxidation because electrons are lost. Candidates who failed to gain credit often suggested that the wrong species was losing electrons, e.g. chlorine, or chlorine ions, loses electrons.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
46	a	i	0.6 (cm^3 / hour) (1)	1	Examiner's Comments The majority of candidates correctly identified 0.6 cm^3/hour as the highest rate of production of hydrogen gas.
		ii	(pH) 6	1	Examiner's Comments In this part pH 6 was usually correct.
	b		$2A? + 3H_2SO_4 \rightarrow A?_2(SO_4)_3 + 3H_2$ formulae (1) balancing (1)	2	balancing mark is conditional on correct formulae **allow** any correct multiple e.g. $4A? + 6H_2SO_4 \rightarrow 2A?_2(SO_4)_3 + 6H_2$ **allow** = or → for arrow **not** 'and' or & for + **allow** one mark for correct balanced equation with incorrect use of upper and lower case formulae e.g. $2A? + 3H_2SO_4 \rightarrow A?2(So_4)_3 + 3H_2$ Examiner's Comments This question required candidates to write a balanced symbol equation for the reaction of aluminium with sulfuric acid. One mark was awarded for the correct reactants and products and 1 mark for the correct balancing. The balancing mark was dependent on the correct formulae, but 1 mark was allowed for a balanced equation with a minor error in subscripts or formulae. When candidates did not gain marks it was often because they tried to balance the equation by writing Al_2 or H_23SO_4.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
47		i	(iron oxide + carbon →) **iron + carbon dioxide** ✓	1(AO 2.1)	**ALLOW** carbon monoxide / carbon oxide **ALLOW** symbols iof correct Examiner's Comments The word equation was well known. Even candidates who were confused still suggested answers such as 'iron and water' or 'iron and oxygen'.
		ii	Oxygen is removed (from iron oxide) ✓	1(AO 2.1)	The mark is for the process of reduction, not the products. 'It' refers to iron oxide **ALLOW** iron separates from the oxygen **BOD** **ALLOW** oxide is removed **IGNORE** oxygen is formed, iron is formed **ALLOW** iron **gains** electrons **IGNORE** electrons are gained Examiner's Comments All candidates found it difficult to explain how they could tell that the iron oxide had been reduced.
			Total	2	
48			C ✓	1(AO2.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
49	a	i	x-axis labelled volume of hydrochloric acid **in cm^3** **and** y-axis labelled pH ✓ All points plotted correctly ✓ Line of best fit drawn ✓	3(AO2.2 × 2) (AO1.2)	**ALLOW** ±½ square Must be identifiable as a titration curve Examiner's Comments To gain 3 marks on this question candidates were required to: • correctly label both the x-axis and y-axis • plot all the points correctly • draw a line of best fit. When candidates did not gain full marks it was usually because they omitted the units (cm^3) on the x-axis or drew a straight line through the points.
		ii	Answer ± 0.1cm^3 of their own graph ✓	1(AO2.2)	**Scores 0 if no line of best fit in (i)** Examiner's Comments Most candidates gained this mark. Candidates who did not attempt to draw a line of best fit in part (i) did not gain marks for this question.
		iii	Decreases ✓	1(AO3.1a)	**ALLOW** diluted Examiner's Comments Many candidates correctly deduced that the concentration of hydroxide ions decreases as the hydrochloric acid is added.
		iv	$H^+ + OH^- \rightarrow H_2O$ ✓	1(AO1.1)	**ALLOW** correct multiples **IGNORE** state symbols Examiner's Comments Many candidates were able to write the balanced ionic equation for neutralisation.

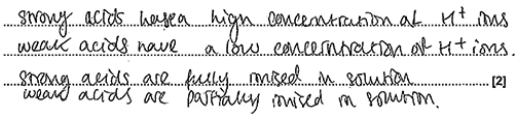
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Question			Answer/Indicative content	Marks	Guidance
	b		Strong acids are fully ionised or completely dissociated (in aqueous solution) ✓ Weak acids are partially ionised or not completely dissociated (in aqueous solution) ✓	2(AO1.1)	**ALLOW** all molecules release H^+ ions **ALLOW** $HCl \rightarrow H^+ + Cl^-$ **DO NOT ALLOW** strong acids have many H^+ ions / strong acids have a high concentration of H^+ ions **IGNORE** strong acids are more ionised / dissociated **ALLOW** not all molecules release H^+ ions **ALLOW** $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$ **DO NOT ALLOW** weak acids have few H^+ ions / weak acids have a low concentration of H^+ ions Examiner's Comments Higher ability candidates gave a clear, concise answer to this question stating that strong acids are fully ionised / completely dissociated (in aqueous solution), whereas weak acids are only partially ionised / not completely dissociated. Candidates who tried to expand on the idea of complete / partial ionisation often showed confusion as to what this meant, relating it to H^+ concentration or the number of H^+ lost from the acid. Lower ability candidates often simply referred to pH. Misconception 'Strong acids are almost fully ionised' was a common misconception. Exemplar 1 • Strong acid, the H^+ ions fully dissociate / ionise • Weak acid, the H^+ ions only partly dissociate / ionise (reversable reaction) [2] This response illustrates a concise response to this question, which was given both marks.

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Question			Answer/Indicative content	Marks	Guidance
					Exemplar 2  strong acids have a high concentration of H^+ ions weak acids have a low concentration of H^+ ions. strong acids are fully mixed in solution [2] weak acids are partially mixed in solution. This response, however, shows confusion and a contradiction in the candidate's understanding of what is meant by a strong and weak acid by relating it to H^+ concentration. This response scored 0 marks.
	c	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = pH 4 award 2 marks Concentration of H^+ decreases by factor of 10, the pH increases by 1 ✓ Factor of 100 = 10 × 10 so pH increases by 2 pH value = 4 ✓	2 (AO2.1) (AO2.2)	Examiner's Comments High ability candidates correctly calculated the new pH as 4. The most common error was 12, i.e. 2 + 10.
		ii	$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$ ✓	1(AO1.1)	ALLOW any correct multiple, including fractions ALLOW = / ⇌ instead of → DO NOT ALLOW and / & instead of '+' IGNORE state symbols Examiner's Comments Most candidates were able to write the balanced symbol equation for the neutralisation of sodium hydroxide by nitric acid.

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Question			Answer/Indicative content	Marks	Guidance
		iii	**Any two from:** Evaporate water (slowly) / heat the solution ✓ Idea of forming a saturated solution ✓ Idea of crystallisation ✓ Cool solution (slowly) ✓ Idea of drying in a warm oven / air drying / leave on filter paper to dry ✓	2(AO3.3a)	**DO NOT ALLOW** idea of boiling the solution **IGNORE** just 'crystals should be dried' Examiner's Comments Good responses to this question appreciated that in order to produce **dry** crystals the water should be evaporated and then the solution cooled / left to dry in a warm place. Credit was not given for the idea of **boiling** the solution. Lower ability candidates tended to focus their response on how the reaction was carried out, rather than how **dry** crystals were made.
			Total	13	
50			B	1 (AO 2.1)	Examiner's Comments A was a popular incorrect response.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
51	a	i	7.6✓	1 (AO3.2b)	
		ii	error taking the temperature (at start or at end) ✓	1 (AO3.2a)	ALLOW used more/less metal / used more/less acid ALLOW reaction did not finish IGNORE faulty thermometer Examiner's Comments Most candidates explained what an anomalous result is rather than explain what might have caused the anomalous result.
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 10.3 (°C) award 2 marks (10.3 + 10.5 + 10.2) ÷ 3 = 10.3333…. (°C) ✓ = 10.3 (°C) (1 decimal place) ✓	2 (AO2.2)	Examiner's Comments Most candidates calculated the mean correctly but some truncated their answer rather than rounding it.
	b	i	Improvement Any one from: Put a lid on the polystyrene cup / Put insulating material around the polystyrene cup / Use a digital thermometer ✓ Use a data logger ✓ AND Reason Any one from: Stops/reduces heat loss (through evaporation) / Prevents/reduces heat loss (from the polystyrene cup) / (Digital thermometer) is easier to read / (Digital thermometer) gives more accurate/precise readings ✓ (data logger) gives continuous data so can get max T	2 (AO3.3b) (AO2.2)	Reason must be linked to the Improvement to be awarded the second mark ALLOW add same amount of metal / acid/measure mass metal / measure volume acid ..... so can compare results ALLOW more metal / acid ..... gives larger T change / errors are less significant Examiner's Comments Candidates found this very difficult. Repetition was the most common improvement with accuracy for the reason. Some thought glass to be a better insulator than polystyrene. Most able candidates discussed either heat loss or digital devices.

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Question			Answer/Indicative content	Marks	Guidance
		ii	**Any two from:** Use different types of acids ✓ Use a wider range of metals ✓ Change the mass of metal used ✓ Change the volume of acid used ✓	2 (AO3.3a)	**ALLOW** more reactive/less reactive metals **IGNORE** concentration Examiner's Comments Candidates found this difficult with a significant number omitting the question. Those that answered the question usually only gave one further test. Using a wider range of metals was the most common response.
			Total	8	
52			A	1 (AO2.1)	
			Total	1	
53		i	pH meter ✓	1 (AO1 1.2)	**ALLOW** pH probe
		ii	Wash the probe with water ✓ Put the probe into the solution ✓	2 (AO1.2)	**ALLLOW** calibrate the meter / probe
			Total	3	
54			A	1 (AO1.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
55	a	i	Hydrogen ion / H^+	1 (AO1.1)	
		ii	$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ Reactant ✓ Product ✓	2 (AO2.2 ×2)	

Question			Answer/Indicative content	Marks	Guidance
	b		*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** Correctly names the acid and the base used in the neutralisation reaction. **AND** Method can be followed to make a pure, dry sample of potassium chloride. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Correctly names the acid and the base used in the neutralisation reaction. **OR** Method can be followed to make a salt sample. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Method includes adding acid to base. **OR** Correctly names either the acid or the base used in the neutralisation reaction. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	6 (AO1.1 ×2 2.2 ×2 3.3a ×2)	**AO1.1 Demonstrates knowledge and understanding of neutralisation reactions** • base neutralises the acid • acid + base → salt + water • potassium chloride is a salt • potassium chloride is neutral **AO2.1 Application of knowledge and understanding related to making a salt by neutralisation** • acid used is hydrochloric acid • base used is potassium hydroxide / potassium oxide / potassium carbonate • pH paper / pH probe is used to show solution made is neutral **AO3.3 Analyse of information and ideas to develop experimental procedures** • pH probe will not contaminate the solution • evaporate some of the water to form crystals • leave the crystals to dry / dry crystals in an oven

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Question			Answer/Indicative content	Marks	Guidance
			Total	9	
56			A ✓	1 (AO2.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
57			*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** Detailed evaluation of the advantages and disadvantages of <u>all</u> of the pH testing kits A-E **AND** Suggested pH kit the farmer should use *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Evaluation of the advantages and disadvantages of some of the pH testing kits A-E **OR** Detailed evaluation of the advantages of <u>all</u> of the pH testing kits A-E **OR** Detailed evaluation of the disadvantages of <u>all</u> of the pH testing kits A-E <u>**AND**</u> Suggested pH kit the farmer should use **OR** Detailed evaluation of the advantages and disadvantages of <u>all</u> of the pH testing kits A-E *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Evaluation of the advantages of some of the pH testing kits A-E **OR** Evaluation of the disadvantages of some of the pH testing kits A-E **OR** Evaluation of the advantages and disadvantages of some of the pH testing kits A-E <u>**AND**</u>	6 (AO6 × 3.2a)	**AO3.2a Analyse information and ideas to make a judgement of which pH testing kit the farmer should use** **Advantages** • **A** is one of the least expensive testing kits • **A** changes colour across the pH scale • **A** can be used in acidic and alkaline soils • **D** is the least expensive **Disadvantages** • Idea that **B** and **D** only have two possible colours and therefore cannot tell you the pH • Idea that **C** and **E** don't change colour past pH 7, therefore is no use in alkaline soils • **E** is the most expensive **Choice** • **A** should be used by the farmer

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Question			Answer/Indicative content	Marks	Guidance
			Suggested pH kit the farmer should use. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*		
			Total	**6**	
58		i	Na_2O (s) + H_2O (l) → **2**NaOH (aq) Formulae ✓ Balancing ✓ State symbols ✓	3 (AO2.1) (AO1.2) (AO2.1)	**ALLOW** any correct multiple, including fractions **ALLOW** = **OR** ⇌ instead of → **DO NOT ALLOW** and / & instead of '+' balancing mark is dependent on the correct formulae but **ALLOW** 1 mark for a balanced equation with a minor error in subscripts / formulae e.g. NAO + H_2O →**2**NaOH State symbols mark is independent of formulae & balancing marks
		ii	Hydroxide / OH^- ions ☐	1 (AO1.1)	
		iii	Sodium sulfate✓	1 (AO2.1)	**ALLOW** Na_2SO_4 **IGNORE** incorrect formulae if correct name is given
		iv	**FIRST CHECK ANSWER ON ANSWER LINE** **If answer = 100 award 2 marks** pH increased by 2 concentration decreases by a factor of 10 × 10 ✓ 100 ✓	2 (AO2.2)	**ALLOW** for 1 mark pH increase by 1, so concentration decreased by a factor of 10
			Total	**7**	
59			(acid + alkali →) **salt** ✓ + **water** ✓	2 (AO1.2)	**ALLOW** answers in either order
			Total	**2**	

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Question			Answer/Indicative content	Marks	Guidance
60		i	Any value <7 ✓	1 (AO2.1)	
		ii	**Any one from:** Acid rain ✓ erosion of stonework ✓ corrosion of metals ✓ kills trees or kills living things in rivers / lakes ✓ breathing difficulties ✓	1 (AO1.1)	
			Total	2	
61			(Sodium atom) loses an electron / Oxidation is loss of electrons ✓	1 (AO1.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
62			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Describes tests, the results, and identifies each of the three samples **AND** Includes correct balanced symbol equations for the reactions which occur. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Describes tests, the results, and identifies each of the three samples **OR** Describes a test and the result, to identify one of the three samples and attempts to identify the other two **AND** Includes a balanced symbol equation for the reaction which occurs. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Describes a test and the result, to identify one of the three samples. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	6 (AO3 × 1.2) (AO3 × 2.2)	**AO1 Knowledge and understanding of alkanes, alkenes and acids** • Alkanes do not react with bromine water • Alkenes react with bromine water / bromine water is decolourised • Acids react with carbonates to give off carbon dioxide / fizzing observed **AO2 Application and knowledge of tests and results** • Add sodium carbonate (or any suitable carbonate) • Ethanoic acid effervesces • Pentane and pentene do not effervesce • ALLOW other suitable reactions, eg addition of a metal; ethanoic acid effervesces • ALLOW use of universal indicator to identify ethanoic acid • Add bromine water to separate samples of pentane and pentene and shake • With pentene bromine water changes from orange to colourless / bromine water is decolourised • With pentane and ethanoic acid bromine water stays orange **AO2.1 Application of knowledge and understanding to produce balanced symbol equations** $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + CO_2 + H_2O$ $C_5H_{10} + Br_2 \rightarrow C_5H_{10}Br_2$
			Total	6	

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>63</td><td></td><td></td><td>correct measuring equipment to measure volume of gas in diagram e.g. gas syringe / displacement of water using measuring cylinder or upturned burette (1)

equipment will work and it is gas tight (1)</td><td>2</td><td>The measuring apparatus does not have to be set up or part of a correct diagram

Examiner's Comments

Most candidates used a gas syringe to collect the carbon dioxide produced although some collected the gas by displacement of water from a measuring cylinder or an upturned burette.
Candidates must take sufficient time when drawing diagrams to ensure that they are fully labelled and that the system is gas tight.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
<tr><td>64</td><td></td><td></td><td><table><tr><th>acid</th><th>base</th><th>salt</th></tr><tr><td>sulfuric acid</td><td>copper oxide</td><td>copper sulfate</td></tr><tr><td>nitric acid</td><td>sodium carbonate</td><td>sodium nitrate (1)</td></tr><tr><td>hydrochloric acid (1)</td><td>zinc oxide</td><td>zinc chloride</td></tr><tr><td>sulfuric acid</td><td>magnesium oxide / magnesium hydroxide / magnesium carbonate (1)</td><td>magnesium sulfate</td></tr></table></td><td>3</td><td>allow correct formulae i.e.
$NaNO_3$ (1)

HCl (1)

MgO / $Mg(OH)_2$ / $MgCO_3$ (1)

Examiner's Comments

This question was about fertilisers.

Many candidates were awarded the marks for sodium nitrate and magnesium oxide (or carbonate). Hydrochloric acid was less well known, with chloric acid being a common response.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>3</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
65			Level 3 Correct word and symbol equation AND explanation that reaction involves both oxidation and reduction. Quality of communication does not impede communication of science at this level. (5 – 6 marks) Level 2 Correct word and symbol equation OR explanation that reaction involves both oxidation and reduction. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) Level 1 Correct word equation OR Correct symbol equation OR Correct statement about OIL RIG OR explains why iron is oxidised OR explains why copper ions are reduced. Quality of communication impedes communication of the science at this level. (1 – 2 marks) Level 0 Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to A* Indicative scientific points at levels 3 must include: • Fe + $CuSO_4$? $FeSO_4$ + Cu • oxidation because Fe loses electrons – could be shown as a half equation • reduction because Cu^{2+} gains electrons – could be show as a half equation Indicative scientific points for all levels could include: • oxidation is loss of electrons (OIL) • reduction is gain of electrons (RIG) • electrons are transferred • iron + copper(II) sulfate ? copper + iron(II) sulfate ignore missing oxidation states in the names do not allow copper(II) instead of copper in RHS of equation Use the L1, L2, L3 annotations in Scoris, do not use ticks Examiner's Comments This six mark question was about oxidation and reduction in a displacement reaction. Candidates had to construct both a word and a symbol equation and to obtain level 3 explain why the reaction involved both oxidation and reduction. Many candidates could write the two equations but a common misconception was to refer to the element copper as copper(II) and use the oxidation numbers in the formulae writing 'Fe_2SO_4' and 'Cu_2SO_4'. The concept of OIL RIG was often well known but candidates had real difficulty applying this information Candidates needed to be precise when explaining the species oxidised and the

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Question			Answer/Indicative content	Marks	Guidance
					one reduced. It was important that it was the iron losing electrons and the copper ions gaining electrons. The best answers made this clear by the use of the appropriate half-equations.
			Total	6	
66			C	1	
			Total	1	

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