OCR GCSE GATEWAY CHEMISTRY A · J248

CHEMISTRY



MARK SCHEME

C3.1 INTRODUCING CHEMICAL REACTIONS

SCORE	PERCENTAGE
/251	%

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Question			Answer/Indicative content	Marks	Guidance
1			$C_{15}H_{32} \rightarrow 2C_6H_{12} + C_3H_8$ (1)	1	ALLOW any correct multiple
			Total	**1**	
2	a		$S + O_2 \rightarrow SO_2$ (1) $2SO_2 + O_2 \leftrightharpoons$ (1) $2SO_3$ (1) $SO_3 + H_2O \rightarrow H_2SO_4$ (1)	4	One mark for each correct balanced equation One mark for reversible reaction sign
	b		17 (g) of ammonia makes 66 (g) of ammonium sulfate So 51 g makes 198 g of ammonium sulfate (1)	1	
			Total	**5**	
3		i	Same number of electrons in outer shell / all have 7 electrons in outer shell (1)	1	ALLOW outer electrons or valence electrons rather than electrons in the outer shell ALLOW valence shell rather than outer shell DO NOT ALLOW the wrong number of electrons in the outer shell
		ii	$2Na + Br_2 \rightarrow 2NaBr$ Correct formulae of reactants and products (1) Balancing – depend on correct formulae (1)	2	ALLOW any correct multiple of the equation including fractions **ALLOW** = or ⇌ instead of → DO NOT ALLOW and or & instead of + ALLOW one mark for correct balanced equation with minor errors of case and subscript e.g. 2NA + Br2 → 2NaBr
		iii	KAt (1)	1	
			Total	**4**	
4			C	1	
			Total	**1**	
5			C	1	
			Total	**1**	
6	a	i	no of moles of X = 0.2 (1) no of moles of oxygen = 0.1 (1) no of moles of X oxide = 0.2 (1)	3	

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Question			Answer/Indicative content	Marks	Guidance
		ii	$2X + O_2 \rightarrow 2XO$ (2) formulae (1) balancing (1)	2	balancing is conditional on correct formulae ALLOW ecf from calculations of numbers of moles
	b		16.9 (g) scores (3) but if answer incorrect then RFM of NaOH = 40.0 and RFM of Na_2SO_4 = 142.1 (1) idea that 2 moles of NaOH react to produce 1 mole of Na_2SO_4 (1)	3	ALLOW 16.89 (2) ALLOW ecf from incorrect RFMs
			Total	6	
7			$ZnO + 2HNO_3 \rightarrow Zn(NO_3)_2 + H_2O$ correct formulae (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 + $2HNO^3 \rightarrow Zn(No_3)_2 + H_2$
			Total	2	
8			$24.3 / 6.022 \times 10^{23}$ (1) 4.04×10^{-23} (1)	2	1 mark for $4.03520425 \times 10^{-23}$ or correctly rounded up but not to 3 sig. fig.
			Total	2	
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		i	Same number of electrons in outer shell / all have 7 electrons in outer shell (1)	1	**ALLOW** outer electrons or valence electrons rather than electrons in the outer shell **ALLOW** valence shell rather than outer shell **DO NOT ALLOW** the wrong number of electrons in the outer shell
		ii	$2Na + Br_2 \rightarrow 2NaBr$ Correct formulae of reactants and products (1) Balancing – depend on correct formulae (1)	2	**ALLOW** any correct multiple of the equation including fractions **ALLOW** = or ⇌ instead of → **DO NOT ALLOW** and or & instead of + **ALLOW** one mark for correct balanced equation with minor errors of case and subscript, e.g. 2NA + Br2 → 2NaBr
		iii	KAt (1)	1	
			Total	**4**	
11	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**	

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Question			Answer/Indicative content	Marks	Guidance
12			B	1	
			Total	1	
13			* *Please refer to the marking instruction point 10 for guidance on how to mark this question.* Level 3 (5–6 marks) Suggestion would enable pure dry samples of all three components to be obtained in the correct sequence with clear explanations of why the methods work. *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) Suggestion would enable pure dry samples of two of the components of the mixture to be obtained with an attempt at an explanation. *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) Suggestion would enable a pure sample of one of the components to be obtained. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* 0 marks *No response or no response worthy of credit.*	6	AO3.3a: Analyse information in the table to develop experimental procedures • Wash solid **C** with water and allow to dry. • Evaporate solution of **B** to obtain solid crystals. • Using a magnet will separate **A** from other two. • Add water to mixture of **B** and **C**. • Filter mixture of **B** and **C**. • Rinse and dry solid **C**. • Evaporate solution of **B**. AO2.2: Apply knowledge of purification techniques • **A** is magnetic or **B** and **C** are not magnetic. • **A** can be removed from the mixture as it will stick to the magnet. • **B** will dissolve but **C** will not. • Solid **C** will be left after filtering.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
14			**Correct – Any two from:** sulfuric acid reacts with zinc and / or zinc carbonate to make zinc sulfate (1) zinc reacts with acid to make hydrogen (1) zinc carbonate reacts with acid to make carbon dioxide (1) **Incorrect – Any two from:** Both reactions do not make hydrogen (1) zinc and / or zinc carbonate will not react with hydrochloric acid to make zinc sulfate (1) zinc carbonate does not make hydrogen when it reacts with acid (1)	4	
			Total	**3**	
15	a	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	
	b		$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ (2) correct formulae (1) balancing (1)	2	balancing mark is conditional on correct formulae **ALLOW** any correct multiple, e.g. $2C_3H_8 + 10O_2 \rightarrow 6CO_2 + 8H_2O$ (2) **ALLOW** = or Δ or ⇌ 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. $C^3H^8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ (2)
			Total	**6**	
16	a		large surface area to volume ratio (2)	2	**ALLOW** large surface area (1)
	b		Number of particles = 80.0 mg ÷ (5.0×10^{-3} mg) (1) = 16 000 particles (1)	2	
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
17		i	sulfuric acid ? 6.12 (g) (1) hydrogen ? 0.16 (g) (1)	2	**Examiner's Comments** Many candidates correctly used the data to calculate the missing masses
		ii ii	**LOOK FOR ANSWER FIRST OF ALL** **IF mass = 50 g AWARD 2 MARKS** idea of 1 × 10 / 2 × 5 / 0.5 × 20 (1)	2	**allow** 10 × 10/2 or 10 × 5/1 or 10 × 2.5/0.5 (1) **Examiner's Comments** Calculate the mass of magnesium sulfate made from 10 g of magnesium.
			Total	**4**	
18			$2SO_2 + O_2$? $2SO_3$ formulae (1) balancing conditional on correct formulae (1)	2	**allow** any correct multiple e.g $4SO_2 + 2O_2$? $4SO_3$ (2) **allow** = or ? for arrow **not** 'and' or & for + **allow** one mark for correct balanced equation with minor errors in case, subscript and superscript e.g. $2So_2 + O^2$? $2SO_3$ (1) **Examiner's Comments** Many candidates were able to write the correct balanced symbol equation for the reaction of sulfur dioxide with oxygen to make sulfur trioxide. 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 the product as SO_4.
			Total	**2**	

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Question			Answer/Indicative content	Marks	Guidance
19			96 (1)		Examiner's Comments The mass of oxygen in the sample of vitamin C was usually corrected calculated as 96g.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
20			[Level 3] Identifies compounds A and B, with explanations AND constructs the word equation Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) [Level 2] Identifies either compound A or B, or the elements or ions present in either A or B AND constructs the word equation OR Identifies both compounds A and B, or the elements or ions present in both A or B, with explanations Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) [Level 1] Identifies one element or ion present in either A or B OR constructs the word equation 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 C Indicative scientific points may include: Word equation potassium chloride + silver nitrate ? silver chloride + potassium nitrate allow correct formulae or mix of words and formulae allow $KCl + AgNO_3$? $AgCl + KNO_3$ Compound A • compound A contains sodium (ions) • compound A contains chloride (ions) • compound A is sodium chloride Reasons • because sodium gives a yellow flame test colour • because chloride ions give a white ppt with silver nitrate Compound B • compound B contains iron(II) (ions) • compound B contains bromide (ions) • compound B is iron(II) bromide Reasons • iron(II) (ions) give a green ppt with sodium hydroxide • bromide (ions) give a cream ppt with silver nitrate allow solid instead of ppt Use the L1, L2, L3 annotations in RM Assessor; do not use ticks. Examiner's Comments This 6 mark question was targeted up to grade C. To gain credit at level 3 (5 – 6 marks) candidates needed to write the

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Question			Answer/Indicative content	Marks	Guidance
					word equation for the reaction and to identify compounds A and B with explanations. Most candidates were unable to interpret the results to identify compounds A and B and only gained credit at Level 1 for the word equation.
			Total	6	
21			potassium hydroxide (1) hydrogen (1)	2	order unimportant **allow** correct formulae i.e. H2 (1) and KOH (1) **not** H **Examiner's Comments** Examiners saw a range of incorrect responses.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
22			acid strength – idea that acid strength or strong or weak is a measure of the degree of ionisation of the acid (1) concentration – idea of the number of moles (of acid) in 1dm^3 (1)	2	**allow** strong acid –dissociation is complete / weak acid- dissociation is partial (1) reference to concentration or number of hydrogen ions is **not** sufficient reference to pH is **not** sufficient **ignore** proportion of hydrogen ions that ionise in water but **allow** proportion of molecules that ionise **allow** amount of particles in a given or fixed volume / amount in 1 dm^3 **ignore** amount of particles in an area **allow** amount, mass or moles is any specified volume e.g. cm^3 or litre **Examiner's Comments** This question was about chlorine and fluorine. Candidates found it difficult to give an accurate definition for either acid strength or for concentration. Common misconceptions for acid strength were to refer to the number of hydrogen ions, the strength of the hydrogen ions or the pH of the solution. The best answers often gave an example such as ethanoic acid is a weak acid since it only partially ionises in solution. Another misconception was to refer to the hydrogen ions being ionised rather than the acid molecules. Candidates were more likely to be awarded a mark for acid concentration. Typical answers that gained credit included 'the amount of acid in a certain volume' or 'the mass in 1 cm^3'.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
23			**A** – chloride (ions) **B** – iodide (ions) and sulfate (ions) **C** – sulfate (ions) **all correct (2)** **BUT** **one or two correct (1)** **then one** correct explanation from (1) white ppt with lead nitrate indicates chloride (ions) yellow ppt with lead nitrate indicates iodide (ions) white ppt with barium chloride indicates sulfate (ions)	3	**allow** correct formulae of ions **allow** chlorine and iodine (ions) **ignore** names of compounds **allow** lead ions rather than lead nitrate **allow** barium ions rather than barium chloride **Examiner's Comments** Candidates found this question very challenging and many candidates did not understand the term negative ion and as a result identified barium chloride ions, lead nitrate ions or sodium ions as negative ions. The test for halide ions was recognised by more candidates than that for sulfate ions and some candidates identified the sulfate ion as S^{2-}. Only the most able candidates were able to give all the correct ions present in the three solutions and provide at least one correct explanation.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
24			idea of electron gained (1) **but** (Group 7 elements) going up the group easier to gain electrons / fluorine gains electrons more readily / ora for astatine (2)	2	assume unspecified comments refer to fluorine electrons lost = 0 for the question **allow** fluorine has a smaller atom / astatine has a larger atom / fluorine has less (electron) shielding / astatine has more (electron) shielding / stronger attraction between outer electrons and nucleus in fluorine / ora where appropriate (1) **Examiner's Comments** This question was about trends in Group 7. Candidates found quite challenging and often referred to electron loss rather than electron gain. Other candidates used the wrong information from the table relating reactivity with melting and boiling point. The best answers referred to fluorine being the most able to gain electrons. Sometimes candidates gave higher level answers such as increased shielding down the group.
			Total	2	
25			zinc + (dilute) hydrochloric (acid) → zinc chloride + hydrogen	1	any order for reactants any order for products **allow** unbalanced symbol equation e.g. Zn + HC*?* ? Zn C*?*$_2$ +H_2 **allow** mix of name and correct formula **Examiner's Comments** This question was about the reactions of zinc and iron with hydrochloric acid. Most candidates could write the word equation for the reaction between zinc and hydrochloric acid.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
26		i	gas produced / gas escapes / carbon dioxide made / steam made (1)	1	**not** name or formula of incorrect gas **ignore** references to evaporation unless linked with water Examiner's Comments This question was about the thermal decomposition of sodium hydrogencarbonate. Candidates did not often appreciate that sodium hydrogencarbonate made a gas when it is heated and that this explains why there is a loss in mass. Even when candidates appreciated that a gas was made they often called the gas hydrogen.
		ii	5.3	1	unit **not** needed Examiner's Comments This question was about the thermal decomposition of sodium hydrogencarbonate. Some candidates were able to use simple ratios to work out that 5.3 g of sodium hydrogencarbonate would be made.

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Question			Answer/Indicative content	Marks	Guidance
		iii	**any two from** reaction not complete / AW did not heat for long enough / temperature not high enough (1) some solid spits out of the test-tube (1)	2	**allow** not all the water escapes (1) **allow** a mistake in the mass reading (1) <u>Examiner's Comments</u> This question was about the thermal decomposition of sodium hydrogencarbonate. Candidates found part (iii) very challenging and many gave very vague answers about making incorrect measurements. Candidates did not mention that the reaction was incomplete and/or that it was not heated for sufficient time.
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
27	a		nitrogen (1) phosphorus (1)	2	**allow** N **allow** P **not** O / oxygen **not** H / hydrogen i.e. nitrogen, phosphorus and oxygen = 1 mark phosphorus, oxygen and hydrogen = 0 mark Examiner's Comments This question was about fertilisers. Some candidates did not give the names of the essential elements in the fertiliser and gave the names of all the elements or included hydrogen and/or oxygen in their answers.
	b	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.

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Question			Answer/Indicative content	Marks	Guidance
		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	6	
28		i	air (1)	1	**allow** other ways of indicating answer e.g. tick or circle but the answer on the answer line takes precedence Examiner's Comments This question was about the manufacture of ammonia by the Haber process. Many candidates recognised that air was the source for nitrogen.
		ii	recycled (1)	1	**allow** sent round again / it is reacted together (again) Examiner's Comments This question was about the manufacture of ammonia by the Haber process. Some candidates thought that unreacted nitrogen and hydrogen was recycled but others stated it was vented into the air.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
29	a		Zn + 2HC*l* ? ZnCl_2 + H_2 (1)	1	**allow** correct multiples **allow** = or ? instead of ?. **not** 'and' or & instead of + **all** subscripts and case **must** be correct Examiner's Comments This question focused on rates of reaction. Most candidates correctly constructed the balanced symbol equation.
	b	i	1.47 (1)	1	**allow** 1.46 / 1.5 (1) **unit not needed** Examiner's Comments This question focused on rates of reaction. Many candidates correctly calculated the rate of reaction in part (i). 30 ÷ 44 was a common error, as was misreading the volume of hydrogen as 42 cm_3.
		ii	60 (1)	1	**unit not needed** Examiner's Comments This question focused on rates of reaction. In part (ii) the most common incorrect response was 120 cm_3.

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Question			Answer/Indicative content	Marks	Guidance
	c		particles more crowded / particles closer together / more particles in the same volume / more particles per unit volume (1) more collisions (1)	2	**allow** particles more concentrated / more particles in the same area **not** just more particles **not** particles have more energy / move faster / more energetic collisions **allow** higher level answers e.g. more frequent collisions / more collisions per second / collisions more often / more chance of collisions (1) Examiner's Comments This question focused on rates of reaction. Good responses explained the increase in the rate of reaction in terms of particles being more crowded / more particles in the same volume, hence more collisions. Candidates who did not score both marks often simply stated that there were more particles, but failed to describe within the same volume.
			Total	5	

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Question			Answer/Indicative content	Marks	Guidance
30		i	0.631 × 2.5 = 1.578 (1)	1	**allow** $\frac{2.500}{1.000} = 2.5$ and 0.631 × 2.5 = 1.578 (1) **allow** $\frac{1.000}{2.500} = 0.4$ and 0.631 ÷ 0.4 = 1.578 (1) **allow** 2.500 g makes $\frac{106}{168} \times 2.5\,\text{g}$ (1) **allow** correct working that shows both masses are 63% of original mass (1) Examiner's Comments This question tested aspects of quantitative chemistry, including conservation of mass and percentage yield. In part (i) most candidates realised that 0.631 x 2.5 = 1.578g.
		ii	LOOK FOR ANSWER FIRST OF ALL IF % YIELD = 71.2 AWARD 2 MARKS $\frac{1.124}{1.578} \times 100$ (1) 71.2 (1)	2	answer must have **three sig figs** **but** 71 scores (1) **allow** $\frac{actual}{predicted} \times 100$ **or** $\frac{am}{pm} \times 100$ (1) Examiner's Comments Most candidates correctly calculated the percentage yield in part (ii). A common error was 45.0% where candidates calculated 1.124/2.500 x 100, incorrectly using 2.500g as the theoretical mass instead of 1.578g. A significant number of candidates were penalised for not expressing their answer to three significant figures.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
31		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
32			potassium hydroxide + nitric (acid) → potassium nitrate + water one correct product, ie potassium nitrate / water (1) rest 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. Common misconception in this question were potassium nitroxide and nitrogen hydroxide as products of the reaction.
			Total	**2**	
33			$4Al + 3O_2$? $2Al_2O_3$ formulae (1) balancing - mark is conditional on correct formulae (1)	2	**allow** correct multiples e.g. $2Al + {}^3/_2O_2$? Al_2O_3 **allow** = or ? instead of ? **not** 'and' or & instead of + **allow** one mark for correct balanced equation with minor errors of case, subscript and superscript e.g. $4AL + 3O^2$? $2Al_2o_3$ (1) Examiner's Comments This question was about alloys. Many candidates were able to write the correct balanced symbol equation for the reaction of aluminium with oxygen to make aluminium oxide. 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 Al_23O_2.
			Total	**2**	

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Question			Answer/Indicative content	Marks	Guidance
34			$H^+ + OH^-$? 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	1	
35			nitrogen + oxygen ? nitrogen monoxide (1)	1	**allow** symbol equation even if not balanced $N_2 + O_2$? NO (1) **allow** = for ? **not** & or and for + Examiner's Comments The word equation was well constructed by most candidates. Occasionally 'water' was added on the right hand side, losing the mark.
			Total	1	
36	a		gas (1)	1	Examiner's Comments Less than half of candidates understood that (g) is the state symbol for a gas. 'Grams' was a very common incorrect answer.
	b		reversible reaction (1)	1	**allow** reaction that goes both ways / reaction that goes backwards and forwards (1) Examiner's Comments This question was well answered with most recognising that ? means that the reaction is reversible.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
37		i	copper carbonate ? copper oxide + carbon dioxide (1)	1	**allow** = instead of ? **not** and or & for + **allow** symbol equation but does not need to be balanced **allow** mix of correct formulae and words e.g. $CuCO_3$? copper oxide + CO_2 (1) **not** copper carbonate + heat ? copper oxide + carbon dioxide Examiner's Comments was poorly answered. Most candidates did not realise that copper oxide was the solid and stated copper carbonate ? carbon dioxide + solid and failed to score.
		ii	break down (of a substance) (using heat) (1)	1	**allow** a reaction which produces two or more substances from one substance (by heating) (1) **allow** (substance) decomposes (with heat) / break up (of a substance)(with heat) (1) **allow** cracking at high temperature (1) **allow** molecules break down / ion molecules break down (1) **ignore** breaks up bonds **not** heat particles broken down **not** breakdown of heat **not** elements or atoms break down **ignore** decay / dissolve Examiner's Comments just under a half of candidates understood what is meant by thermal decomposition. A number thought that it was a change of state or that elements were broken down and so failed to score.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
38			$2H_2 + O_2$? $2H_2O$ correct formulae (1) balancing (1) balancing mark is conditional on correct formulae	2	**allow** any correct multiple e.g. $4H_2 + 2O_2$? $4H_2O$ (2) **allow** = or ? for arrow **not** 'and' or & for + **allow** one mark for correct balanced equation with minor errors in case, subscript and superscript e.g. $2h_2 + O^2$? $2H_2o$ (1) ?Examiner's Comments? Many candidates could write the balanced equation for the reaction of hydrogen and oxygen to make water.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
39	a		idea of ion that is in the solution at start and at the end of the reaction (1)	1	**allow** an ion present that takes no part in the reaction / ion that does not react / they do not contribute towards the reaction **ignore** they do not change state during the reaction ?Examiner's Comments?? Candidates often mentioned that spectator ions do not take part in a reaction.
	b		collision frequency (between ions) is high (1)	1	**allow** large number of collisions (between ions) every second / lots of collisions (between ions) per unit time / high chance of collision (between ions) / highly likelihood of collisions (between ions) **not** collision frequency between atoms or molecules is high **allow** collision frequency between Pb^{2+} and $I^{?}$ is high **allow** positive and negative **ions** attract / oppositely charged ions attract **allow** has a low activation energy **ignore** ions cancel out Examiner's Comments Most candidates did not appreciate that the collision frequency of ions must be very high if the reaction is fast. Many candidates stated that the collision frequency would increase but this was not sufficient to be awarded a mark.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
40			FIRST LOOK AT THE ANSWER IF ANSWER = 33% AWARD 2 MARKS 0.33 g (1) 33 (%) (1)	2	**allow** ecf from wrong mass ?Examiner's Comments?? Many candidates could calculate the percentage of oxygen as 33%. Good answers showed the working out to show that the mass of oxygen in the sample was 0.33g. However a significant proportion of the candidates did not show any working out so they could not be awarded any error carried forward mark if they gave an incorrect percentage.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
41		i	idea that average only uses titrations 2, 3 and 4 / titration 1 is not used to calculate the average (1) titrations 2, 3 and 4 have a consistent value / titration 1 is a rough estimate / titration 1 could be an anomalous value / titration 1 is a range-finder / titration 1 is an outlier (1)	2	**allow** calculation of the mean using the values from 2, 3 and 4 **not** just use titration 3 **not** titration 3 is the mid-value **Examiner's Comments** Although many candidates appreciated that titre 1 was an anomaly or an outlier they did not always go on to state that the other three were used to calculate the mean. Only a small proportion of the candidates commented on the closeness of the last three titres. The best answers indicated why titre 1 was not used and then showed how the other three titres are used to get the mean titre. A common misconception was that 25.2 cm^3 was used as a titre because it was the mid-range value of the three best titres.
		ii	0.0015 **or** $1.5 \times 10^{?3}$ (1)	1	**ignore** trailing zeroes **Examiner's Comments** Many candidates could not calculate the amount in moles as 0.0015. The most common misconception was to forget to convert cm^3 into dm^3 and calculate the number of moles as 1.5.

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Question			Answer/Indicative content	Marks	Guidance
		iii	moles of HNO^3 = 0.0015 **or** 1.5 × $10^{?3}$ (1) concentration of HNO_3 = 0.0595 (1)	2	LOOK FOR THE ANSWER FIRST IF IT IS 0.0595 AWARD 2 marks **allow** ecf from (ii) **allow** one mark for 0.06 / 0.05952 or answers with more significant figures **allow** ecf providing answer has three significant figures i.e. mole/volume Examiner's Comments A significant proportion of the candidates did not attempt this question often because they could not do (ii). Only the very best answers showed the working out for the calculation. Centres should advise candidates that it is important to show the working out to allow examiner's to award error carried forward marks. Many candidates did not quote the final answer, 0.0595 mol/dm^3, to three significant figures as required in the question and gave the answer as 0.06 mol/dm^3.
			Total	5	
42			zinc + copper sulfate ? copper + zinc sulfate (1)	1	**allow** = instead of ? **not** and or & in equation **allow** reactants and products in any order **not** copper(II) as one of the products **allow** mix of words and correct formulae **ignore** state symbols **allow** correct symbol equation even if not balanced Zn + $CuSO_4$? Cu + $ZnSO_4$ **allow** correct name with an incorrect formula but not incorrect name with correct formula Examiner's Comments Although many candidates could construct the word equation a significant proportion wrote copper(II) rather than just copper.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
43	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
44			Level 3 Applies knowledge to correctly rank all of the samples in order of hardness AND identifies the type of hardness in two of the samples with a correct explanation for at least one of them. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) Level 2 Applies knowledge to correctly rank all of the samples in order of hardness AND identifies the type of hardness in one of the samples (no explanation needed). OR identifies the type of hardness in two of the samples (no explanation needed). OR Identifies the type of hardness in one of the samples with a correct explanation. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) Level 1 Applies knowledge to either correctly rank two of the samples in order of hardness OR identifies the type of hardness in one of the samples (no explanation needed). 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 C. Indicative scientific points may include: Order of hardness • B>A>C Types of hardness and explanation • sample A contains permanent hardness • as not softened by boiling • sample B contains both temporary and permanent hardness • as some (but not all) of the hardness is removed by boiling • sample C contains only temporary hardness • as it completely softened by boiling Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments Many candidates found this to be a difficult question. Few candidates could place the water samples in order of hardness. This was usually because they thought that if some or all of the hardness could be removed by boiling then the water sample must be softer than one where hardness was not removed by boiling. This gave an order of B, C, A which limited the response to level 1 (1 or 2 marks). Better candidates identified sample A as permanently hard water and sample C as temporary hard water. Very few noted that sample B contained both temporary and permanent hardness. Correct identification of the type of hardness in one of the samples with a correct reason scored level 2 (3 or 4 marks). Correct identification of the type of hardness in two of the samples with no explanation also scored level 2. To gain level 3 candidates needed to rank the samples correctly in order of hardness and identify the types of hardness in two of the

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Question			Answer/Indicative content	Marks	Guidance
					samples with correct reasons.
			Total	6	
45			$C_6H_{12}O_6$? $2CO_2$ + $2C_2H_5OH$ formulae (1) balancing - dependent on correct formulae (1)	2	**allow** C_2H_6O as formula for ethanol **allow** any correct multiple e.g. $2C_6H_{12}O_6$? $4CO_2$ + $4C_2H_5OH$ **allow** = or ? for arrow **not** 'and' or & for + **allow** one mark for correct balanced equation with minor errors of case, subscript or superscript e.g. $C_6H_{12}O_6$? $2Co_2$ + $2C_2H_5OH$ **Examiner's Comments** The best candidates invariably scored 2 marks on this question. They gave a correctly balanced symbol equation. Weaker candidates either failed to score or gave the correct formulae with either no attempt at balancing or incorrect balancing and scored 1 mark.
			Total	2	
46		i	carbon, hydrogen **and** fluorine (1)	1	**all three** required **allow** any order **ignore** symbols **not** fluoride **Examiner's Comments** This question was well answered. Most candidates identified carbon, hydrogen and fluorine in part (i). Occasionally chlorine was incorrectly stated. Most identified 8 atoms in part (ii). Weaker candidates attempted to calculate the relative formula mass.
		ii	8 (1)	1	
			Total	2	

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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>47</td><td>a</td><td></td><td>copper hydroxide ? copper oxide + water (1)</td><td>1</td><td>allow steam for water

allow correct formulae and mix of formulae and names the equation does not need to be balanced
$Cu(OH)_2$? $CuO + H_2O$ (1)

allow heat above arrow
not copper hydroxide + heat ? copper oxide + water

Examiner's Comments

Better candidates correctly wrote this word equation. A significant number of candidates lost the mark as they included ‘+ heat’ on the left hand side of the equation.</td></tr>
<tr><td></td><td>b</td><td></td><td><table><tr><th>experiment number</th><th>Mass of water made in g</th></tr><tr><td>1</td><td>0.09</td></tr><tr><td>2</td><td>0.18</td></tr><tr><td>3</td><td>0.28</td></tr><tr><td>4</td><td>0.37</td></tr></table>
mass of water calculated for missing values (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)</td><td>3</td><td>allow ecf from incorrect calculation

Examiner's Comments

Most candidates could correctly calculate the mass of water by subtraction. A small number followed the pattern of mass of water and stated 0.27 and 0.36 and lost that mark. Many also stated that, as the mass of copper hydroxide increases the mass of water produced also increases, and gained the second mark. Few gained the third mark for recognising that the relationship is a direct proportionality.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
48	a		colour of chlorine – (pale) green (1) state of bromine – liquid (1) use of iodine – sterilise wounds / antiseptic (1)	3	**allow** light green (1) **ignore** yellow / green **allow** disinfectant / pharmaceuticals / medicines / photographic chemicals / printing ink / dyes / making animal feeds / added to salt (to avoid thyroid disease) / making ethanoic acid / making polymers (1) **allow** sterilisation (1) **allow** testing for starch (1) **ignore** cleaning medical equipment **Examiner's Comments** Most candidates scored at least 1 mark on this question with many scoring 2 marks and a few all 3 marks. The colour of chlorine was not well known. 'Yellow' and 'blue' were common incorrect answers. The majority of candidates knew that bromine was a liquid. The commonest use of iodine was as an antiseptic although 'making medicines' was a common acceptable answer.
	b		sodium + bromine ? sodium bromide (1)	1	**allow** correct formulae i.e. Na + Br_2 ? NaBr or mix of words and correct formulae If formulae used balancing is not necessary **Examiner's Comments** Most candidates could successfully write the word equation.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
49			$Mg + 2HCl$? $MgCl_2 + H_2$ formulae correct (1) balancing (1)	2	**allow** any correct multiple, including fractions **allow** = / ? instead of ? **not** and / & balancing mark is dependent on the correct formula **but allow** 1 mark for a balanced equation with minor errors of case, subscripts, superscripts, etc Mg + 2HCL ? MgCl2 + H_2 **Examiner's Comments** Most candidates scored 2 marks for the correct balanced symbol equation. As before, 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 altering the formula for hydrochloric acid, i.e. H_2CI_2.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
50		i	at the anode electrons are lost which is oxidation (1) at the cathode electrons are gained which is reduction (1)	2	**allow** 1 mark if oxidation is described as electron loss and reduction as electron gain without identification of the electrodes or with incorrect identification of the electrodes **Examiner's Comments** Good responses described the reaction at the anode as oxidation because electrons are lost and the reaction at the cathode as reduction because electrons are gained. One mark was awarded to candidates who described oxidation as electron loss and reduction as electron gain, without identification of the electrodes (or with incorrect identification of the electrodes).
		ii	the anode loses mass because copper ions go into solution (1) the cathode gains mass because the copper ions gain electrons and become copper (1)	2	if ion is missed out in both marking points then **allow** one mark **allow** copper ions move from the anode to the cathode for 1 mark if no other mark awarded **Examiner's Comments** The aspects of the specification was not well known in this part. To gain credit candidates were required to describe copper ions going into solution at the anode and then those copper ions gaining electrons and becoming copper at the cathode.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
51			C_3H_8 + 3½O_2 ? 3CO + 4H_2O formulae (1) balancing (1)	2	**allow** any correct multiple, including fractions **allow** = / ? instead of ? **not** and / & balancing mark is dependent on the correct formula **but allow** 1 mark for a balanced equation with minor errors of case, subscripts, superscripts, etc eg C_3H_8 + 3½O2 ? 3CO + 4H2O **Examiner's Comments** This question required candidates to write a balanced symbol equation for the incomplete combustion of propane in oxygen. This was a challenging equation for candidates. 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 wrote an incorrect formula for carbon monoxide, e.g. CO_2, or failed to balance the oxygen atoms on the left hand side of the equation.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
52		i	$H_2 + O_2$? H_2O_2 (1)	1	**allow** = or ? for arrow **allow** correct multiples Examiner's Comments Many candidates could write the balanced symbol equation. Only a very small proportion of the candidates changed the formulae either writing H or O or having the product as H_2O. The definition of 100% atom economy
		ii	no unwanted products / no waste products / all atoms in reactants end up in the product (1)	1	**allow** only one product **ignore** has the same number of atoms on both sides of the equation Examiner's Comments Was not well known and many candidates gave a definition that was more appropriate for the conservation of mass.
		iii	idea that 100 g is 20 × 5 g (1) So mass is 85 × 20 (1)	2	**allow** 1 g of H_2 makes 17 g of H_2O_2 **allow** 100 g of H_2 makes 17 × 100 g of H_2O_2 Examiner's Comments Candidates used a variety of approaches to show that 100g of hydrogen makes 1700g of hydrogen peroxide. The best answers worked out how much 1g of hydrogen would make and then multiplied this answer by 100.
		iv	LOOK FOR ANSWER FIRST OF ALL IF percentage yield = 90 AWARD 2 MARKS $\frac{1530}{1700} \times 100$ (1) 90 (1)	2	**allow** $\frac{actual}{predicted} \times 100$ **or** $\frac{am}{pm} \times 100$ (1) Examiner's Comments Many candidates could calculate the percentage yield as 90%.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
53	a		$CuCO_3$? $CuO + CO_2$ (1)	1	**allow** = for ? **not** and or & for + **allow** any correct multiples **Examiner's Comments** The balanced symbol equation was correctly written down by a number of candidates. A number reversed the equation and put copper carbonate as the product scoring no marks.
	b	i	4.40 g (1)	1	**Examiner's Comments** Was well answered.
		ii	8.80 g (1)	1	**allow** ecf from part (i) ie 2 × answer (i) **Examiner's Comments** Required a deeper understanding of the figures and was found to be a difficult calculation.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
54		i	$2CuO + C$? $2Cu + CO_2$ 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** Was well answered.
		ii	carbon dioxide given off (1)	1	**allow** gas given off **not** the name of a wrong gas given off **Examiner's Comments** Was not well answered. An explanation of why the mass of the test tube and contents decreased was often attributed to evaporation. Change of state was another common answer.
			Total	3	
55			zinc + copper sulfate ? copper + zinc sulfate (1)	1	**allow** = instead of ? order of reactants and products does not matter **not** and or & in equation **ignore** roman numerals in formula **allow** correct symbol equation even if not balanced $Zn + CuSO_4$? $Cu + ZnSO_4$ **Examiner's Comments** Many candidates correctly gave the word equations. Many lost marks by adding extra things to the equation.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
56			$2C_6H_{14} + 19O_2$? $12CO_2 + 14H_2O$ right hand side correct (1) left hand side correct (1)	2	Examiner's Comments Many candidates correctly balanced the equation. One mark was awarded for balancing the oxygen molecules and one mark for balancing the products. Where candidates scored only one mark it was usually for balancing the products.
			Total	2	
57			6 (1)	1	unit **not** needed Examiner's Comments Candidates found this question more difficult than (a)(ii) because it involved the use of a ratio. Candidates rarely showed the working out used to get to the correct answer of 6.0 tonnes.
			Total	1	
58			2Na + Cl_2 ? 2NaCl correct reactants and products (1) correct balancing (1)	2	**allow** any correct multiple, including fractions **allow** = instead of ? **not** 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. 2NA + C*l*2 ? 2NAC*l* Examiner's Comments Candidates found balancing the equation for the reaction between sodium and chlorine very demanding. Candidates often changed the formulae given and used Cl instead of Cl_2, $NaCl_2$ instead of NaCl. Some candidates even use diatomic sodium, Na_2, in their equations.
			Total	2	

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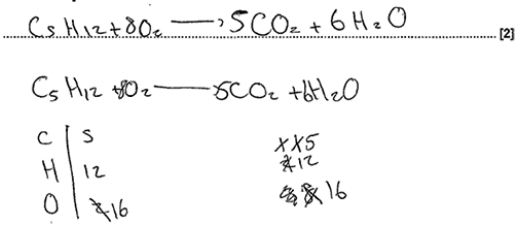
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Question			Answer/Indicative content	Marks	Guidance
59			3 / three (1)	1	ignore Cu, Fe, S Examiner's Comments Many candidates could interpret the formula given and deduce that it contains three different elements. Some candidates gave answers that referred to the number of atoms in the formula instead.
			Total	1	
60	a		sulfur + oxygen ? sulfur dioxide (1)	1	allow $S + O_2$? SO_2 allow mix of formulae and names allow = in the equation not & or and instead of + not sulfur oxide but allow sulfur( ) oxide Examiner's Comments Most candidates could write the word equation. There were very few examples of answers where the candidate attempted a symbol equation.
	b		$2NO_2 + H_2O$? $HNO_2 + HNO_3$	1	allow in the question if answer line is blank ignore errors in case, subscript and superscript Examiner's Comments Candidates found this question very challenging. A significant proportion of the candidates changed the formulae given for example writing H_2O_2 rather than H_2O.
			Total	2	
61			MgF_2 (1)	1	Allow F_2Mg allow $Mg^{2+}(F^-)_2$ not $Mg^{2+}F_2^-$
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
62			$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$ Formulae ✓ Balancing ✓	1(AO 1.1)	**ALLOW** any correct multiple, including fractions **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 eg $C_5H_{12} + 8O2 \rightarrow 5Co_2 + 6h_2O$ Examiner's Comments Many candidates wrote out the formulae correctly and so gained the first marking point, although some candidates used lower case letters. Many stopped at the formula stage without attempting the more difficult problem of balancing the equation. higher ability candidates went on to do the balancing, often with careful working showing lists of the different atoms on each side. See **exemplar 3**. Exemplar 3 
			Total	**2**	
63			C ✓	1(AO2.2)	Examiner's Comments **Misconception** B was a very common misconception in this question, when candidates calculated the number of oxygen molecules rather than the number of oxygen atoms.
			Total	**1**	
64			D ✓	1(AO2.2)	
			Total	**1**	

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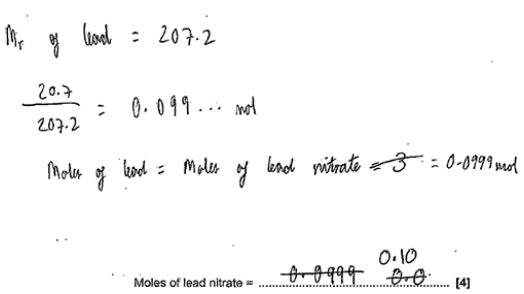
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Question			Answer/Indicative content	Marks	Guidance
65		i	$3Pb + 8HNO_3 \rightarrow 3Pb(NO_3)_2 + 2NO + 4H_2O$ Formulae ✓ Balancing ✓	2 (AO1.1) (AO2.2)	**ALLOW** any correct multiple, including fractions **ALLOW** = / ⇌ instead of → **DO NOT ALLOW** 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. $3PB + 8HNO_3 \rightarrow 3Pb(NO_3)_2 + 4H_2O$ Examiner's Comments Higher ability candidates were able to write the correct balanced symbol equation for the reaction of lead with nitric acid. One mark was given 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. Most candidates gained 1 mark for the correct reactants and products but were unable to correctly balance the equation.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.10 award 4 marks M_r of $Pb(NO_3)_2$ = 331.2 or 207g of Pb would produce 331.2g of $Pb(NO_3)_2$ / 20.7g of Pb would produce 33.12g of $Pb(NO_3)_2$ ✓ Moles = mass ÷ M_r / 33.1 ÷ 331.2 ✓ = 0.09993961 ✓ = 0.10 (2 sig. figs) ✓ OR Ratio of Pb : $Pb(NO_3)_2$ is 3:3 / 1:1 ✓ RAM of Pb is 207 or 207.2 ✓ (so) 20.7g of Pb is 0.10 mol or 0.099903474 ✓	4 (AO3 × 2.2) (AO1.2)	**ALLOW** 331 **ALLOW ECF** from balanced equation in (i) **ALLOW** 3 marks for 0.1 (ie not 2 sig figs) **ALLOW ECF** from incorrect calculation for sig fig mark **ALLOW ECF** from balanced equation in (i) **ALLOW ECF** for calculation of mol of Pb from incorrect RAM Examiner's Comments Higher ability candidates scored 4 marks on this question. 'Error carried forward'

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Question			Answer/Indicative content	Marks	Guidance
			(and so) this will make 0.10 mol of $Pb(NO_3)_2$ ✓		was allowed from the candidate's symbol equation in part (i). It is worth centres stressing to candidates that if they are asked to give their answer to a specific number of significant figures, they can only gain full marks by doing so. Exemplar 5  This response illustrates a clearly set out calculation response, which is easy for the examiner to follow. When candidates write numbers at random in the answer space it is difficult for the examiner to seek out credit-worthy points and / or give marks for errors carried forward.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
66			$Mg + 2HCl \rightarrow MgCl_2 + H_2$ Formulae ✓ Balancing ✓	2(AO 2 × 2.2)	**ALLOW** any correct multiple, including fractions **ALLOW** = / ⇌ 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 eg Mg + 2HCL → Mgcl_2 + H2 **IGNORE** state symbols Examiner's Comments As in Question 18(a), one mark was given for the correct reactants and products and one mark for the correct balancing. The balancing mark was dependent on the correct formulae, but one mark was allowed for a balanced equation with minor errors in subscripts or formulae. When candidates did not gain marks, it was usually because they wrote MgC*l* as the formula of magnesium chloride. 2H, rather than H_2, as the other product was also a common error.
			Total	2	
67			B	1 (AO 1.1)	
			Total	1	
68			C	1 (AO 2.1)	Examiner's Comments Candidates found this difficult, A and B were common incorrect responses.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
69			$N_2 + 3H_2 \rightleftharpoons 2NH_3$ Formulae ✓ Balancing ✓	2(AO 2.2)	**ALLOW** any correct multiple, including fractions **DO NOT ALLOW** and / & instead of '+' balancing mark is dependent on the correct formulae but **ALLOW** = / → instead of ⇌ **ALLOW** 1 mark for a balanced equation with a minor error in subscripts / formulae eg $N_2 + 3H_2 \rightleftharpoons 2Nh_3$ <u>Examiner's Comments</u> Most candidates were able to write the correct balanced symbol equation for the reaction of nitrogen with hydrogen. One mark was given for the correct reactants and products and one mark for the correct balancing. The balancing mark was dependent on the correct formulae, but one mark was allowed for a balanced equation with minor errors in subscripts or formulae. For example, $N_2 + 3H2 \rightleftharpoons 2Nh_3$, would gain one mark. When candidates did not gain marks, it was often because they wrote 6H as a reactant, rather than $3H_2$. AfL Although it was not penalised in this question, candidates should be taught to use the ⇌ symbol for a reversible reaction, rather than an →.
			Total	2	
70			A	1 (AO1.1)	
			Total	1	
71			B	1 (AO2.1)	
			Total	1	

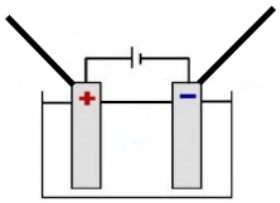
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Question			Answer/Indicative content	Marks	Guidance
72			C	1 (AO2.1)	
			Total	**1**	
73			D	1 (AO2.1)	
			Total	**1**	
74		i	Hydrogen ion / H^+	1 (AO1.1)	
		ii	$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ Reactant ✓ Product ✓	2 (AO2.2 ×2)	
			Total	**3**	

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Question			Answer/Indicative content	Marks	Guidance
75	a	i	anode  cathode	2 (AO2 × 1.2)	All correct = 2 marks 1 or 2 correct = 1 mark
		ii	Positive electrode: bromine ✓ Negative electrode: lead ✓	2 (AO2 × 2.2)	**DO NOT ALLOW** bromide **ALLOW** reversed 1 mark
		iii	$PbBr_2$ ✓	1 (AO2.1)	
	b	i	All points plotted correctly scores 2 mark ✓✓ Straight line of best fit through the points ✓	3 (AO2 × 2.2 1.2)	**ALLOW** ± ½ square 3 or 4 points plotted correctly scores 1 mark **ALLOW** correctly drawn line of best fit through incorrectly drawn points; this may be a curve
		ii	0.72 (A) ✓	1 (AO3.1a)	**ALLOW** answer in the range 0.70 A – 0.74 A / ecf
		iii	**FIRST CHECK ANSWER ON ANSWER LINE** **If answer = 47(g) award 2 marks** 5A = 15.5(g) = 15.5 × 3 = 46.5(g) ✓ = 47(g) (2 sig. figs) ✓	2 (AO2.1 1.2)	**ALLOW** 1.0 A = 3.1 (g) (from graph or table) 10(A) = 31(g) and 5 (A) = 1.55 (g) ✓ 15(A) = 31 + 1.55 = (46.5) 47 (g) ✓
			Total	**11**	

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Question			Answer/Indicative content	Marks	Guidance
76			$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$ Formulae ✓ Balancing ✓	2 (AO2.2 ×2)	**ALLOW** any correct multiple, including fractions **ALLOW** = / ⇌ instead of → **NOT** 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. $CH_{4\,(g)} + 2O_{2\,(g)} \rightarrow 2H_2O_{\,(g)} + Co_{2\,(g)}$
			Total	**2**	
77			B ✓	1 (AO2.1)	
			Total	**1**	
78			D ✓	1 (AO2.2)	
			Total	**1**	
79			B ✓	1 (AO2.2)	
			Total	**1**	
80			D ✓	1 (AO1.1)	
			Total	**1**	
81			B ✓	1 (AO2.1)	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
82	a	i	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$ Reactants ✓ Balancing ✓	2 (AO2.2)	**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 eg $Zn + 2HCL \rightarrow ZNCl_2 + H_2$
		ii	Exothermic ✓	1 (AO1.1)	
	b		Energy required to start the reaction / energy required for a successful collision to occur / AW ✓	1 (AO1.1)	**IGNORE** energy needed to activate the reaction / amount of energy for the reaction to take place
			Total	**4**	
83			**FIRST CHECK ANSWER ON ANSWER LINE** **If answer = 297 award 3 marks** Relative formula mass of $MgCO_3$ = 24.3 + 12 + 16 × 3 = 84.3 ✓ Number of moles = $25 \times \frac{1000}{84.3} = 296.5599051$ = 297 ✓ (to 3 sig fig)	3 (AO2.2 × 2) (AO1.2)	**DO NOT ALLOW** 84 **ALLOW ECF** from incorrect RFM of $MgCO_3$ eg RFM of 84, number of moles = 298 **ALLOW** ECF for sig fig mark
			Total	**3**	

Question			Answer/Indicative content	Marks	Guidance
84		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**	

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Question			Answer/Indicative content	Marks	Guidance
85	a	i	x- axis: mass of copper carbonate (g) **AND** y-axis: mass of copper oxide(g) ✓ Appropriate scale ✓ All points plotted correctly ✓ Line of best fit through the points ✓	4 (AO4 × 2.2) (AO1.2)	**ALLOW** correct formulae, ie $CuCO_3$ and CuO **ALLOW** just copper carbonate (g) **AND** copper oxide(g) **ALLOW** ± ½ square **ALLOW** line that starts at (1, 0.7) and does not go through (0,0) **ALLOW** correctly drawn line of best fit through incorrectly drawn points; this may be a curve
		ii	3.8(0) (g) ✓	1 (AO3.1a)	**ALLOW** ± ½ square **ALLOW** ECF from graph
		iii	Idea that carbon dioxide (gas) escapes ✓	1 AO3.2b)	**ALLOW** idea that a gas is produced / escapes, but **DO NOT ALLOW** incorrectly named gas
	b		**FIRST CHECK ANSWER ON ANSWER LINE** **If answer = 373 (tonnes) award 4 marks** M_r $CaCO_3$ = 100.1 **and** M_r CaO = 56.1 ✓ $209\text{ g of calcium oxide} = \frac{100.1}{56.1} \times 209$ = 372.9215686 (g) ✓ = 373 (g) (**3 significant figures**) ✓	4 (AO3 × 2.2) (AO1.2)	Need both relative formula masses for 1 mark **DO NOT ALLOW** 100 or 56 **ALLOW** ECF from incorrect RFMs **ALLOW** ECF **ALLOW** ECF for sig fig mark
			Total	**10**	

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Question			Answer/Indicative content	Marks	Guidance
86		i	Iodine + sodium bromide ✓	1 (AO2.1)	**Both required for the mark** **ALLOW** answers in either order
		ii	Bromine is more reactive than iodine / ORA ✓	1 (AO1.1)	**ALLOW** iodine cannot displace bromine
		iii	$CI_2 + 2NaI \rightarrow 2NaCI + I_2$ Formulae ✓ Balancing ✓	2 (AO1.1) (AO2.1)	**ALLOW** any correct multiple, including fractions **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 eg $CL_2 + 2NAI \rightarrow 2NaCI + I2$
			Total	**4**	
87		i	Green ✓	1 (AO3.2b)	
		ii	Magnesium most reactive Zinc Iron Copper least reactive correct order – 2 marks magnesium as most reactive and copper as least – 1 mark	2 (AO3.2b)	
		iii	$Mg + CuSO_4 \rightarrow MgSO_4 + Cu$ ✓	1 (AO2.2)	**ALLOW** any correct multiple, including fractions **DO NOT ALLOW** and / & instead of '+' **ALLOW** a minor error in subscripts / formulae
			Total	**4**	
88			$2Na + 2H_2O \rightarrow 2NaOH + H_2$ Formulae ✓ Balancing ✓	2 (AO1.1) (AO2.1)	**ALLOW** any correct multiple, including fractions **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 eg $2Na + 2H_2O \rightarrow 2NaoH + H2$
			Total	**2**	

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Question			Answer/Indicative content	Marks	Guidance
89	a	i	FIRST CHECK THE ANSWER ON ANSWER LINE **If answer = 0.00125 / 1.25×10^{-3} award 2 marks** Moles = $\frac{\text{volume}}{24}$ / $\frac{0.030}{24}$ / $\frac{30}{24{,}000}$ ✓ = 0.00125 / 1.25×10^{-3} ✓	2 (AO2.2)	**ALLOW** 1 mark only for 30 ÷ 24 or 0.030 ÷ 24,000, correctly calculated
		ii	0.0025 / 2.5×10^{-3} (g) ✓	1 (AO2.2)	**unit not needed** **ALLOW** ECF from **(i)** ie 2 x answer from **(i)**
	b		Moles of chromium = $\frac{10.40}{52.0}$ = 0.2 ✓ Moles of nickel = $\frac{17.61}{58.7}$ = 0.3 ✓ Idea that ratio is 2:3 / ratio isn't 1:1 so <u>equation 2</u> ✓	3 (AO2.2)	**ALLOW** other methods of calculation eg 10.40g of chromium forms $\frac{10.40}{52.0} \times 58.7$ = 11.74g nickel $\frac{11.74}{3} \times 2 = 17.61\text{g}$ of nickel So, equation 2 **ALLOW** answers that show equation 1 is not correct **Third marking point is dependent on correct mathematical reasoning**
			Total	**6**	

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