Mark scheme – Introducing Chemical Reactions (H)

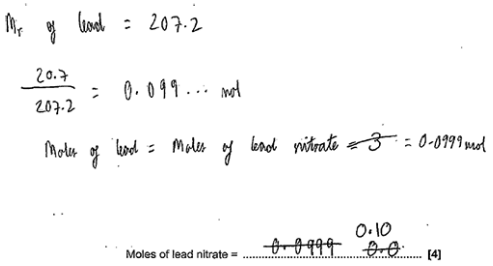
Question			Answer/Indicative content	Marks	Guidance
1			B ✓	1 (AO2.1)	
			Total	**1**	
2			D ✓	1 (AO2.2)	
			Total	**1**	
3			B ✓	1 (AO2.2)	
			Total	**1**	
4			D ✓	1 (AO1.1)	
			Total	**1**	
5			B ✓	1 (AO2.1)	
			Total	**1**	
6			D ✓	1(AO2.2)	
			Total	**1**	
7			C ✓	1(AO2.2)	**Examiner's Comments** **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**	
8	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 ✓	3 (AO2.2)	**ALLOW** other methods of calculation

			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> ✓		eg 10.40g of chromium forms $\frac{10.40}{52.0} \times 58.7$ = 11.74g nickel $\frac{11.74}{3} \times 2 = 17.61$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**	
9			$2Na + 2H_2O \rightarrow 2NaOH + H_2$ 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**	
10		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**	
11	a	i	x- axis: mass of copper carbonate (g) **AND** y-axis: mass of copper oxide(g) ✓	4 (AO4 × 2.2)	**ALLOW** correct formulae**,** ie $CuCO_3$ and CuO **ALLOW** just copper carbonate (g) **AND**

			Appropriate scale ✓ All points plotted correctly ✓ Line of best fit through the points ✓	(AO1.2)	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 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**	
12			**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**	
13	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→ 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**	
14			$N_2 + 3H_2 \rightleftharpoons 2NH_3$ 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 $N_2 + 3H_2 \rightleftharpoons 2Nh_3$ **Examiner's Comments** 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**	
15			$Mg + 2HCl \rightarrow MgCl_2 + H_2$ 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**	
16		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 $Pb(NO_3)_2$ ✓	4 (AO3 × 2.2)	**ALLOW** 331 **ALLOW ECF** from balanced equation in (i) **ALLOW** 3 marks for 0.1 (ie not 2 sig figs)

			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 ✓ (and so) this will make 0.10 mol of $Pb(NO_3)_2$ ✓	(AO1.2)	**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' 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**	
17	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 $\times 10^{-3}$ **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**	
18		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**	
19			$Ca + 2HCl \rightarrow CaCl_2 + H_2$	2	1 mark for both correct reactants 1 mark for both correct products
			Total	**2**	
20			$24.3 / 6.022 \times 10^{23}$ (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**	
21			$ZnO + 2HNO_3 \rightarrow Zn(NO_3)_2 + H_2O$ 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 ⇌ 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**	

22	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	
		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**	
23			C	1	
			Total	**1**	
24			C	1	
			Total	**1**	