Mark scheme – Types of Chemical Reactions (H)

Question			Answer/Indicative content	Marks	Guidance
1			A ✓	1 (AO2.1)	
			Total	**1**	
2			C ✓	1(AO2.1)	
			Total	**1**	

3			(Sodium atom) loses an electron / Oxidation is loss of electrons ✓	1 (AO1.1)	
			Total	**1**	
4		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**	
5			*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	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**

			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>** 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.*		• 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
			Total	**6**	
6	a		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. **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.
	b	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = pH 4 award 2 marks** Concentration of H^+ decreases by factor of	2 (AO2.1)	**Examiner's Comments** High ability candidates correctly calculated the new pH as 4.

			10, the pH increases by 1 ✓ Factor of 100 = 10 × 10 so pH increases by 2 pH value = 4 ✓	(AO2.2)	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.
		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.
	c	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)** **<u>Examiner's Comments</u>** 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 **<u>Examiner's Comments</u>** 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 **<u>Examiner's Comments</u>** Many candidates were able to write the balanced ionic equation for neutralisation.
			Total	**13**	
7	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**	
8		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)	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

			Burette and other chemical apparatus not suitable for using large quantities / very difficult to use a steam bath in the large scale (1)		
		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**	
9			$Ca + 2HCl \rightarrow CaCl_2 + H_2$	2	1 mark for both correct reactants 1 mark for both correct products
			Total	**2**	
10			The oxidising agent is **oxygen** and the reducing agent is **magnesium** (1)	1	
			Total	**1**	
11	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**	
12			C	1	
			Total	**1**	
13			B	1	
			Total	**1**	
14			B	1	
			Total	**1**	
15			B	1	
			Total	**1**	