Question Number	Answer	Acceptable answers	Mark
1(a)	$CaCl_2$ = 40 + 35.5 + 35.5 (=111) (1) THEN moles = 11.1 / 111 (= 0.1) (1) conc = **moles** x 1000/500 (=0.2) (1) OR mass conc = 11.1 x 1000/500 (=22.2) (1) conc = **mass conc**/111 (= 0.2) (1)	0.2 scores 3 ecf: 11.1 / Mr ecf: mass conc / 111	**(3)**

Question Number	Answer	Acceptable answers	Mark
1(b)(i)	A description linking • **pipette** (1) • one practical point eg draw liquid up to line/ use pipette filler/ rinse first / read at eye level (1)	**ignore** burette etc for 1st mpt if using measuring cylinder/ burette allow suitable practical point eg read at eye level/ add dropwise from burette near 25 cm^3 (1) ignore as 2nd point: transfer liquid to flask / safety precautions	**(2)**

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

Question Number		Indicative Content	Mark
QWC	***1(c)**	A description / explanation including some of the following points **soft** • add soap (solution) • shake/ mix • lather (immediately) • no scum/ no precipitate **permanent hard** • add soap (solution) • shake • no lather / less than with soft water • scum/ precipitate • boiled sample • same results / boiling does not change • becomes soft after ion exchange but not after boiling **temporary hard** • add soap (solution) • shake • no lather / less than with soft water • scum/ precipitate • **boiled** sample • after boiling precipitate / (lime)scale formed • lather (immediately) credit quantitative approaches e.g. titration with soap solution	**(6)**

Level	**0**	No rewardable content
1	**1 - 2**	• a limited description e.g. test and one result / when shaken with soap, soft water makes lather but no scum • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 - 4**	• a simple description e.g. describe test and results to distinguish the soft water and the two samples that are hard water / when shaken with a small amount of soap, soft water makes a lather and no scum but the other waters make scum but no (less) lather • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	**5 - 6**	• a detailed description e.g. describe test and results to identify all three of the samples / as 3-4 and boil the two hard water samples and repeat test. That which now gives a lather is temporarily hard • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Question Number	Answer	Acceptable answers	Mark
2(a)	A neutralisation		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(b)	Any one from • no {sharp/clear/distinct} change in colour • gradual colour change • there are too many different colours	ignore not as accurate/reliable allow too difficult to see when it is {neutral/reaction is complete} ignore speed of colour change	**(1)**

Question Number		Indicative Content	Mark
QWC	***2(c)**	A description including some of the following points **titration experiment** • rinse pipette with alkali and burette with acid • measure alkali using a pipette • into suitable container e.g. flask/beaker • add a few drops of indicator / suitable named indicator (eg methyl orange/phenolphthalein) • flask on a white tile • fill burette with acid • read level/volume (of acid) in burette • add acid from burette to the flask slowly / swirl the flask • until {indicator just changes colour/correct colour change for named indicator (eg methyl orange yellow to peach/orange, phenolphthalein pink to colourless)/solution is neutral} • read level/volume (of acid) in burette • repeat experiment • until concordant results **salt preparation** • mix the same volume of alkali with the volume of acid determined from the first experiment but do not add indicator (or add (activated) charcoal to remove indicator, then filter) • pour solution into an evaporating basin • {heat solution/leave the water to evaporate} until pure salt crystals are left	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description of titration and/or salt preparation e.g. add hydrochloric acid to sodium hydroxide solution in a flask, then evaporate the water from solution. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple description of titration and/or salt preparation e.g. pipette sodium hydroxide solution into flask, add indicator, place hydrochloric acid in burette, add acid to alkali until colour change. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description including titration **and** salt preparation e.g. pipette sodium hydroxide solution into flask, add indicator, hydrochloric acid in burette, add acid to alkali until colour change, repeat until concordant results, evaporate water. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Question Number	Answer	Acceptable answers	Mark
2(d)(i)	$\frac{22.6 + 22.8}{2}$ (1) (= 22.7)		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(d)(ii)	marks are for the working no. moles HCl = $\frac{23.2 \times 0.1}{1000}$ (1) (= 2.32×10^{-3}) no. moles NaOH = no. moles HCl (1) conc NaOH = $\frac{2.32 \times 10^{-3} \times 1000}{25.0}$ (1) (= 0.0928 mol dm^{-3}) mark consequentially OR $\frac{\text{no. moles NaOH reacting}}{\text{no. moles HCl reacting}} = \frac{1}{1}$ (1) $\frac{25.0 \times \text{conc}}{23.2 \times 0.1} = \frac{1}{1}$ (1) conc NaOH = $\frac{0.1 \times 23.2}{25.0}$ (1) (= 0.0928) mol dm^{-3} OR use of $c_1v_1 = c_2v_2$ (1) 0.1x 23.2 = conc x 25.0 (1) conc NaOH = $\frac{0.1 \times 23.2}{25.0}$ (1) (= 0.0928) mol dm^{-3}	0.0928/0.093 with or without working (3) 0.09 with no working (2) common incorrect answers with working 0.108/0.1077 (2) – used 1:1 ratio but 25x0.1/23.2 0.928 (2) – used 1:1 ratio but missed out 0.1	**(3)**

Question number	Answer	Additional guidance	Mark
3(a)	Formula mass ammonium chloride = 14.0 + 4.00 + 35.5 = 53.5 moles of ammonium chloride = $\frac{10.0}{53.5}$ = 0.187 (1) volume ammonia = 0.187 × 24 = 4.49 dm^3 (1) or • 2 × 53.5 = 107 g ammonium chloride produces 2 × 24 = 48 dm^3 ammonia (1) • 10.0 g ammonium chloride produces $\frac{10.0}{2\times53.5} \times 2 \times 24 = 4.49\ dm^3$ ammonia (1)	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	25 ÷ 1000 × 0.1 = 0.0025 (1) 35 ÷ 1000 × 0.075 = 0.002 625 (1) The acid is in excess (1)	Third mark only awarded as conclusion from calculated data.	**(3)**

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

Question number	Answer	Mark
3(b)(iii)	D	**(1)**

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

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

Question Number	Answer	acceptable answers	Mark
4(b)	$H^+ + OH^-$ (1) → H_2O (1)	LHS (1) RHS (1) ignore state symbols, even if incorrect. allow inclusion of spectator ions, Na^+ and Cl^-, if shown on both sides for one mark max	**(2)**

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

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

Link 4ci and 4cii together on e-Pen

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

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