

Question Number	Answer	Acceptable answers	Mark
<b>1(a)</b>	$\text{CaCl}_2 = 40 + 35.5 + 35.5$ (=111) (1)  THEN $\text{moles} = 11.1 / 111$ (= 0.1) (1) $\text{conc} = \underline{\text{moles}} \times 1000/500$ (=0.2) (1)  OR $\text{mass conc} = 11.1 \times 1000/500$ (=22.2) (1) $\text{conc} = \underline{\text{mass conc}}/111$ (= 0.2) (1)	<u>0.2 scores 3</u>  ecf: 11.1 / Mr  ecf: mass conc / 111	<b>(3)</b>

Question Number	Answer	Acceptable answers	Mark
<b>1(b)(i)</b>	A description linking <ul style="list-style-type: none"> <li>• <b>pipette</b> (1)</li> <li>• one practical point eg draw liquid <u>up to line</u>/ use pipette filler/ rinse first / read at eye level (1)</li> </ul>	<b>ignore</b> burette etc for 1 <sup>st</sup> mpt if using measuring cylinder/ burette allow suitable practical point eg read at eye level/ add dropwise from burette near 25 cm <sup>3</sup> (1) ignore as 2 <sup>nd</sup> point: transfer liquid to flask / safety precautions	<b>(2)</b>

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<b>1(b)(ii)</b>	<b>D</b> 25.20 cm <sup>3</sup>		<b>(1)</b>

Question Number	Indicative Content	Mark
<b>QWC</b>	<p data-bbox="272 275 368 312"><b>*1(c)</b></p> <p data-bbox="403 275 1377 312">A description / explanation including some of the following points</p> <p data-bbox="403 351 472 380"><b>soft</b></p> <ul data-bbox="451 388 855 526" style="list-style-type: none"> <li>• add soap (solution)</li> <li>• shake/ mix</li> <li>• lather (immediately)</li> <li>• no scum/ no precipitate</li> </ul> <p data-bbox="403 565 671 594"><b>permanent hard</b></p> <ul data-bbox="451 602 1289 849" style="list-style-type: none"> <li>• add soap (solution)</li> <li>• shake</li> <li>• no lather / less than with soft water</li> <li>• scum/ precipitate</li> <li>• boiled sample</li> <li>• same results / boiling does not change</li> <li>• becomes soft after ion exchange but not after boiling</li> </ul> <p data-bbox="403 888 663 917"><b>temporary hard</b></p> <ul data-bbox="451 926 1158 1172" style="list-style-type: none"> <li>• add soap (solution)</li> <li>• shake</li> <li>• no lather / less than with soft water</li> <li>• scum/ precipitate</li> <li>• <b>boiled</b> sample</li> <li>• after boiling precipitate / (lime)scale formed</li> <li>• lather (immediately)</li> </ul> <p data-bbox="403 1212 1331 1240">credit quantitative approaches e.g. titration with soap solution</p>	<b>(6)</b>

<b>Level</b>	<b>0</b>	No rewardable content
<b>1</b>	<b>1 - 2</b>	<ul style="list-style-type: none"> <li>• a limited description e.g. test and one result / when shaken with soap, soft water makes lather but no scum</li> <li>• the answer communicates ideas using simple language and uses limited scientific terminology</li> <li>• spelling, punctuation and grammar are used with limited accuracy</li> </ul>
<b>2</b>	<b>3 - 4</b>	<ul style="list-style-type: none"> <li>• 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</li> <li>• the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately</li> <li>• spelling, punctuation and grammar are used with some accuracy</li> </ul>
<b>3</b>	<b>5 - 6</b>	<ul style="list-style-type: none"> <li>• 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</li> <li>• the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately</li> <li>• spelling, punctuation and grammar are used with few errors</li> </ul>

Question Number	Answer	Acceptable answers	Mark
<b>2(a)</b>	A neutralisation		<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>2(b)</b>	Any one from <ul style="list-style-type: none"> <li>• no {sharp/clear/distinct} change in colour</li> <li>• gradual colour change</li> <li>• there are too many different colours</li> </ul>	ignore not as accurate/reliable allow too difficult to see when it is {neutral/reaction is complete} ignore speed of colour change	<b>(1)</b>

Question Number		Indicative Content	Mark
<b>QWC</b>	<b>*2(c)</b>	<p>A description including some of the following points</p> <p><b>titration experiment</b></p> <ul style="list-style-type: none"> <li>• rinse pipette with alkali and burette with acid</li> <li>• measure alkali using a pipette</li> <li>• into suitable container e.g. flask/beaker</li> <li>• add a few drops of indicator / suitable named indicator (eg methyl orange/phenolphthalein)</li> <li>• flask on a white tile</li> <li>• fill burette with acid</li> <li>• read level/volume (of acid) in burette</li> <li>• add acid from burette to the flask slowly / swirl the flask</li> <li>• 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}</li> <li>• read level/volume (of acid) in burette</li> <li>• repeat experiment</li> <li>• until concordant results</li> </ul> <p><b>salt preparation</b></p> <ul style="list-style-type: none"> <li>• 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)</li> <li>• pour solution into an evaporating basin</li> <li>• {heat solution/leave the water to evaporate} until pure salt crystals are left</li> </ul>	<b>(6)</b>
<b>Level</b>	<b>0</b>	No rewardable content	
<b>1</b>	<b>1 - 2</b>	<ul style="list-style-type: none"> <li>• 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.</li> <li>• the answer communicates ideas using simple language and uses limited scientific terminology</li> <li>• spelling, punctuation and grammar are used with limited accuracy</li> </ul>	
<b>2</b>	<b>3 - 4</b>	<ul style="list-style-type: none"> <li>• 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.</li> <li>• the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately</li> <li>• spelling, punctuation and grammar are used with some accuracy</li> </ul>	
<b>3</b>	<b>5 - 6</b>	<ul style="list-style-type: none"> <li>• a detailed description including titration <b>and</b> 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.</li> <li>• the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately</li> <li>• spelling, punctuation and grammar are used with few errors</li> </ul>	



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

Question Number	Answer	Acceptable answers	Mark
<b>2(d)(ii)</b>	<p>marks are for the working</p> <p>no. moles HCl = <math>\frac{23.2 \times 0.1}{1000}</math> (1) (= <math>2.32 \times 10^{-3}</math>)</p> <p>no. moles NaOH = no. moles HCl (1)</p> <p>conc NaOH = <math>\frac{2.32 \times 10^{-3} \times 1000}{25.0}</math> (1) (= <math>0.0928 \text{ mol dm}^{-3}</math>)</p> <p>mark consequentially OR</p> <p><math>\frac{\text{no. moles NaOH reacting}}{\text{no. moles HCl reacting}} = \frac{1}{1}</math> (1)</p> <p><math>\frac{25.0 \times \text{conc}}{23.2 \times 0.1} = \frac{1}{1}</math> (1)</p> <p>conc NaOH = <math>\frac{0.1 \times 23.2}{25.0}</math> (1) (= <math>0.0928</math>) mol dm<sup>-3</sup></p> <p>OR</p> <p>use of <math>c_1V_1 = c_2V_2</math> (1)</p> <p><math>0.1 \times 23.2 = \text{conc} \times 25.0</math> (1)</p> <p>conc NaOH = <math>\frac{0.1 \times 23.2}{25.0}</math> (1) (= <math>0.0928</math>) mol dm<sup>-3</sup></p>	<p>0.0928/0.093 with or without working (3)</p> <p>0.09 with no working (2)</p> <p>common incorrect answers with working</p> <p>0.108/0.1077 (2) – used 1:1 ratio but <math>25 \times 0.1 / 23.2</math></p> <p>0.928 (2) – used 1:1 ratio but missed out 0.1</p>	<b>(3)</b>

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 $= 0.187 \times 24$ $= 4.49 \text{ dm}^3$ (1) or <ul style="list-style-type: none"> <li><math>2 \times 53.5 = 107 \text{ g}</math> ammonium chloride produces <math>2 \times 24 = 48 \text{ dm}^3</math> ammonia (1)</li> <li>10.0 g ammonium chloride produces  <math>\frac{10.0}{2 \times 53.5} \times 2 \times 24 = 4.49 \text{ dm}^3</math>                ammonia (1)</li> </ul>	Award full marks for correct numerical answer without working.	(2)

Question number	Answer	Additional guidance	Mark
3(b)(i)	$25 \div 1000 \times 0.1 = 0.0025$ (1)  $35 \div 1000 \times 0.075 = 0.002625$ (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
<b>3(c)</b>	mol of acid = $24.80 \div 1000 \times 0.200$ (= 0.004 96 mol) (1)  mol NaOH = $2 \times 0.004 96$ (= 0.009 92) (1)  conc. of NaOH = $0.009 92 \div 25.0 \times 1000$ (1)  = 0.3968/0.397 (mol dm <sup>-3</sup> ) (1)  or  $(25.00 \times \text{conc NaOH}) \div 2 = 24.80 \times 0.200$ (2)  conc NaOH = $2 \times 24.80 \times 0.200 \div 25.00$ (1)  = 0.3968/0.397 (mol dm <sup>-3</sup> ) (1)	Award full marks for correct numerical answer without working.  Allow max 3 marks if missing '2 ×' in step 2.	<b>(4)</b>



Question Number	Answer	Acceptable answers	Mark
<b>4(a)</b>	<b>D</b> aq l		<b>(1)</b>

Question Number	Answer	acceptable answers	Mark
<b>4(b)</b>	$H^+ + OH^- (1) \rightarrow H_2O (1)$	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	<b>(2)</b>

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

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

Link 4ci and 4cii together on e-Pen

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

