Question Number	Answer	Mark
4	**The only correct answer is B** (0.04) ***A*** *is incorrect because this is the difference in the concentration and not the pH* ***C*** *is incorrect because this is decrease in pH if the concentration becomes 0.110 instead of 0.0110* mol dm^{-3} ***D*** *is incorrect because this is not the decrease in pH but the pH of the 0.0110* mol dm^{-3} *solution*	**(1)**

Question Number	Answer	Mark
16	**The only correct answer is D** (13.1) ***A*** *is incorrect because the molarity was divided by 200 instead of 0.2* ***B*** *is incorrect because the moles of barium hydroxide were used instead of the concentration of hydroxide ions* ***C*** *is incorrect because the concentration of barium hydroxide is used instead of the concentration of hydroxide ions*	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is D** (the dissociation of the carboxylic acid is almost complete) ***A*** *is incorrect because this is a valid assumption* ***B*** *is incorrect because this is a valid assumption* ***C*** *is incorrect because this is a valid assumption*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is B** (13.6) ***A*** *is incorrect because the concentration of hydroxide ions has been ignored* ***C*** *is incorrect because only one mole of hydroxide ions has been used* ***D*** *is incorrect because the hydroxide ion concentration has been squared*	**(1)**

Question Number	Answer	Mark
7	**The only correct answer is B** (neutral with a pH of 6.6) ***A*** *is incorrect because this is the pH of water at 25* °C ***C*** *is incorrect because the water is neutral* $[H^+] = [OH^-]$ ***D*** *is incorrect because the water is neutral and the pH has been calculated incorrectly*	**(1)**

Question Number	Answer	Mark
12(a)	**The only correct answer is C** (Curve 3) ***A*** *is not correct because Curve 1 is a strong base being added to a strong acid* ***B*** *is not correct because Curve 2 is a strong acid being added to a strong base* ***D*** *is not correct because Curve 4 is a weak acid being added to a strong base*	**(1)**

Question Number	Answer	Mark
12(b)	**The only correct answer is C** (thymol blue (base) ; 8.0-9.6) ***A*** *is not correct because the indicator would not change colour at the end-point* ***B*** *is not correct because the indicator would not change colour at the end-point* ***D*** *is not correct because the indicator would not change colour at the end-point*	**(1)**

Question Number	Answer	Mark
9	**The only correct answer is D** (4, 3, 1, 2) ***A*** *is not correct because Beaker 4 has the highest pH* ***B*** *is not correct because Beaker 4 has the highest pH* ***C*** *is not correct because Beaker 4 has the highest pH*	(1)

Question number	Answer	Mark
12(a)	**The only correct answer is C** (10.3) ***A*** *is incorrect because the concentration of* OH^- *ions has been obtained by halving the concentration of magnesium hydroxide rather than doubling it* ***B*** *is incorrect because the concentration of* OH^- *ions has been taken as equal to the concentration of magnesium hydroxide* ***D*** *is incorrect because the concentration of* OH^- *ions has been obtained by taking the square root of the concentration of magnesium hydroxide*	**(1)**

Question number	Answer	Mark
12(b)	**The only correct answer is B**(higher; higher) ***A*** *is incorrect because the solution at 100℃ will be more alkaline* ***C*** *is incorrect because the concentration of* OH^- *ions at 100°C will be higher as solubility is greater* ***D*** *is incorrect because the concentration of* OH^- *ions at 100°C will be higher and the solution will be more alkaline*	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is A** (10) ***B** is not correct because this is the pH after a dilution of 10* ***C** is not correct because this is the pH after increasing the concentration by 10* ***D** is not correct because this is the pH after increasing the concentration by 100*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is C** (the dissociation of water is endothermic so the concentration of hydrogen ions is higher at 75ºC) ***A** is not correct because in pure water the concentrations of hydrogen ions and hydroxide ions are always equal* ***B** is not correct because the concentration of hydrogen ions increases* ***D** is not correct because the reaction is endothermic*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is B** (13.53) ***A** is incorrect because this is the pH determined using the value of pK_w at 298 K* ***C** is incorrect because this is the value of pK_w minus the concentration* ***D** is incorrect because this is the value of pK_w*	**(1)**

Question Number	Answer	Mark
13(a)	**The only correct answer is C** (5.07) ***A** is incorrect because this is the value from using [acid] ÷ [salt] instead of the other way around* ***B** is incorrect because this is the pK_a value* ***D** is incorrect because this is the value using the natural logarithm of salt divided by acid instead of logarithm to the base 10*	**(1)**

Question Number	Answer	Mark
13(b)	**The only correct answer is C** (to prevent deterioration by fungal activity) ***A*** *is incorrect because to prevent deterioration of the food which in the long run maintains the taste is not the same as improving the taste of food* ***B*** *is incorrect because this is not the reason for the addition of buffers to food* ***D*** *is incorrect because to prevent deterioration of the food which in the long run maintains the colour and appearance of food this is not the same as enhancing these qualities*	**(1)**

Question Number	Answer	Mark
13(c)	**The only correct answer is C** (the pH will decrease due to the equilibria shifting to the right) ***A*** *is incorrect because exercise produces CO_2 so the equilibria shift to the right* ***B*** *is incorrect because the increase in carbon dioxide produced will shift the equilibria to the right* ***D*** *is incorrect because the definition of buffers does not state that the pH is always kept constant but varies only slightly if small amounts of acid or base are added*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is C** (6.8) ***A*** *is incorrect because the increase in T moves the equilibrium to the right, increasing the concentration of H^+ ions, hence lowering the pH from 7 (at 298 K)* ***B*** *is incorrect because this is the pH at 298 K and the increase in T moves the equilibrium to the right, increasing the concentration of H^+ ions, hence lowering the pH* ***D*** *is incorrect as it would require an increase in K_w of approximately 250 times*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is C** (the dissociation of water is endothermic, so the concentration of hydrogen ions is higher at 100ºC than at 25ºC) ***A*** *is incorrect because at lower pH the concentration of hydrogen ions is higher* ***B*** *is incorrect because at lower pH the concentration of hydrogen ions is higher and the reaction is endothermic* ***D*** *is incorrect because the forward reaction is endothermic*	(1)

Question Number	Answer	Mark
8	**The only correct answer is B** ($CH_2ClCOOH$) ***A*** *is incorrect because hydrogen is not as electronegative as chlorine so acid is less dissociated* ***C*** *is incorrect because bromine is not as electronegative as chlorine so acid is less dissociated* ***D*** *is incorrect because iodine is not as electronegative as chlorine so acid is less dissociated*	**(1)**

Question Number	Answer	Additional Guidance	Mark
17(a)(i)	• correct expression for K_a	Example of expression: $K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$ Allow H_3O^+ Ignore state symbols even if incorrect Do not award curly brackets Do not award HA etc	(1)

Question Number	Answer	Additional Guidance	Mark
17(a)(ii)	• calculation of $[H^+]$ (1) • calculation of pH (1)	Example of calculation: No TE from wrong Ka expression in i for M1 $\sqrt{(1.7 \times 10^{-5} \times 0.25)} = 2.0616 \times 10^{-3}$ / 0.0020616 (mol dm^{-3}) $-\log 2.0616 \times 10^{-3} = 2.6858/2.69/2.7$ TE from $[H^+]$ as long as the pH is below 7 Ignore SF except 1 Correct answer without working scores 2	(2)

Question Number	Answer	Additional Guidance	Mark
17(a)(iii)	An answer that makes reference to the following point: • degree of ionisation/dissociation of the acid is very small / negligible/ Or $[CH_3COOH]_{eqm} = [CH_3COOH]_{initial}$ Or $[H+] = [CH_3COO^-]$ Or all of the hydrogen ions come from the acid	 Allow HA and A^- Allow H_3O^+ Allow no hydrogen ions come from the water	(1)

Question Number	Answer	Additional Guidance	Mark
17(b)(i)	An answer that makes reference to the following point: • the Cl is electron withdrawing / (highly) electronegative/ negatively inductive **and** so stabilises the COO^- anion/ weakens the O−H bond (causing the H^+ to be removed more easily)		(1)

Question Number	Answer	Additional Guidance	Mark
17(b)(ii)	• correct equation (1) • correct conjugate acids and bases (1)	Example of equation: $CH_3COOH + CH_2ClCOOH \rightleftharpoons CH_3COOH_2^+ + CH_2ClCOO^-$ B1 A2 A1 B2 Or B2 A1 A2 B1 M2 dependent on M1 or near miss such as missing a charge or a subscript 2 Allow any indication of linkage eg lines	(2)

Question Number	Answer		Additional Guidance	Mark
17(c)	concentration route		Example of calculation:	(4)
	• calculation of $[CH_3COONa]$	(1)	$8.2 \div 82 \times 1000 / 250 = 0.4$ (mol dm^{-3})	
	• rearrangement of K_a equation	(1)	$[H^+] = K_a \times \frac{[HA]}{[A^-]}$ OR $\frac{[H^+]}{K_a} = \frac{[HA]}{[A^-]}$	
	• calculation of $[H^+]$	(1)	$[H^+] = 1.7 \times 10^{-5} \times \frac{0.7}{0.4} = 2.975 \times 10^{-5}$ (mol dm^{-3})	
	• calculation of pH	(1)	$-\log 2.975 \times 10^{-5} = 4.5265$	
	moles route			
	• calculation of moles CH_3COONa **and** calculation of moles CH_3COOH	(1)	$8.2 \div 82 = 0.1$(mol) **and** $250 \times 0.7 \div 1000 = 0.175$(mol)	
	• rearrangement to get $[H^+]$	(1)	$[H^+] = K_a \times 0.175 \div 0.1$	
	• calculation of $[H^+]$	(1)	$[H^+] = 1.7 \times 10^{-5} \times 0.175 \div 0.1 = 2.975 \times 10^{-5}$ (mol dm^{-3})	
	• calculation of pH	(1)	$-\log 2.975 \times 10^{-5} = 4.5265$	
			Correct answer with or without working scores 4 Allow TE throughout but if final answer is above pH 7, do not award M4.	

	Henderson-Hasselbalch route			
	• calculation of $[CH_3COONa]$ or moles of CH_3COONa and CH_3COOH	(1)	$8.2 \div 82 \times 1000 / 250 = 0.4$ (mol dm^{-3}) $8.2 \div 82 = 0.1$(mol) **and** $250 \times 0.7 \div 1000 = 0.175$(mol)	
	• HH equation	(1)	$pH = pK_a - \log \frac{[HA]}{[A^-]}$ or $pH = pK_a + \log \frac{[A^-]}{[HA]}$	
	• calculation of pK_a	(1)	$-\log 1.7 \times 10^{-5} = 4.76955$	
	• calculation of pH	(1)	Put the numbers into HH $= 4.5265$	
			Correct answer with or without working scores 4 Allow TE throughout but if final answer is above pH 7, do not award M4.	

Question Number	Answer	Additional Guidance	Mark
17(d)	An answer that makes reference to the following points: • (because of the weak acid) the pH of the bubble bath is lower (or equal) than 3.8 at the start so (the bromocresol green) is yellow **(1)** • when diluted/ water added (to the bath) **and** the $[H^+]$ decreases/ the pH increases/less acidic **(1)** • (the bromocresol green) turns (green then) blue as the pH is equal or higher than **5.4** **(1)**	Allow just yellow in acidic solution/low pH Do not award any mention of water acting as a base/ acid being neutralised/reacting with OH^- Allow at a pH of 4.7 the colour will be green Do not award if they state that pH 5.4 is alkaline Ignore any reference to acid dissociating	**(3)**

Question Number	Answer	Additional Guidance	Mark
17(a)	An answer that makes reference to the following points: • calculation of moles of hydroxide ions **(1)** • calculation of moles of hydrogen ions OR calculation of moles of sulfuric acid **(1)** • calculation of excess moles of hydroxide ions **(1)** • calculation of concentration of excess hydroxide ions **(1)** • calculation of concentration of hydrogen ions **(1)** • calculation of pH to 1dp **(1)** Alternative method for M5 and M6 • M5 calculation of pOH / calculation of $\log[OH^-]$ • M6 calculation of pH to 1dp	<u>Example of calculation</u> $(80.0 \div 1000) \times 0.240 = 0.0192$ (mol) $(20.0 \div 1000) \times 0.072 \times 2 = 2.88 \times 10^{-3}$ (mol) $(20.0 \div 1000) \times 0.072 = 1.44 \times 10^{-3}$ (mol) $0.0192 - 2.88 \times 10^{-3} = 0.01632$ (mol) No subtraction loses M3 **and** M4 $(0.01632) \div (100 \div 1000) = 0.1632$ (mol dm^{-3}) $(1.00 \times 10^{-14}) \div 0.1632 = 6.1275 \times 10^{-14}$ (mol dm^{-3}) $-\log(6.1275 \times 10^{-14}) = 13.2$ Allow TE throughout M1 to M5 TE for M6 must give a value greater than 7 and less than 14 Comment Take care to check as use of 1.44×10^{-3} in the subtraction as this gives an answer very close to the true answer but would not score M3 $-\log(0.1632) = 0.78728$ / $\log(0.1632) = -0.78728$ $14 - 0.78728 = 13.2$ / $14 - (-0.78728) = 13.2$	**(6)**

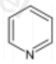
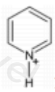
Question Number	Answer	Additional Guidance	Mark
17(b)(i)	An answer that makes reference to the following point: • (an acid solution) that contains a significant proportion / amount of undissociated acid	Allow an acid that hardly dissociates / an acid that is (only) partially dissociated / an acid that doesn't dissociate completely / dissociation is low / dissociation is small / equilibrium lies to the left / K_a is small / pK_a is large Ignore comments about concentration or number of H^+ ions	(1)

Question Number	Answer	Additional Guidance	Mark
17(b)(ii)	A description that makes reference to two of the following points: • a solution whose pH barely changes / resists changes in pH **(1)** • when **small** amounts of **acid** are added **and** when **small** amounts of **base / alkali** are added **(1)**	Allow a solution whose pH remains (almost) constant Allow prevents pH (of solution) from changing (significantly) Allow H^+ for acid Allow OH^- for base Ignore any comments regarding composition of buffer even if incorrect	(2)

Question Number	Answer	Additional Guidance	Mark
17(b)(iii)	An answer that makes reference to the following points: • calculation of concentration of hydrogen ions **(1)** • rearrangement of K_a expression **(1)** • calculation of concentration of sodium hydrogensulfite **(1)** • calculation of moles of sodium hydrogensulfite **(1)** • calculation of mass of sodium hydrogensulfite **(1)** Alternative M1, M2 and M3 via Henderson-Hasselbalch • calculation of pK_a **(1)** • rearrangement of Henderson-Hasselbalch expression **(1)** • calculation of concentration of sodium hydrogensulfite **(1)** Comment allow use of moles instead of concentration in Henderson-Hasselbach expression.	<u>Example of calculation</u> $10^{-2.18}$ / 6.6069×10^{-3} (mol dm^{-3}) $1.54 \times 10^{-2} = \dfrac{6.6069 \times 10^{-3} \times [NaHSO_3]}{0.048}$ $[NaHSO_3] = \dfrac{1.54 \times 10^{-2} \times 0.048}{6.6069 \times 10^{-3}}$ 0.11188 (mol dm^{-3}) $(0.11188) \times (50.0 \div 1000) = 5.5941 \times 10^{-3}$ (mol) $5.5941 \times 10^{-3} \times 104.1 = 0.58235$ (g) Ignore SF except 1 SF Allow TE throughout $-\log(1.54 \times 10^{-2}) = 1.8125$ $pH = pK_a + \log\dfrac{[NaHSO_3]}{0.048}$ $2.18 = 1.8125 + \log[NaHSO_3] - \log(0.048)$ $\log[NaHSO_3] = 2.18 - 1.8125 - 1.3188 = -0.9513$ $[NaHSO_3] = 10^{-0.9513} = 0.11188$ (mol dm^{-3})	(5)

(Total for Question 17 = 14 marks)

Question Number	Answer	Additional Guidance	Mark
19(a)(i)	$C_5H_5NH^+$ K_a: • calculation of inverse log(−5.25) to 2SF **(1)** $CHCl_2COOH$ pK_a: • calculation of $-\log(4.5 \times 10^{-2})$ to 3SF **(1)**	<u>Example of calculation:</u> $(5.6234 \times 10^{-6} =)$ 5.6×10^{-6} Do not award 6×10^{-6} (1.3468 =) 1.35 Do not award 1.4 or 1.34 Penalise inconsistent SF once only Penalise incorrect rounding once only	**2**

Question Number	Answer	Additional Guidance	Mark
19(a)(ii)	An answer that makes reference to the following point: • $(Ka =) \dfrac{[H^+]\,[C_5H_5N]}{[C_5H_5NH^+]}$	Do not award C_6 for C_5 Do not award non-square brackets Allow $[H_3O^+]$ for $[H^+]$ Allow use of  for C_5H_5N Do not award C_5H_4NH for C_5H_5N Do not award charged C_5H_5N, eg $C_5H_5N^-$ Allow use of  for $C_5H_5NH^+$ Allow $C_5H_6N^+$ for $C_5H_5NH^+$ Do not award omission of charge from $C_5H_5NH^+$	**1**

Question Number	Answer	Additional Guidance	Mark
19(a)(iii)	An answer that makes reference to the following points: • $CH_3CH_2COOH_2^+$ **and** $HCOO^-$ **(1)** • HCOOH A1 **and** $HCOO^{(-)}$ B1 **and** CH_3CH_2COOH B2 **and** $CH_3CH_2COOH_2^{(+)}$ A2 **(1)**	 Allow $COOH^-$ Allow A2 and B2 for A1 and B1 Allow B1 and A1 for B2 and A2 TE on M1 for $HCOOH_2^{(+)}$ and $CH_3CH_2COO^{(-)}$ only	**2**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>19(a)(iv)</td>
<td>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5-4</td><td>3</td></tr>
<tr><td>3-2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
The following table shows how the marks should be awarded for structure and lines of reasoning.
<table>
<tr><th></th><th>Number of marks awarded for structure and sustained lines of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning.</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured.</td><td>0</td></tr>
</table>
</td>
<td>The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).

If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).

If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded, do not deduct mark(s).

Comment: Look for the indicative marking points first, then consider the mark for the structure of the answer and sustained line of reasoning.</td>
<td>6</td>
</tr>
</table>

<table>
<tr>
<td></td>
<td>Indicative points:

IP1: use of $[H^+] = \sqrt{(K_a \times [HA])}$
IP2: use of $pH = -\log[H^+]$
IP3: indication that $[HA]_{equilibrium}$ is lower than $[HA]_{initial}$
IP4: (because) dissociation (of both acids) is significant
IP5: (calculated pH values lower than measured pH values because) [HA] is overestimated in the calculations
IP6: (difference greatest for) $CHCl_2COOH$ (as is) stronger acid
or
two Cl atoms in $CHCl_2COOH$ are more electron withdrawing than one / stabilise anion more / weaken O–H bond more

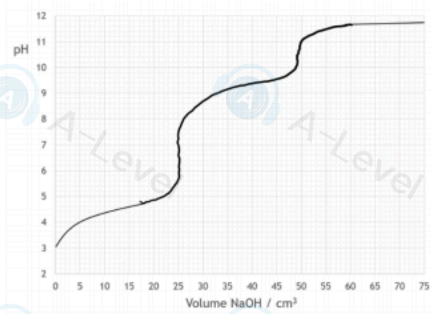
</td>
<td>If calculations shown, pH values are 2.0775 and 1.3239

Ignore $[H^+] = [A^-]$ assumption is not valid
Ignore $[H^+] > [A^-]$
Do not award $[A^-] > [H^+]$

Allow dissociation is not negligible
Allow dissociation occurs
Do not award dissociation is negligible
Do not award dissociation is complete

Do not award $[H^+]$ overestimated in calculation due to dissociation of water

Allow more dissociated for stronger
Ignore strong acid for stronger acid
Ignore $CHCl_2COOH$ has larger K_a / smaller pKa</td>
<td></td>
</tr>
</table>

Question Number	Answer		Additional Guidance	Mark
19(b)	An answer that makes reference to the following points:		Example of completed titration curve: 	3
	• vertical section at 25 cm^3 **and** with height in the range of 1 to 4 pH units	**(1)**	Allow slight slope in range of 24 cm^3 to 26 cm^3	
	• vertical section at 50 cm^3 **and** with height greater than 0.4 pH units	**(1)**		
	• (buffered section with) pH 9.3 at 37.5 cm^3	**(1)**	Allow any pH between 9.0 and 9.6 Allow reading of pH from midpoint volume between two vertical sections as TE on M1/M2	

Question Number	Answer		Additional Guidance	Mark
19(c)	**M1 and M2:** • calculation of [H$^+$] at both pH values **or** calculation of pOH at both pH values	**(1)**	Example of calculation: $[H^+] = 10^{-12.43} = 3.7154 \times 10^{-13}$; $[H^+] = 10^{-12.00} = 1 \times 10^{-12}$ **or** pOH = 14 – 12.43 = 1.57; pOH = 14 – 12.00 = 2.00	5
	• calculation of [OH$^-$] at both pH values	**(1)**	$[OH^-] = 1 \times 10^{-14} \div 3.7154 \times 10^{-13} = 10^{-1.57} = 0.026915$ $[OH^-] = 1 \times 10^{-14} \div 1 \times 10^{-12} = 10^{-2.00} = 0.01$	
	M3, M4 and M5 (Method 1): • calculation of moles of NaOH in 50.0 cm^3 at pH 12.43	**(1)**	$0.026915 \times \frac{50.0}{1000} = 1.3458 \times 10^{-3}$	
	• calculation of volume of NaOH required at pH 12.00	**(1)**	$1.3458 \times 10^{-3} \div 0.01 = 0.13458$ dm^3 = 134.58 cm^3	
	• volume of water required in cm^3	**(1)**	134.58 – 50.0 = 84.58 / 84.6 / 85 (cm^3) TE on M4	
	M3, M4 and M5 (Method 2): • expression for dilution	**(1)**	$c_1V_1 = c_2V_2$	
	• calculation of volume of NaOH required at pH 12.00	**(1)**	$V_2 = \frac{c_1V_1}{c_2} = \frac{0.026915 \times 50.0}{0.01} = 134.58$ cm^3	
	• volume of water required in cm^3	**(1)**	134.58 – 50.0 = 84.58 / 84.6 / 85 (cm^3)	

	M3, M4 and M5 (Method 3): • calculation of moles of NaOH in 50.0 cm^3 at pH 12.43 **(1)** • calculation of moles of NaOH in 50.0 cm^3 at pH 12.00 **and** difference in moles of NaOH **(1)** • calculation of volume of NaOH required **(1)** **M3, M4 and M5 (Method 4):** • difference in concentrations of NaOH **(1)** • difference in moles of NaOH **(1)** • calculation of volume of NaOH required **(1)** OHER METHODS MAY BE POSSIBLE	$0.026915 \times \frac{50.0}{1000} = 1.3458 \times 10^{-3}$ $0.01 \times \frac{50.0}{1000} = 5 \times 10^{-4}$ **and** $1.3458 \times 10^{-3} - 5 \times 10^{-4} = 8.458 \times 10^{-4}$ $8.458 \times 10^{-4} \div 0.01 = 84.58\ (cm^3)$ $0.026915 - 0.01 = 0.016915$ $0.016915 \times \frac{50.0}{1000} = 8.458 \times 10^{-4}$ $8.458 \times 10^{-4} \div 0.01 = 84.58\ (cm^3)$ If no other marks awarded, calculation of $[H^+]$/pOH **and** calculation of $[OH^-]$ at either pH scores (1)	