A Level AQA Chemistry

Chapter 9 – answers

Question	Answers	Extra information	Mark	AO Spec reference
01.1	A proton donor that fully dissociates in water		1 1	3.1.12.1 AO1
01.2	Rinse beaker (and funnel) with distilled water Fill volumetric flask so bottom of meniscus is on line Using a pipette		1 1 1	3.1.2.5 AO1
01.3	$-\log[H^+]$		1	3.1.12.1 AO1
01.4	Moles at start = $0.3.00 \times 0.05 = 0.015$ Concentration = $0.015/0.25 = 0.06$ mol dm^{-3} Diprotic so 0.06×2 $[H^+]$ pH = $-\log(2 \times 0.06) = 0.92$	Must be 2 d.p.	1 1 1 1	3.1.12.2 3.1.2.5 AO2 MS0.4, MS2.5
02.1	$mol^2\ dm^{-6}$		1	3.1.12.3 AO1
02.2	$M_r\ Ba(OH)_2 = 137.3 + (2 \times 17) = 171.3$ g mol^{-1} Moles $Ba(OH)_2 = 3.50/171.3 = 0.02$ Mole $OH^- = 0.04$ $[OH^-] = 0.04/0.5 = 0.08$ mol dm^{-3} $K_w = [H^+][OH^-] = 1\times10^{-14}$ $[H^+] = 1\times10^{-14}/0.08 = 1.22\times10^{-13}$ pH = $-\log(1.22\times10^{-13})$ = 12.91	Must be 2 d.p.	1 1 1 1 1 1 1	3.1.12.3 AO2
02.3	Barium carbonate is insoluble Would be removed by filtration		1 1	3.2.2 AO3

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02.4	Moles of $Ba(OH)_2$ = 0.02/5 = 0.004 Moles HCl = 0.1 × 0.25 = 0.025 Excess H^+ = 0.025−/2 – 0.004 = 0.0085 Concentration H^+ = 0.0085/0.45 = 0.0189 mol dm^{-3} pH = −log(0.06) = 1.72	Allow their mark 2 from **02.2**	1 1 1 1 1	3.1.12.2 AO2
03.1	Place pH probe into **multiple** buffer solutions of known pH Rinse between solutions Record pH on meter Plot graph of pH or buffer vs pH on meter		1 1 1 1	3.1.12.5 AO3
03.2	$K_a = \frac{[H^+]^2}{[HA]}$ $[H^+] = \sqrt{1.76 \times 10^{-5} \times 0.10}$ = 0.00133 pH = −log(0.00133) = 2.88	 Must be 2 d.p.	1 1 2	3.1.12.4 AO2
03.3	H on y axis, volume of acid on x Must start between 13.00 and 14.00 Must turn vertical by pH 11.00 Vertical line must be at 25 cm^3 Point 37.5 cm^3 must be within +/− 0.25 of pH 4.75 Must end by pH 3.00		1 1 1 1 1	3.1.12.5 AO3

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03.4	Thymolphthalein ticked	Accept ticks or marks not in box but clearly indicate the correct answer	1	3.1.12.5 AO1
04.1	A buffer solution maintains an approximately constant pH, despite dilution or addition of small amounts of acid or base.		1 1	3.1.12.6
04.2	$K_a = 10^{-4.19} = 6.46 \times 10^{-5}$ mol dm^{-3} Moles sodium benzoate = 4.65/144.1 = 0.0323 Concentration = 0.0323/0.25 = 0.129 mol dm^{-3} $K_a = \frac{[H^+][A^-]}{[HA]}$ $6.46 \times 10^{-5} \times \frac{0.20}{0.129} = [H^+] = 0.0001$ mol dm^{-3} pH = −log(0.0001) = 4.00	Allow words of reagents	1 1 1 1 1 1	3.1.12.6
04.3	**Dissolve** impure crystals in **minimum** volume **Hot** water/solvent Filter using a hot funnel Allow (filtrate) to cool and crystals to form Filter under reduced pressure/Buchner funnel and side-arm flask	Ignore reference to pumps, etc.	1 1 1 1 1	3.3.9.2
05.1	A proton acceptor that fully dissociates in water		1 1	3.1.12.1 AO1
05.2	Volume of acid on x-axis + pH on y-axis Suitable scales All points plotted correctly Smooth line with vertical line that crosses pH 7 at 25 cm^3	Allow 2 errors outside 1 mm	1 1 1 1	3.1.12.5 AO3
05.3	Reads pH from 12.5 cm^3 (should be 3.75) Expected answer is 1.77×10^{-4}	Allow evidence on graph Allow range of 1.58×10^{-4} – 2.00×10^{-4}	1 1	3.1.12.5 AO2

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05.4	% oxygen = 100 − 26 − 4.3 = 69.7 C = 26/12 = 2.17 H = 4.3/1 = 4.3 O = 69.7/16 = 4.36 C = 2.17/2.17 = 1 H = 4.3/2.17 = 1.98 = 2 O = 4.36/2.17 = 2.00 CH_2O_2	 Allow any order	1 1 1 1	3.1.2.4 AO2
05.5	CH_2O_2		1	3.1.2.4 AO2
05.6	Methanoic acid		1	3.3.1.1 AO1
06.1	$K_w = [H^+][OH^-]$		1	3.1.12.3 AO1
06.2	$5.84 \times 10^{-14} = [H^+]^2$ as $[H^+] = [OH^-]$ $\sqrt{5.84 \times 10^{-14}} = 2.42 \times 10^{-7}$ pH = −log (2.42×10^{-7}) = 6.62	 Must be 2 d.p.	1 1 1 1	3.1.12.3 AO2
06.3	Same concentration of OH^- and H^+		1	3.1.12.3 AO1

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06.4	$(2 \times 293) + (-22.1) + (-300)$ $= 263.9\ \text{kJ mol}^{-1}$		1 1	3.1.4.3 AO2 MS2.4
07.1	$K_a = \dfrac{[CH_3COO^-][H^+]}{[CH_3COOH]}$		1	3.1.12.4 AO1
07.2	$[H^+] = 10^{-4} = 1.00 \times 10^{-4}\ \text{mol dm}^{-3}$ $1.74 \times 10^{-5} = \dfrac{1.00 \times 10^{-4} \times 0.129}{[HA]}$ $[HA] = \dfrac{1.00 \times 10^{-4} \times 0.129}{1.74 \times 10^{-5}}$ $= 0.741\ \text{mol dm}^{-3}$	 Must be 3 s.f. to score final mark	1 1 1 1	3.1.12.6 AO2 MS0.4
07.3	Moles $HA = 0.520 \times 0.25 = 0.13$ Moles $A^- = 0.212 \times 0.25 = 0.053$ Moles after $HA = 0.13 - 6.5 \times 10^{-3} = 0.1235$ Moles after $A^- = 0.053 + 6.5 \times 10^{-3} = 0.0595$ $[H^+] = \dfrac{1.74 \times 10^{-5} \times 0.1235}{0.0595} = 3.612 \times 10^{-6}$ $\text{pH} = -\log(3.612 \times 10^{-6})$ $= 4.44$	 Must be 2 d.p.	1 1 1 1 1 1 1	3.1.12.6 AO2 MS0.4

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08.1	$H_2CO_3\,(aq) \rightleftharpoons HCO_3^-\,(aq) + H^+\,(aq)$		1	3.1.12.4 AO1
08.2	Addition of small amounts of acid send equilibrium to left or extra H^+ removed by reaction with HCO_3^- ratio $[H_2CO_3]/[HCO_3^-]$ remains constant hence $[H^+]$ and pH remain const		1 1	3.1.12.6 AO3
08.3	$K_a = \frac{[H^+][A^-]}{[HA]}$ $[H^+] = 10^{-7.41} = 3.89\times10^{-8}$ $\frac{4.30\times10^{-7} \times 1.25\times10^{-3}}{3.89\times10^{-8}} = [HA]$ 0.0138 mol dm^{-3}		1 1 1 1	3.1.12.6 AO2 MS0.4
08.4	$[HA]$ change $= 1.25\times10^{-3} \times 0.25 = 3.125\times10^{-4}$ $1.25\times10^{-3} + 3.125\times10^{-4} = 1.5625\times10^{-3}$ $[A^-] = 0.0138 - 3.125\times10^{-4} = 0.0134875$ mol dm^{-3} $[H^+] = \frac{1.5625\times10^{-3} \times 4.30\times10^{-7}}{0.0134875} = 4.98\times10^{-8}$ pH $= -\log(4.98\times10^{-8})$ $= 7.30$	Can be awarded from correct ka equation Must be 2 d.p.	1 1 1 1 1	3.1.12.6 AO2 MS0.4

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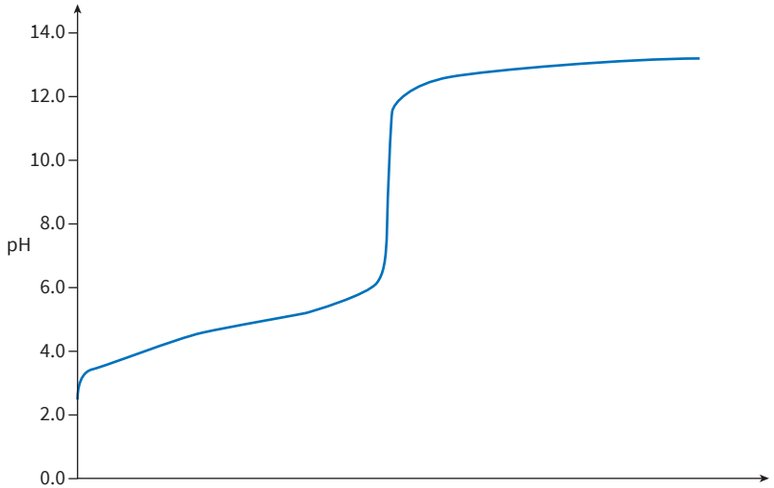
Skills box answers:

1. 

   Make sure the axes are labelled and the x-axis has units.

2. Read off the middle of the vertical portion of the graph: 8.8 ≤ pH ≤ 9.2.
3. Phenolphthalein (or any sensible suggestion: – cresolphthalein or thymol blue, second step).
4. At the start the pH = 2.5.

   $[H^+]=10^{-2.5}$

   $K_a = [H^+][A^-] / [HA] \approx [H^+]^2 / [HA] = 10^{(-2.5\times2)} / 0.5 = 2.00\times10^{-5}\ \text{mol dm}^{-3}$

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