Assessment schedule: practice paper 2026

AS 91392 Demonstrate understanding of equilibrium principles in aqueous systems · Vertex Academy practice paper, not an NZQA paper

QUESTION ONE

Part	Evidence	Achievement (u)	Merit (r)	Excellence (t)
(a)	$Mg(OH)_2(s) \rightleftharpoons Mg^{2+}(aq) + 2OH^-(aq)$ $K_s = [Mg^{2+}][OH^-]^2$	Correct equation AND Ks expression.		
(b)	$K_s = s(2s)^2 = 4s^3$ $s^3 = 5.61 \times 10^{-12} \div 4 = 1.40 \times 10^{-12}$ $s = 1.12 \times 10^{-4}$ mol L^{-1}	$s = 1.12 \times 10^{-4}$ mol L^{-1}.		
(c)	$[OH^-] = 0.0500$ mol L^{-1} $s = 5.61 \times 10^{-12} \div 0.0500^2$ $s = 2.24 \times 10^{-9}$ mol L^{-1}	$s = 2.24 \times 10^{-9}$ mol L^{-1}, OR states that the common ion (OH^-) lowers the solubility.	$s = 2.24 \times 10^{-9}$ mol L^{-1} AND explains with the common ion effect: added OH^- shifts the equilibrium to the left.	
(d)	$[Mg^{2+}] = 0.00100 \times 20.0 \div 50.0 = 4.00 \times 10^{-4}$ $[OH^-] = 0.000200 \times 30.0 \div 50.0 = 1.20 \times 10^{-4}$ $Q = 4.00 \times 10^{-4} \times (1.20 \times 10^{-4})^2 = 5.76 \times 10^{-12} > K_s$ $H_3O^+ + OH^- \rightarrow 2H_2O$ equilibrium shifts right	Correct diluted concentration of Mg^{2+} OR OH^-.	$Q = 5.76 \times 10^{-12}$ compared with Ks to show a precipitate forms, OR explains why acid dissolves $Mg(OH)_2$.	$Q = 5.76 \times 10^{-12} > K_s$ so a precipitate forms, AND discusses the acid removing OH^-, so $Q < K_s$ and the equilibrium shifts right until the solid dissolves.

QUESTION TWO

Part	Evidence	Achievement (u)	Merit (r)	Excellence (t)
(a)	$K_a = [CH_3COO^-][H_3O^+] \div [CH_3COOH]$ $CH_3COOH > CH_3COO^- = H_3O^+ > OH^-$	Correct Ka expression AND correct order of species.		
(b)	$[H_3O^+] = \sqrt{(1.74 \times 10^{-5} \times 0.100)}$ $[H_3O^+] = 1.32 \times 10^{-3}$ mol L^{-1} pH = 2.88	pH = 2.88.		

(c)	$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$ $Kb = 1.00 \times 10^{-14} \div 1.74 \times 10^{-5} = 5.75 \times 10^{-10}$ $[OH^-] = \sqrt{(5.75 \times 10^{-10} \times 0.0500)} = 5.36 \times 10^{-6}$ $pOH = 5.27$	Correct equation for ethanoate reacting with water, OR $Kb = 5.75 \times 10^{-10}$.	pH = 8.73 AND explains that ethanoate is a base that produces OH^- ions when it reacts with water.	
(d)	$pKa = 4.76$ $pH = 4.76 + \log(0.0800 \div 0.100) = 4.66$ acid added: $CH_3COO^- + H_3O^+ \rightarrow CH_3COOH + H_2O$ base added: $CH_3COOH + OH^- \rightarrow CH_3COO^- + H_2O$ ratio changes little	pKa = 4.76, OR one correct equation for the buffer reacting with added acid or base.	pH = 4.66, OR both buffer equations with an explanation.	pH = 4.66 AND discusses both additions with equations, justifying that the ratio of acid to conjugate base changes only slightly, so the pH barely changes.

QUESTION THREE

Part	Evidence	Achievement (u)	Merit (r)	Excellence (t)
(a)	$n(NH_3) = 0.120 \times 0.0200 = 0.00240$ mol $V(HCl) = 0.00240 \div 0.100 = 24.0$ mL half-equivalence: pH = pKa = 9.24	Equivalence volume = 24.0 mL AND pH = 9.24 at half-equivalence.		
(b)	equivalence pH below 7 (about 5.3) methyl red: 4.4 to 6.2	Chooses methyl red with a reason linked to the acidic equivalence point.		
(c)	$[NH_4^+] = 0.00240 \div 0.0440 = 0.0545$ mol L^{-1} $Ka = 10^{-9.24} = 5.75 \times 10^{-10}$ $[H_3O^+] = \sqrt{(5.75 \times 10^{-10} \times 0.0545)} = 5.60 \times 10^{-6}$ $pH = 5.25$	$[NH_4^+] = 0.0545$ mol L^{-1}, OR the equation for NH_4^+ reacting with water.	pH = 5.25 AND explains that NH_4^+ is a weak acid that produces H_3O^+.	

(d)	(i) NH_3 left 0.00180 mol, NH_4^+ 0.000600 mol pH = 9.24 + log(0.00180 ÷ 0.000600) = 9.72 (ii) excess HCl 0.000600 mol in 50.0 mL pH = 1.92 NH_3 → NH_3 and NH_4^+ buffer → NH_4^+ and Cl^- → excess H_3O^+	One correct mole calculation (0.00180 mol NH_3 left, or 0.000600 mol excess HCl).	pH = 9.72 at 6.00 mL OR pH = 1.92 at 30.0 mL.	Both pH values correct (9.72 and 1.92) AND discusses the main species before, at and after equivalence, including the buffer region.

Judgement for each question

N0	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a.	2a, or 1m.	3a, or 1a and 1m.	4a, or 2a and 1m.	2m, or 1e.	2a and 2m, or 1m and 1e.	1e and 1m, with a minor error or omission elsewhere.	2a, 1m and 1e: every part correct.

Grade score out of 24 (each question's grade: N0 = 0 to E8 = 8): Not Achieved 0 to 8, Achieved 9 to 13, Merit 14 to 19, Excellence 20 to 24 (the 2025 exam's cut scores).