HINTS & SOLUTION TO WORKBOOK-2

Ionic Equilibrium

Daily Tutorial Sheet - 12	Level-3

141.(B) $pH(I) = pK_a + \log\frac{4\times0.1}{4\times1} = pK_a - 1$

$pH(II) = pK_a + \log\frac{40\times0.1}{4\times1} = pK_a$

$pH(III) = pK_a + \log\frac{4\times0.1}{40\times1} = pK_a - 2$

$pH(IV) = pK_a + \log\frac{10\times0.1}{0.1\times1} = pK_a + 1$

142.(B) $HA(aq) + OH^-(aq) \rightleftharpoons A^-(aq) + H_2O(\ell) : K_C = 10^9$

$A^-(aq) + H_2O(\ell) \rightleftharpoons HA(aq) + OH^-(aq) : K_h = 10^{-9}$

$\therefore \quad [\bar{O}H] = \sqrt{K_{h\cdot c}} = 10^{-5} \quad \Rightarrow \quad pH = 9$

143.(A)

	$H_2CO_3(aq) \rightleftharpoons$	$H^+(aq) +$	$HCO_3^-(aq)$
$t = t_{eq}$	$0.034 - x$	$x + y$	$x - y$
	≈ 0.034	$\approx x$	$\approx x$

	$HCO_3^-(aq) \rightleftharpoons$	$H^+(aq) +$	$CO_3^{2-}(aq)$
$t = t_{eq}$	$x - y$	$x + y$	y
	$\approx x$	$\approx x$	

144.(A) $[\bar{N}H_2] = [\overset{+}{N}H_2] = \sqrt{10^{-30}} = 10^{-15}$

$\therefore \quad 6.02\times10^{23}\times10^{-15}\ \bar{N}H_2$ ions per litre

or $\quad 6.02\times10^{23}\times10^{-15}\times10^{-6}\ \bar{N}H_2$ ions per mm^3

$\Rightarrow \quad 602\ \bar{N}H_2$ ions

145.(A) $HCOOH \rightleftharpoons H^+ + HCOO^- \quad ; \quad K_{a_1}$

	0.1	–	–
	$0.1(1-\alpha_1)$	$0.1\alpha_1$	$0.1\alpha_1$

$HOCN \rightleftharpoons H^+ + \bar{O}CN \quad ; \quad K_{a_2}$

	0.1	–	–
	$0.1(1-\alpha_2)$	$0.1\alpha_2$	$0.1\alpha_2$

Final $[H^+] = 0.1(\alpha_1 + \alpha_2)$

Both HCOOH & HOCN are weak acid, due to common ion effect we can assume

$\alpha_1 << 1 \; ; \; \alpha_2 << 1$

$(1-\alpha_1) \approx 1 \qquad (1-\alpha_2) \approx 1$

$K_{a_1} = 1.8 \times 10^{-14} = 0.1(\alpha_1 + \alpha_2)\alpha_1$

$K_{a_2} = 3.1 \times 10^{-4} = 0.1(\alpha_1 + \alpha_2)\alpha_2$

$\therefore \qquad K_{a_1} + K_{a_2} = 4.9 \times 10^{-4} = 0.1(\alpha_1 + \alpha_2)^2$

$\Rightarrow \qquad (\alpha_1 + \alpha_2) = \sqrt{49 \times 10^{-4}} = 0.07$

$[H^+] = 0.07 \times 0.1 = 7 \times 10^{-3} \approx 10^{-2} M$

146.(AC) $K_a = K_{a_1} \times K_{a_2} \times K_{a_3}$, $K_{a_1} > K_{a_2} > K_{a_3}$