Acid-Base Review

#1. Arrhenius concept - Acids have 'H'; Bases have 'OH'
Revised Arrhenius - Acids have 'H^+'; Bases have 'OH^-'
Bronsted-Lowry - Acids are protondonors; Bases are proton acceptors

#2. $HS^- \rightarrow S^{2-}$ $\qquad$ $HS^- \rightarrow H_2S$

conjugate acid / conjugate base $\qquad$ conjugate base / conjugate acid

#3 a) $HBr_{(aq)} + H_2O_{(l)} \rightleftharpoons Br^-_{(aq)} + H_3O^+_{(aq)}$

b) $NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$

c) $HCO_3^-{}_{(aq)} + H_2O_{(l)} \rightleftharpoons CO_3^{2-}{}_{(aq)} + H_3O^+_{(aq)}$

$HCO_3^-{}_{(aq)} + H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)} + OH^-_{(aq)}$

#4. a) $HCOOH_{(aq)} + CN^-_{(aq)} \overset{>50\%}{\rightleftharpoons} HCOO^-_{(aq)} + HCN_{(aq)}$

b) $HPO_4^{2-}{}_{(aq)} + HCO_3^-{}_{(aq)} \overset{<50\%}{\rightleftharpoons} H_2PO_4^-{}_{(aq)} + CO_3^{2-}{}_{(aq)}$

#5 a) $HF_{(aq)}$ and $K_2SO_{4(aq)}$

$HF_{(aq)}$, $K^+_{(aq)}$, $SO_4^{2-}{}_{(aq)}$, $H_2O_{(l)}$
SA $\quad$ – $\quad$ SB $\quad$ A/B

$HF_{(aq)} + SO_4^{2-}{}_{(aq)} \overset{<50\%}{\rightleftharpoons} F^-_{(aq)} + HSO_4^-{}_{(aq)}$

b) $NaHSO_{4(aq)}$ and $NaHS_{(aq)}$

$Na^+_{(aq)}$, $HSO_4^-{}_{(aq)}$, $HS^-_{(aq)}$, $H_2O_{(l)}$
— (SA)/B A/B A/B

$HSO_4^-{}_{(aq)} + HS^-_{(aq)} \overset{>50\%}{\rightleftharpoons} SO_4^{2-}{}_{(aq)} + H_2S_{(aq)}$

c) $HCOOH_{(aq)}$ and $NaOH_{(aq)}$

$HCOOH_{(aq)}$, $Na^+_{(aq)}$, $OH^-_{(aq)}$, $H_2O_{(l)}$
SA — SB A/B

$HCOOH_{(aq)} + OH^-_{(aq)} \overset{>50\%}{\rightleftharpoons} HCOO^-_{(aq)} + H_2O_{(l)}$

*6. $[OH^-_{(aq)}] = 2.5 \times 10^{-7}$ mol/L

$K_w = [H^+_{(aq)}][OH^-_{(aq)}]$

$[H^+_{(aq)}] = \frac{1.0 \times 10^{-14}}{2.5 \times 10^{-7}}$

$[H^+_{(aq)}] = 4.0 \times 10^{-8}$ M

$pH = -\log[H^+_{(aq)}]$

$pH = -\log[4.0 \times 10^{-8}]$

pH = 7.40

#7. $8.50\text{ g NaOH} \times \frac{1\text{ mol NaOH}}{40.00\text{ g NaOH}} = 0.2125\text{ mol NaOH}$

$C = \frac{n}{V} = \frac{0.2125\text{ mol}}{0.500\text{ L}} = 0.425\text{ M}$

$NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$

0.425M 0.425M

$pOH = -\log[OH^-_{(aq)}]$

$pOH = -\log[0.425]$

pOH = 0.372

*8. $HA_{(aq)} + H_2O_{(\ell)} \rightleftharpoons A^-_{(aq)} + H_3O^+_{(aq)}$ $K_a = 3.27 \times 10^{-4}$

0.018M

$K_a = \frac{[A^-_{(aq)}][H_3O^+_{(aq)}]}{[HA_{(aq)}]}$, $[A^-_{(aq)}] = [H_3O^+_{(aq)}]$

$K_a = \frac{[H_3O^+_{(aq)}]^2}{[HA_{(aq)}]}$

$[H_3O^+_{(aq)}] = \sqrt{(3.27 \times 10^{-4})[0.018]}$

$[H_3O^+_{(aq)}] = 0.00243\ M$

$pH = -\log [H_3O^+_{(aq)}]$

$pH = -\log [0.00243]$

$pH = 2.62$

*9. $H_2SO_{4(aq)} \longrightarrow 2H_3O^+_{(aq)} + SO_4^{2-}{}_{(aq)}$

0.090M 0.180M

$pH = -\log [H_3O^+_{(aq)}]$

$pH = -\log [0.180]$

$pH = 0.74$

*10. $CH_3COOH_{(aq)} + H_2O_{(\ell)} \rightleftharpoons CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$

0.625M

$K_a = \frac{[CH_3COO^-_{(aq)}][H_3O^+_{(aq)}]}{[CH_3COOH_{(aq)}]}$, $[CH_3COO^-_{(aq)}] = [H_3O^+_{(aq)}]$

$K_a = \frac{[H_3O^+_{(aq)}]^2}{[CH_3COOH_{(aq)}]}$

$[H_3O^+_{(aq)}] = \sqrt{(1.8 \times 10^{-5})[0.625]}$

$[H_3O^+_{(aq)}] = 0.00335\ M$

$pH = -\log [H_3O^+_{(aq)}]$

$pH = -\log [0.00335]$

$pH = 2.475$

#11. $CO_{3(aq)}^{2-} + H_2O_{(l)} \rightleftharpoons HCO_{3(aq)}^{-} + OH_{(aq)}^{-}$

1.25M

$K_b = \frac{[HCO_{3(aq)}^{-}][OH_{(aq)}^{-}]}{[CO_{3(aq)}^{2-}]}$, $[HCO_{3(aq)}^{-}] = [OH_{(aq)}^{-}]$

$K_b = \frac{[OH_{(aq)}^{-}]^2}{[CO_{3(aq)}^{2-}]}$

$[OH_{(aq)}^{-}] = \sqrt{(2.13\times10^{-4})[1.25]}$

$[OH_{(aq)}^{-}] = 0.0163M$

$K_aK_b = K_w$

$K_b = \frac{1.0\times10^{-14}}{4.7\times10^{-11}} = 2.13\times10^{-4}$

$pOH = -\log[OH_{(aq)}^{-}]$

$pOH = -\log[0.0163]$

$pOH = 1.79$

$pH + pOH = 14.00$

$pH = 14.00 - 1.79$

$\boxed{pH = 12.21}$

#12. $Ca(OH)_{2(aq)} \rightarrow Ca_{(aq)}^{2+} + 2OH_{(aq)}^{-}$

0.57M 1.14M

$pOH = -\log[OH_{(aq)}^{-}]$

$pOH = -\log[1.14]$

$pOH = -0.06$

$pH + pOH = 14.00$

$pH = 14.00 - (-0.06)$

$\boxed{pH = 14.06}$