

Unit 4 Review

1) $V = 5L$, $N_2 = 0.1 \text{ mol}$, $NH_3 = 0.3 \text{ mol}$, $K_{eq} = 3.1 \times 10^{-2}$

$$[N_2] = n/V = 0.1/5 = 0.02 \text{ mol/L}$$

$$[NH_3] = n/V = 0.3/5 = 0.06 \text{ mol/L}$$



$$K_{eq} = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$3.1 \times 10^{-2} = \frac{(0.06)^2}{(0.02)(H_2)^3}$$

$$(H_2)^3 = \frac{(0.06)^2}{(0.02)(3.1 \times 10^{-2})}$$

$$(H_2)^3 = 5.81$$

$$\boxed{H_2 = 1.80 \text{ mol/L}}$$

2) $V = 2L$, $n_{Br_2} = 8.0 \text{ mol}$, $n_{Cl_2} = 8.0 \text{ mol}$, $K_{eq} = 28.8$

$$[Br_2] = n/V = 8.0/2 = 4 \text{ mol/L}$$

$$[Cl_2] = n/V = 8.0/2 = 4 \text{ mol/L}$$



I	4M	4M	0
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C	-x	-x	+2x
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E	4-x	4-x	2x
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$$K_{eq} = \frac{[BrCl]^2}{[Br_2][Cl_2]}$$

$$28.8 = \frac{(2x)^2}{(4-x)^2}$$

$$\sqrt{28.8} = \frac{(2x)}{(4-x)}$$

$$\sqrt{28.8}(4-x) = 2x$$

$$21.47 - \sqrt{28.8}x = 2x$$

$$21.47 = 2x + \sqrt{28.8}x$$

$$21.47 = 7.37x$$

$$\rightarrow x = \frac{21.47}{7.37}$$

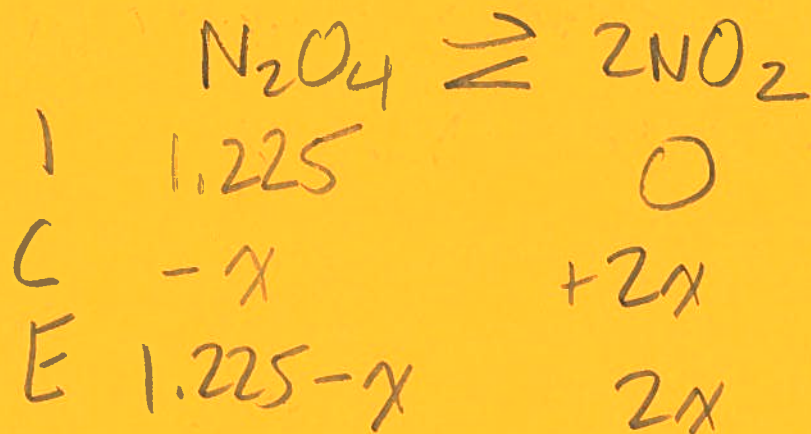
$$x = 2.91$$

$$[BrCl] = 2x = 2(2.91)$$

$$[BrCl] = 5.83 \text{ mol/L}$$

$$3) V = 8L, N_2O_4 = 9.8 \text{ mol}, K_{eq} = 8.9 \times 10^{-11}$$

$$[N_2O_4] = 9.8/8 = 1.225 \text{ mol/L}$$



$$K_{eq} = \frac{[NO_2]^2}{[N_2O_4]} \quad \# \text{ small } K_{eq} = \text{hundreds rule}$$

$$8.9 \times 10^{-11} = \frac{(2x)^2}{(1.225)}$$

$$(2x)^2 = (1.225)(8.9 \times 10^{-11})$$

$$4x^2 = 1.09 \times 10^{-11}$$

$$x^2 = 2.73 \times 10^{-11}$$

$$x = 5.2 \times 10^{-6}$$

$$\begin{aligned} [NO_2] &= 2(x) \\ &= 2(5.2 \times 10^{-6}) \end{aligned}$$

$$\boxed{[NO_2] = 1.04 \times 10^{-5} M}$$

$$4) [N_2] = 0.3M, [H_2] = 0.5, [NH_3] = 1.0M$$

$$Q = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$Q = \frac{(1)^2}{(0.3)(0.5)^3}$$

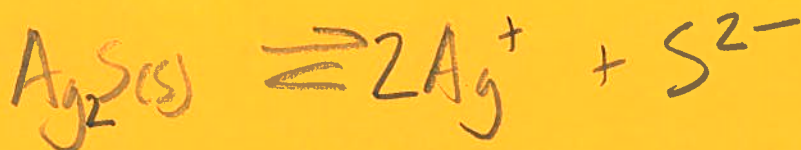
$$Q = 26.67$$

Q key

$$26.67 < 50$$

Reaction proceeds forwards

$$5) Ag_2S(s) = 3.0 \times 10^{-3} \text{ mol/L}$$



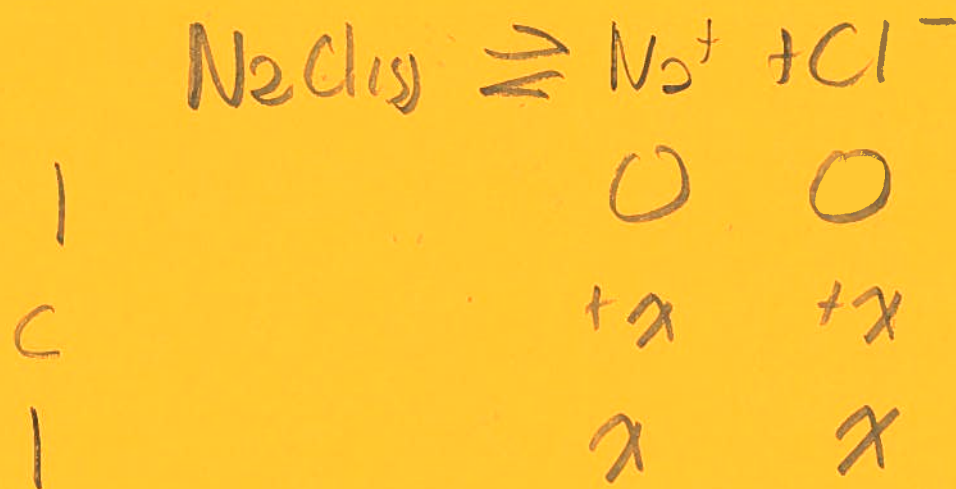
I	3.0×10^{-3}	0	0
C	-x	+2x	+x
E	0	2x	x

$$K_{sp} = [Ag^+]^2 [S^{2-}]$$

$$K_{sp} = [2(3.0 \times 10^{-3})]^2 (3.0 \times 10^{-3})$$

$$K_{sp} = 1.08 \times 10^{-7}$$

$$6) K_{sp} = 1.38$$



$$K_{sp} = [\text{Na}][\text{Cl}]$$

$$K_{sp} = (x)^2$$

$$1.38 = x^2$$

$$\boxed{x = 1.17 \text{ mol/L}}$$

$$7) [\text{H}_3\text{O}^+] = 3.0 \times 10^{-4} \text{ mol/L}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+]$$

$$\text{pH} = -\log(3.0)$$

$$\boxed{\text{pH} = -0.48}$$

$$8) [3.0 \times 10^{-4}] = \text{H}_3\text{O}^+$$

$$\text{pH} = -\log [\text{H}_3\text{O}^+]$$

$$\text{pH} = -\log (3.0 \times 10^{-4})$$

$$\text{pH} = 3.52$$

$$\text{pOH} = 14 - \text{pH}$$

$$\text{pOH} = 14 - 3.52$$

$$\underline{\underline{\text{pOH} = 10.48}}$$

a) $[CH_3CH_2COOH] = 1.0M$, $pH = 3.8$



I	1.0M	0	0
C	x	+x	+x
E	1-x	x	x

$$[H_3O^+] = 10^{-pH}$$

$$= 10^{-3.8}$$

$$[H_3O^+] = 1.58 \times 10^{-4}$$

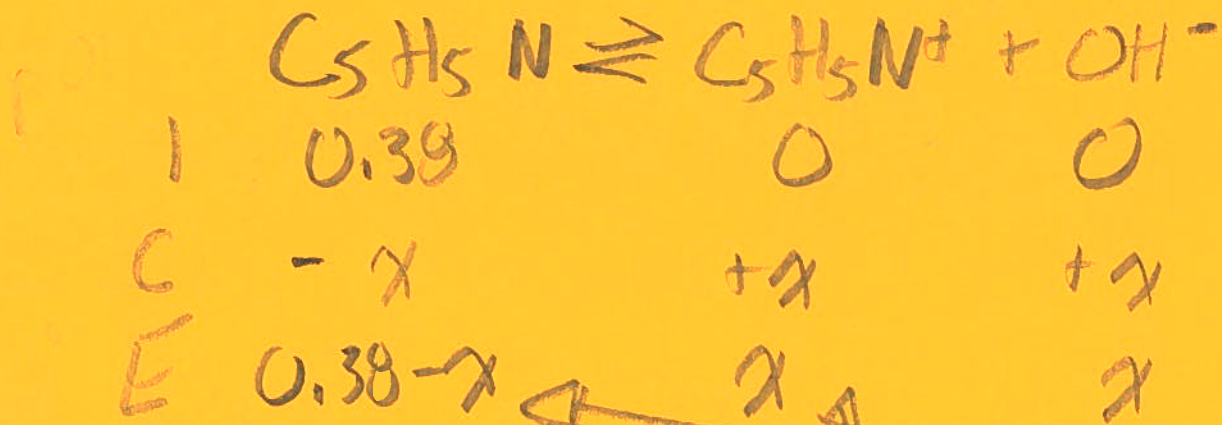
$$K_a = \frac{[CH_3CH_2COO^-][H_3O^+]}{[CH_3CH_2COOH]}$$

$$K_a = \frac{(1.58 \times 10^{-4})^2}{(1 - 1.58 \times 10^{-4})}$$

$$K_a = 2.3 \times 10^{-8}$$

$$\% \text{ ionization} = \frac{[\text{ionized}]}{[\text{initial}]} \times 100 = \frac{1.58 \times 10^{-4}}{1.0} \times 100 = \boxed{0.016\%}$$

10) $[C_5H_5N] = 0.38M, pH = 10.98$



$pOH = 14 - pH = 14 - 10.98$
 $pOH = 3.02$

$[OH^-] = 10^{-pOH} = 10^{-3.02}$

$[OH^-] = 9.55 \times 10^{-4}$

$$K_b = \frac{[C_5H_5N^+][OH^-]}{[C_5H_5N]}$$

$$= \frac{(9.55 \times 10^{-4})^2}{(0.38 - 9.55 \times 10^{-4})}$$

$K_b = 2.4 \times 10^{-6}$

$\% \text{ ion} = \frac{[\text{dissociated}]}{[\text{initial}]} = \frac{9.55 \times 10^{-4}}{0.38} \times 100 = \boxed{0.25\%}$

$$11) V_{\text{LiOH}} = 50 \text{ mL} = 0.05 \text{ L}$$

$$C_{\text{LiOH}} = 1.0 \text{ M}$$

$$V_{\text{HF}} = 35 \text{ mL} = 0.035 \text{ L}$$

$$C_{\text{HF}} = 1.3 \text{ M}$$

Moles of each

$$\begin{aligned} n_{\text{LiOH}} &= C \times V \\ &= 1.0 \text{ M} \times 0.05 \text{ L} \\ &= 0.05 \text{ mol} \end{aligned}$$

$$\begin{aligned} n_{\text{HF}} &= C \times V \\ &= 1.3 \text{ M} \times 0.035 \text{ L} \\ &= 0.0455 \text{ mol} \end{aligned}$$

∴ HF will be used up, 0.0045 mol of LiOH will remain.

Concentration of $[\text{OH}^-]$

$$\begin{aligned} C &= n/V & n &= 0.0045 \text{ mol} \\ & & V &= 35 \text{ mL} + 50 \text{ mL} = 0.085 \text{ L} \end{aligned}$$

$$C = 0.0045 \text{ mol} / 0.085 \text{ L}$$

$$C = 0.053 \text{ M}$$

Calculate pOH

$$\text{pOH} = -\log [\text{OH}^-] = -\log(0.053) = 1.27$$

[D]

$$pH + pOH = 14$$

$$pH = 14 - 1.27$$

$$pH = 12.73,$$