Unit 4 Review

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

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

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

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

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

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

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

$$(H_2)^3 = 5.81$$

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

2) $V = 2L$, $Br = 8.0 mol$ $Cl_2 = 8.0 mol$, $K_{eq} = 28.8$

$[Br] = n/V = 8.0/2 = 4 mol/L$

$[Cl_2] = n/V = 8.0/2 = 4 mol/L$

$$Br_2 + Cl_2 \rightleftharpoons 2BrCl$$

I	4M	4M	0
C	$-x$	$-x$	$+2x$
E	$4-x$	$4-x$	$2x$

$$K_{eq} = \frac{[BrCl]^2}{[Br_2][Cl_2]}$$

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

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

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

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

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

$$21.47 = 7.37x$$

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

$$x = 2.91$$

$$[BrCl] = 2x$$

$$= 2(2.91)$$

$$[BrCl] = 5.83 mol/L$$

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

$[N_2O_4] = 9.8/8 = 1.225 mol/L$

$$N_2O_4 \rightleftharpoons 2NO_2$$

	N_2O_4	$2NO_2$
I	1.225	0
C	$-x$	$+2x$
E	$1.225 - x$	$2x$

$K_{eq} = \dfrac{[NO_2]^2}{[N_2O_4]}$ * small K_{eq} = hundreds rule

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

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

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

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

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

$[NO_2] = 2(x)$

$= 2(5.2 \times 10^{-6})$

$\Rightarrow \boxed{[NO_2] = 1.04 \times 10^{-7} M}$

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 Keq

$26.67 < 50$

Reaction proceeds forwards.

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

$$Ag_2S(s) \rightleftharpoons 2Ag^+ + S^{2-}$$

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

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

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

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

6) $K_{sp} = 1.38$

$$N_2Cl_{3(s)} \rightleftharpoons N_3^+ + Cl^-$$

I	0	0
C	$+x$	$+x$
I	x	x

$$K_{sp} = [N_2][Cl]$$

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

$$1.38 = x^2$$

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

7) $[H_3O^+] = 3.0 \times 10^{-4}$ mol/L

$$pH = -\log[H_3O^+]$$

$$pH = -\log(3.0)$$

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

8) $[3.0 \times 10^{-4}] = H_3O^+$

$pH = -\log [H_3O^+]$

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

$pH = 3.52$

$pOH = 14 - pH$

$pOH = 14 - 3.52$

$\boxed{pOH = 10,48}$

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

$$CH_3CH_2COOH \rightleftharpoons CH_3CH_2COO^- + H_3O$$

	CH_3CH_2COOH	$CH_3CH_2COO^-$	H_3O
I	1.0M	0	0
C	$-x$	$+x$	$+x$
E	$1-x$	$+x$	$+x$

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

$= 10^{-3.8}$

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

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

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

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

$$\% \text{ ionization} = \frac{[\text{ionized}]}{[\text{initial}]} \times 100 = \frac{1.58 \times 10^{-4}}{1.0} = \boxed{0.0158\%}$$

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

$$C_5H_5N \rightleftharpoons C_5H_5N^+ + OH^-$$

	C_5H_5N	$C_5H_5N^+$	OH^-
I	0.38	0	0
C	$-x$	$+x$	$+x$
E	$0.38-x$	x	x

$pOH = 14 - pH = 14 - 10.98$

$pOH = 3.02$

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

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

$$K_b = \frac{[C_5H_5N^+][OH^-]}{[C_5H_5N]} = \frac{(9.55\times10^{-4})^2}{(0.38 - 9.55\times10^{-4})}$$

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

$$\%\text{ion} = \frac{[\text{dissociated}]}{[\text{Initial}]} = \frac{9.55\times10^{-4}}{0.38} \times 100 = 0.25\%$$

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

$C_{LiOH} = 1.0M$

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

$C_{HF} = 1.3M$

Moles of Each

$n_{LiOH} = C \times V$

$= 1.0M \times 0.05L$

$= 0.05mol$

$n_{HF} = C \times V$

$= 1.3M \times 0.035L$

$= 0.0455mol$

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

Concentration of $[OH^-]$

$C = n/V$

$n = 0.0045mol$

$V = 35mL + 50mL = 0.085L$

$C = 0.0045mol / 0.085L$

$C = 0.053M$

Calculate pOH

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

E-D

$pH + pOH = 14$

$pH = 14 - 1.27$

$pH = 12.73,$