

# CALVIN

$$1) a) K_c = \frac{[NO_2]^4}{[NH_3]^4 [O_2]^7}$$

$$b) K_c = \frac{[H_3O^+][CN^-]}{[HCN]}$$

$$c) K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]}$$

$$d) K_c = \frac{[CO_2]}{1}$$

$$e) K_c = \frac{[O_3]^2}{[O_2]^3}$$

$$f) K_c = [H_3O^+][OH^-]$$

$$g) K_c = \frac{[Zn^{2+}]^3}{[Fe^{3+}]^2}$$

$$2) a) K_{eq} = \frac{[NO_2]^4}{[N_2O]^2 [O_2]^3}$$

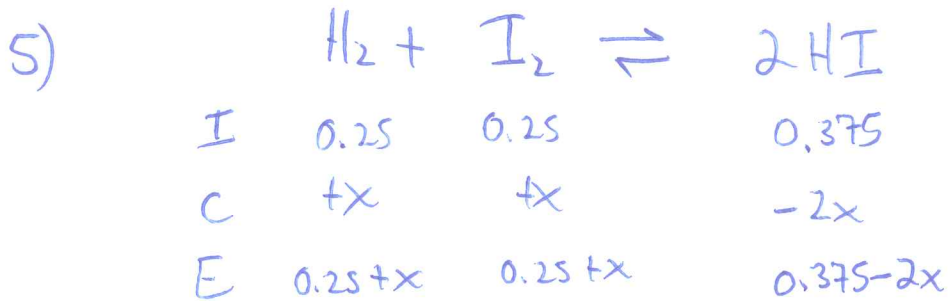
$$b) K'_{eq} = \frac{[NO_2]^2}{[N_2O][O_2]^{3/2}} = (K_{eq})^{1/2}$$

$$c) K''_{eq} = \frac{[N_2O]^2 [O_2]^3}{[NO_2]^4} = \frac{1}{K_{eq}}$$

$$3) K_{eq} = \frac{[H_2O][CO]}{[H_2][CO_2]} = \frac{(0.5)(3.0)}{(1.5)(2.5)} = \boxed{0.40}$$

$$4) K_p = K_c (R \cdot T)^{\Delta n} = (0.55) \left( (0.0821 \cdot 3273) \right)^1$$

$$K_p = 148 = \frac{(P_{Cl_2})^2}{(P_{Cl_2})} = \boxed{15 \text{ atm}}$$

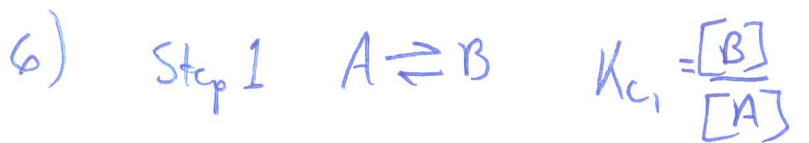


$$Q = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]} = 2.25$$

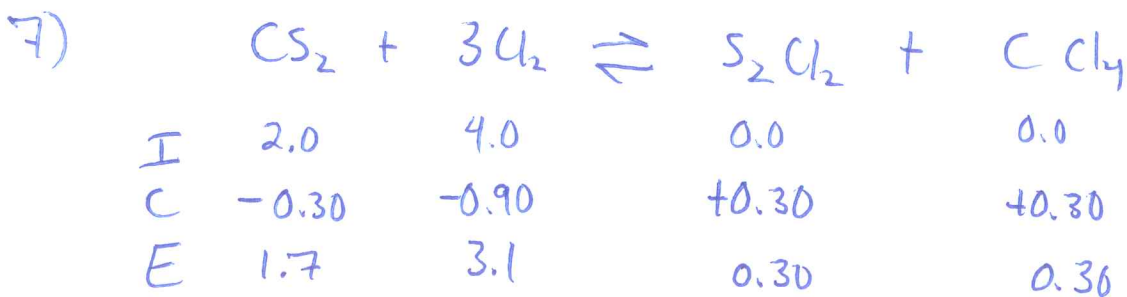
$$K_{eq} = \frac{(0.375-2x)^2}{(0.25+x)^2} = 2.0 \times 10^{-2}$$

$$x = 0.16$$

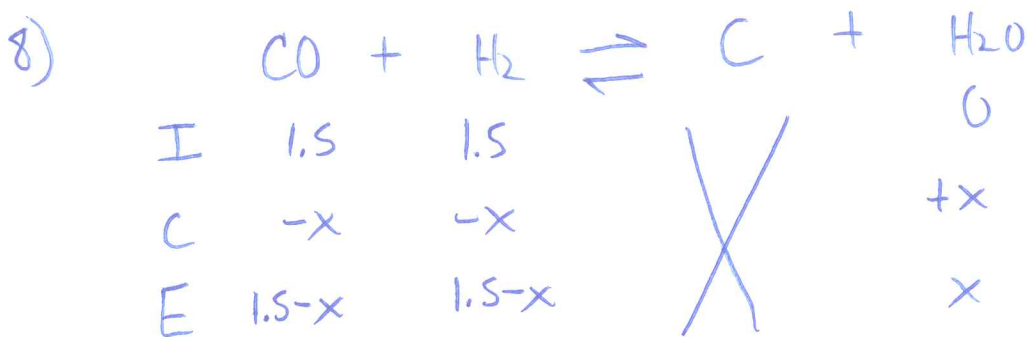
$$[\text{H}_2] = [\text{I}_2] = \boxed{0.41 \text{ M}} \quad [\text{HI}] = \boxed{0.06 \text{ M}}$$



$$K_c = \frac{[B][D]}{[A][C]} = \boxed{K_{c1} \cdot K_{c2}}$$



$$[\text{CS}_2] = 1.7 \text{ M} \quad [\text{Cl}_2] = 3.1 \text{ M} \quad [\text{S}_2\text{Cl}_2] = 0.30 \text{ M}$$



$$K_c = \frac{[H_2O]}{[CO][H_2]} = \frac{(x)}{(1.5-x)(1.5-x)} = 4.0$$

$$x = 9 - 12x + 4x^2$$

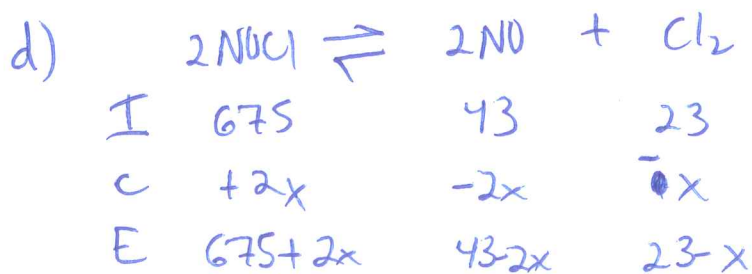
$$x = 1, \text{ or } 2.25$$

$$[H_2O] = \boxed{1.0M}$$

9) a)  $Q_p = \frac{P_{NO}^2 \times P_{Cl_2}}{P_{NOCl}^2} = \frac{(43)^2(23)}{(675)^2} = \boxed{0.093}$

b) No

c) Shift LEFT ( $Q_p > K_p$ )



$$\frac{(43-2x)^2(23-x)}{(675+2x)^2} = 0.066$$

$$x = 3$$

$$P_{NOCl} = \boxed{681 \text{ torr}}$$

$$P_{NO} = \boxed{37 \text{ torr}}$$

$$P_{Cl_2} = \boxed{20 \text{ torr}}$$

10) a) 
$$Q = \frac{[SO_2][Cl_2]}{[SO_2Cl_2]} = \frac{(0.15)(0.0027)}{(0.015)} = \boxed{4.8 \times 10^{-4}}$$

b) No

c)  $Q < K_c$ , shift RIGHT



I	X	0	0
C		+x	+x
E		x	x

$$K_p = \frac{[NH_3][HCl]}{[NH_4Cl]}$$

$$P_{NH_3} \times P_{HCl} = (x)(x) = 0.640$$

$$x = 0.80$$

$$P_{NH_3} = P_{HCl} = 0.80 \text{ atm}$$

$$P_{tot} = P_{NH_3} + P_{HCl} = 0.80 + 0.80 = \boxed{1.60 \text{ atm}}$$



I	0.060	0.060	0
C	-x	-x	+2x
E	0.060-x	0.060-x	2x

$$K_c = \frac{[\text{BrCl}]^2}{[\text{Br}_2][\text{Cl}_2]} = \frac{(2x)^2}{(0.060-x)(0.060-x)} = 36.0$$

$$\frac{2x}{0.060-x} = 6.0$$

$$x = 0.045 \text{ M}$$

$$[\text{BrCl}] = \boxed{0.090 \text{ M}}, \quad n_{\text{BrCl}} = \boxed{0.27 \text{ mol}}$$



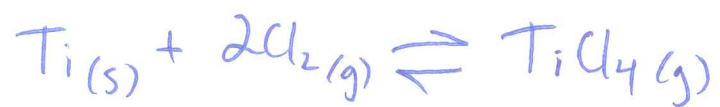
I	0.200		0	0
C	-x		+x	+x
E	0.200-x		x	x

$$K_c = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} = \frac{(x)(x)}{0.200-x} = 1.8 \times 10^{-5}$$

$$x = 0.0019$$

$$[\text{OH}^-] = \boxed{0.0019 \text{ M}}$$

14)



- add  $\text{Cl}_2$
- Remove  $\text{TiCl}_{4(g)}$
- Increase Pressure
- Lower Temperature