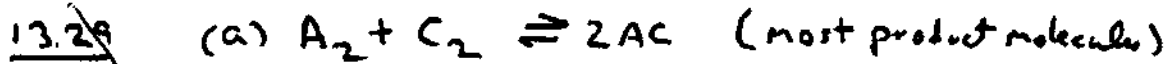
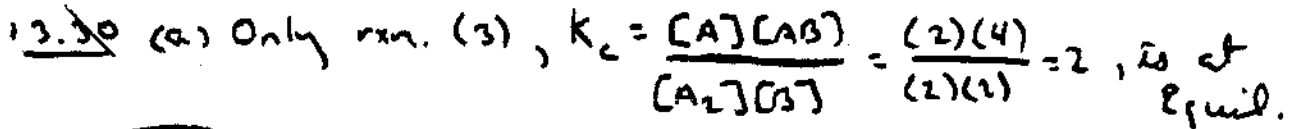


## Chapter 13

27



28



(b)  $Q_c = \frac{[A][AB]}{[A_2][B]} = \frac{(3)(5)}{(1)(1)} = 15$  for rxn (1)

Since  $Q_c > K_c$ , the rxn will go in ~~reverse~~<sup>reverse</sup> to reach equil.

13.31  $Q_c = \frac{[A][AB]}{[A_2][B]} = \frac{(1)(3)}{(3)(3)} = \frac{1}{3}$  for rxn (2)

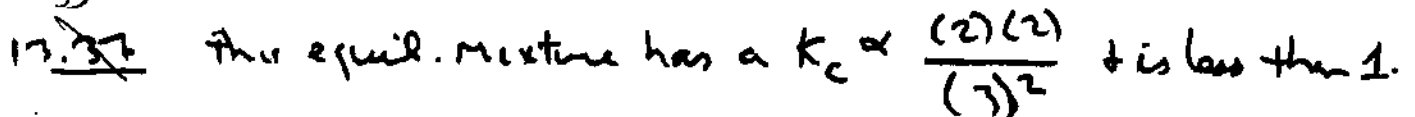
Since  $Q_c < K_c$ , the rxn will go in the forward direction.

29



(b) The # of AB molecules will increase, because as the volume goes down at a constant temperature, the pressure will increase & the rxn. will shift to the side with fewer molecules to reduce the pressure.

35



which means that  $K_c < Q_c$ .

13.40

$$(a) K_c = \frac{[CO][H_2]^2}{[CH_4][H_2O]}$$

$$(b) K_c = \frac{[CF_4]^2}{[F_2]^3 [C_2]}$$

$$(c) K_c = \frac{[HF]^2}{[H_2][F_2]}$$

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13.41 (a)  $K_c = \frac{[CH_3CHO]^2}{[C_2H_4]^2 [O_2]}$

$$(b) K_c = \frac{[N_2][O_2]}{[NO]^2}$$

$$(c) K_c = \frac{[NO]^4 [H_2O]^6}{[NH_3]^4 [O_2]^5}$$

13.44

$$K_c = \frac{[C_2H_5OC_2H_5][H_2O]}{[C_2H_5OH]^2}$$

46

13.48 The two rxns. are the reverse of each other -

$$K_c(\text{rev}) = \frac{1}{K_c(\text{found})} = \frac{1}{7.5 \times 10^9} = 1.3 \times 10^{-10}$$

(3)

13.50<sup>48</sup>  $K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{(1.5 \times 10^{-2})(3.2 \times 10^{-2})}{(8.7 \times 10^{-2})} = 0.058$

13.60<sup>58</sup> (a)  $K_c = \frac{[CO_2]^3}{[CO]^3}$        $K_p = \frac{P_{CO_2}^3}{P_{CO}^3}$

(b)  $K_c = \frac{1}{[O_2]^3}$       or       $K_p = \frac{1}{P_{O_2}^3}$

(c)  $K_c = [SO_3]$       or       $K_p = P_{SO_3}$

(d)  $K_c = [Ba^{+2}][SO_4^{2-}]$

13.62<sup>60</sup> (a) Since  $K_c$  is very ~~small~~<sup>large</sup>, the equil. mixture is mostly product.

(b) Since  $K_c$  is very small, the equil. mixture is mostly reactant.

13.63 (a) does not go much in the forward direction

(b) goes almost to completion -

65  
13.69

$$Q_c = \frac{[\text{CO}]_t [\text{H}_2]_t^3}{[\text{H}_2\text{O}]_t [\text{CH}_4]_t} = \frac{(0.15)(0.20)^3}{(0.035)(0.050)} = 0.69$$

The rxn is not at equil. since  $Q_c < K_c$  ( $0.69 < 4.7$ )  
The rxn. will proceed from left to right to reach equilibrium

13.70

$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} = 0.29 \quad \text{@ equil } [\text{N}_2] = 0.036 \text{ M} +$$

$$[\text{H}_2] = 0.15 \text{ M}$$

$$[\text{NH}_3] = \sqrt{[\text{N}_2] \cdot [\text{H}_2]^3 \cdot K_c} = \sqrt{0.036 \cdot 0.15^3 \cdot 0.29} =$$

$$5.9 \times 10^{-3} \text{ M}$$

13.71

$$K_c = 2.7 \times 10^2 = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2 [\text{O}_2]}$$

Because  $[\text{SO}_3] = [\text{SO}_2]$ ,  
then  $2.7 \times 10^2 = \frac{1}{[\text{O}_2]}$

$$[\text{O}_2] = 3.7 \times 10^{-3} \text{ M}$$

13.78



stat	1.47	-	-
Δ	-x	+x	+x
equl	1.47-x	x	x

$$K_p = \frac{P_{\text{ClF}} P_{\text{F}_2}}{P_{\text{ClF}_3}} = 0.140 = \frac{x^2}{1.47-x}$$

$$x^2 + 0.140x - 0.2058 = 0$$

$$x = \frac{-0.140 \pm \sqrt{0.140^2 - 4 \cdot (-0.2058)}}{2(1)} = \frac{-0.140 \pm 0.918}{2}$$

$$x = 0.389 - 0.29$$

$$P_{\text{ClF}} = P_{\text{F}_2} = x = 0.389 \text{ atm}, \quad P_{\text{ClF}_3} = 1.47 - 0.389 = 1.081 \text{ atm}$$

(6)

13.80 (a) if  $\text{Cl}^-$  is added,  $\text{AgCl}(s)$  increases

(b)  $\text{Ag}^+$  is added,  $\text{AgCl}(s)$  increases.

(c)  $\text{Ag}^+$  is removed,  $\text{AgCl}(s)$  decreases

(d)  $\text{Cl}^-$  removed,  $\text{AgCl}(s)$  decreases.

if  $[\text{Cl}^-] \uparrow$   $Q_c$  increases to a value greater than  $K_c$ , therefore the rxn must go from right to left to decrease  $\text{AgCl}(s)$

13.81

(a)  $\text{ClNO}$  added,  $\text{NO}_2 \downarrow$

(b)  $\text{NO}$  added,  $\text{NO}_2 \uparrow$

(c)  $\text{NO}$  removed,  $\text{NO}_2 \downarrow$

(d)  $\text{ClNO}_2$  added,  $\text{NO}_2 \uparrow$

Adding  $\text{ClNO}_2$  decrease  $Q_c$ , the rxn must shift from left to right to ~~reach~~ reach equilibrium, thus increasing the  $\text{NO}_2$  conc.

13.83

As the Volume  $\uparrow$ , the Pressure  $\downarrow$   $\text{D}$  constant temp.

(a) the rxn will shift to the side with larger # of molecules - since the stress is the decrease in pressure - or an increase in volume. - Toward Products.

(b) The rxn will shift to the reactants, since that is the side with the greater # of mols.

(c) This rxn is not altered by changes in volume or pressure, since there are equal # of molecules on both sides - No change.

13.86- (a)  $\text{HCl}$  is a source of  $\text{Cl}^-$ , the rxn. shifts left, the equil.  $[\text{CoCl}_4^{2-}]$  increases

(b)  $\text{Co}(\text{NO}_3)_2$  is a source of  $\text{Co}(\text{H}_2\text{O})_6^{2+}$ , the rxn. shifts left, the equil. conc. of  $[\text{CoCl}_4^{2-}]$  increases.

(c) All conc. will initially decrease, & the rxn. will shift right, the equil. conc. of  $[\text{CoCl}_4^{2-}]$  decreases

(d) For an exothermic rxn.: the rxn. shifts to the left when the temp increases - the equil.  $[\text{CoCl}_4^{2-}]$  increases

13.87

(a)  $\text{Fe}(\text{NO}_3)_3$  is a source of  $\text{Fe}^{+3}$ .  $\text{Fe}^{+3}$  added; the  $\text{FeCl}^{2+}$  conc. increases.

(b)  $\text{Cl}^-$  removed; the  $\text{FeCl}^{2+}$  conc. decreases.

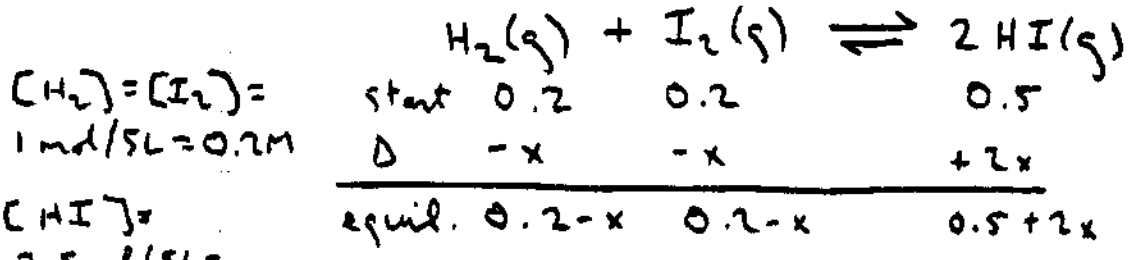
(c) An endothermic rxn. shifts to the right as the temperature increases; the  $\text{FeCl}^{2+}$  conc. increases.

(d) A catalyst does not affect the composition of the equil. mixture; no change in  $\text{FeCl}^{2+}$  conc.

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~~13.99~~  $K_c = \frac{k_c}{k_r} = \frac{0.13}{6.2 \times 10^{-4}} = 210$

13.99  $V = 5.0L$



$$K_c = \frac{[HI]^2}{[H_2][I_2]} = 129 = \frac{(0.50+2x)^2}{(0.20-x)^2}$$

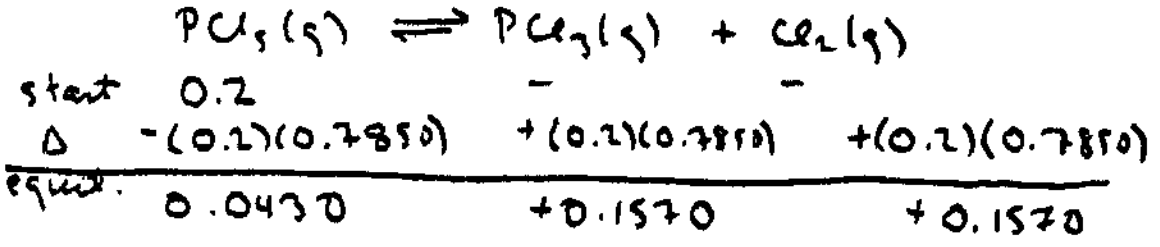
$$\sqrt{129} = \sqrt{\frac{(0.50+2x)^2}{(0.20-x)^2}} = 11.4 = \frac{0.50+2x}{0.20-x}; x = 0.133$$

$$[H_2] = [I_2] = 0.2 - 0.133 = 0.067M; [HI] = 0.5 + 2(0.133) = 0.766M$$

106

~~13.104~~

$[PCl_5] = 1\text{ mol}/5L = 0.2M$



$$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{(0.1570)^2}{(0.0430)} = 0.573$$

$$\Delta n = 1 + k_p = k_c (\pi T)^{\Delta n} = 0.573 (0.0821)(500) = 23.5$$



118

13.16

$$\Delta n = 1 - 2 = -1 \quad K_p = K_c (RT)^{-1} = \frac{(216)(0.0821)(298)^{-1}}{1}$$

$$= 8.83$$

$$K_p = \frac{P_{\text{N}_2\text{O}_4}}{(P_{\text{NO}_2})^2} = 8.83$$

$$\text{Let } X = P_{\text{N}_2\text{O}_4} \text{ \& } Y = P_{\text{NO}_2}$$

$$P_{\text{total}} = 1.50 \text{ atm} = X + Y + \frac{X}{Y^2} = 8.83$$

Now using these 2 equations we can solve for X + Y

$$X = 1.50 - Y$$

$$\frac{1.50 - Y}{Y^2} = 8.83 \quad \rightarrow \quad 8.83Y^2 + Y - 1.50 = 0$$

$$Y = \frac{-1 \pm \sqrt{1^2 - 4(8.83)(-1.50)}}{2(8.83)} = \frac{-1 \pm 7.35}{17.2}$$

$$Y = \cancel{-0.472} \text{ \& } 0.359$$

$$Y = P_{\text{NO}_2} = 0.359 \text{ atm}$$

$$X = P_{\text{N}_2\text{O}_4} = 1.50 - Y = 1.5 - 0.359 = 1.14 \text{ atm}$$