Equilibrium 1a

Name:
Period: Key

1) For each of the following write the equilibrium expression and calculate the value of K.

a) $CH_{4(g)} + Cl_{2(g)} \rightleftharpoons CH_3Cl_{(g)} + HCl_{(g)}$

$[CH_4]= 0.50M$, $[Cl_2]= 0.50M$, $[CH_3Cl]= 1.5M$, $[HCl]= 1.5M$

$$K = \frac{[CH_3Cl][HCl]}{[CH_4][Cl_2]} = \frac{(1.5)(1.5)}{(.5)(.5)} = 9.0$$

b) $2NH_{3(g)} \rightleftharpoons N_{2(g)} + 3H_{2(g)}$

$[NH_3]= 0.00250M$, $[N_2]= 0.100M$, $[H_2]= 0.300M$

$$K = \frac{[N_2][H_2]^3}{[NH_3]^2} = \frac{(.1)(.3)^3}{(.0025)^2} = 432$$

c) $2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$

$[SO_3]= 3.45\times10^{-3}$, $[SO_2]= 6.70\times10^{-4}$, $[O_2]= 3.35\times10^{-4}$

$$K = \frac{[SO_2]^2[O_2]}{[SO_3]^2} = \frac{(6.7\cdot10^{-4})^2(3.35\cdot10^{-4})}{(3.45\cdot10^{-3})^2} = 1.26\cdot10^{-5}$$

2) For each of the following write the equilibrium expression and determine if the system is at equilibrium or not.

a) $2NO_{(g)} + Cl_{2(g)} \rightleftharpoons 2NOCl_{(g)}$

$Kc = 4.6 \times 10^4$; $[NO] = 1.00$ M, $[Cl_2] = 1.00$ M, $[NOCl] = 0$ M

$$K = \frac{[NOCl]^2}{[NO]^2[Cl_2]} \qquad Q = \frac{(0)^2}{(1.0)^2(1.0)} = 0$$

$Q \neq K$ not at Equilibrium

b) $2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$

$Kc = 0.230$; $[SO_3] = 2.00$ M, $[SO_2] = 2.00$ M, $[O_2] = 2.00$ M

$$K = \frac{[SO_2]^2[O_2]}{[SO_3]^2} \qquad Q = \frac{(2.0)^2(2.0)}{(2.0)^2} = 2.0$$

$Q \neq K$ not at Equilibrium

c) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$

$Kc = 0.50$; $[N_2] = 0.100$ M, $[O_2] = 0.200$ M, $[NO] = .1200$ M

$$K = \frac{[NO]^2}{[N_2][O_2]} \qquad Q = \frac{(0.1200)^2}{(.200)(.100)} = 0.72$$

$Q \neq K$ not at Equilibrium

2) Nitrogen monoxide, $NO_{(g)}$, can be formed durning lightning strikes by the direct reaction of nitrogen gas, $N_{2(g)}$, with oxygen gas, $O_{2(g)}$, as shown below:

$$N_{2(g)} + O_{2(g)} <\!\!\longrightarrow 2NO_{(g)}$$

A researcher conducts an experiment by filling a 2.50L reaction vessel to a pressure of 0.750 atm with $NO_{(g)}$ at a temperature of 300.K. Over time the pressure of the $NO_{(g)}$ in the reaction vessel was measured and after 15 minuets the pressure of $NO_{(g)}$ was found to be 0.450 atm.

A) Calculate the equilibrium molarity of $NO_{(g)}$.

$\frac{n}{V} = \frac{P}{RT} = \frac{0.450 atm}{0.08206 \frac{atm \cdot L}{mol \cdot K} \cdot 300K} = 0.0183 M\ NO$

B) Calculate the equilibrium molarity of $N_{2(g)}$ and $O_{2(g)}$.

$\frac{n}{V} = \frac{P}{RT} = \frac{0.750 atm}{0.08206 \cdot 300} = 0.0305$ start

-0.0183 end

$0.0122 M$ used up

$0.0122 M \cdot \frac{1 N_2}{2 NO} = 6.09 \cdot 10^{-3} M\ N_2$

$6.09 \cdot 10^{-3} M\ O_2$

C) Write the equilibrium expression for the formation of $NO_{(g)}$.

$K = \frac{[NO]^2}{[N_2][O_2]}$

D) Calculate the value of the equilibrium constant K for the reaction at 300.K.

$K = \frac{(0.0183)^2}{(6.09 \cdot 10^{-3})(6.09 \cdot 10^{-3})} = 9.03$

E) Based on the value of the equilibrium constant are the reactants or products favored in this reaction?

Since K is greater than 1 the products are favored.