Non Sibi High School

Andover's Chem 250: Introductory/Basic Chemistry

Chapter 15, Review Quiz 1 Answers

1

a. Write the K_c and K_p expressions for the reaction $\frac{1}{2}I_2(s) + \frac{1}{2}Cl_2(g) \rightleftharpoons ICl(l)$.

b. If $K_c = 1.19 \times 10^3$ for this reaction, calculate the equilibrium molarity of chlorine gas.

a.

$$K_c = \frac{1}{[Cl_2]^{\frac{1}{2}}}$$

$$K_p = \frac{1}{{P_{Cl_2}}^{\frac{1}{2}}}$$

b.

$$1.19 \times 10^3 = \frac{1}{[Cl_2]^{\frac{1}{2}}}$$

$$[Cl_2] = 7.06 \times 10^{-7}\,M$$

2

For the reaction $\frac{1}{2}I_2(s) + \frac{1}{2}Cl_2(g) \rightleftharpoons ICl(l)$, the value of $K_p = 241$. Calculate the value of K_p for the following reaction:

$$2ICl(l) \rightleftharpoons I_2(s) + Cl_2(g)$$

$$K_p = \left(\frac{1}{241}\right)^2 = 1.72 \times 10^{-5}$$

3

a. Write the K_c expression for the reaction $2Cr(s) + 3Ge^{4+}(aq) \rightleftharpoons 2Cr^{3+}(aq) + 3Ge^{2+}(aq)$.

b. Solid chromium metal is added to a solution containing the initial concentrations 0.30 M Ge^{4+}, 0.86 M Cr^{3+}, and 0.73 M Ge^{2+}. When equilibrium is reached, the molarity of Cr^{3+} is found to be 0.68 M. Calculate the equilibrium molarity of Ge^{2+} and Ge^{4+} as well as K_c for the reaction.

a.

$$K_c = \frac{[Cr^{3+}]^2[Ge^{2+}]^3}{[Ge^{4+}]^3}$$

b. Molarity of Cr^{3+} decreases, so reaction goes left to reach equilibrium:

R)	2Cr(s)	+	$3Ge^{4+}$(aq)	$\rightleftharpoons$	$2Cr^{3+}$(aq)	+	$3Ge^{2+}$(aq)
I)			0.30		0.86		0.73
C)			+3x		-2x		-3x
E)			0.30+3x		0.86-2x		0.73-3x

$$[Cr^{3+}] = 0.68 = 0.86 - 2x$$
$$x = 0.090\,M$$
$$[Ge^{4+}] = 0.30 + 3(0.090) = 0.57\,M$$
$$[Ge^{2+}] = 0.73 - 3(0.090) = 0.46\,M$$
$$K_c = \frac{(0.68)^2(0.46)^3}{(0.57)^3} = 0.24$$

4

For the reaction $2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$, $K_p = 7.7$. If a mixture initially contains 0.79 atm CO, 0.67 atm O_2, and 0.21 atm CO_2, calculate the equilibrium pressure of each gas and the total pressure at equilibrium.

$$Q_p = \frac{(0.21)^2}{(0.79)^2(0.67)} = 0.11 < K_p = 7.7, \text{so goes right to reach equilibrium}$$

R)	2CO(g)	+	O_2(g)	$\rightleftharpoons$	$2CO_2$(g)
I)	0.79		0.67		0.21
C)	-2x		-x		+2x
E)	0.79-2x		0.67-x		0.21+2x

$$K_p = 7.7 = \frac{(0.21 + 2x)^2}{(0.79 - 2x)^2(0.67 - x)}$$
$$x = 0.22\,atm$$
$$P_{CO} = 0.79 - 2(0.22) = 0.35\,atm$$
$$P_{O_2} = 0.67 - (0.22) = 0.45\,atm$$
$$P_{CO_2} = 0.21 + 2(0.22) = 0.65\,atm$$
$$P_{total} = 0.35 + 0.45 + 0.65 = 1.45\,atm$$

5

a. Write the K_p expression for the decomposition of liquid bromine trifluoride to form bromine gas and fluorine gas:

$$2BrF_3(l) \rightleftharpoons Br_2(g) + 3F_2(g)$$

b. After a 0.85 gram sample of liquid bromine trifluoride was placed in a 225 mL container and heated to 75°C, the equilibrium pressure of fluorine gas was found to be 0.51 atm. Calculate the equilibrium pressure of bromine gas, K_p for this reaction, and the total pressure at equilibrium.

c. Calculate the mass of liquid bromine trifluoride present at equilibrium.

a.

$$K_p = P_{Br_2} {P_{F_2}}^3$$

b.

R)	$2BrF_3(l)$	$\rightleftharpoons$	$Br_2(g)$	+	$3F_2(g)$
I)			0		0
C)			+x		+3x
E)			x		3x

$$P_{F_2} = 0.51 = 3x$$
$$x = 0.17\,\text{atm} = P_{Br_2}$$
$$K_p = (0.17)(0.51)^3 = 0.023$$
$$P_{total} = 0.17 + 0.51 = 0.68\,\text{atm}$$

c.

$$\frac{0.51\,\text{atm} \times \frac{225}{1000}\,\text{L}}{0.0821\,\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} \times (75+273)\,\text{K}} = 0.00402\,\text{mol}\,F_2\left(\frac{2\,\text{mol}\,BrF_3}{3\,\text{mol}\,F_2}\right)\left(\frac{136.9\,\text{g}\,BrF_3}{1\,\text{mol}\,BrF_3}\right) = 0.37\,\text{g}\,BrF_3\,\text{reacted}$$

$$0.85 - 0.37 = 0.48\,\text{g}\,BrF_3\,\text{at equilibrium}$$

6

Consider the reaction:

$$2K(s) + Cl_2(g) + 3O_2(g) \rightleftharpoons 2KClO_3(s) \quad \Delta H < 0$$

a. State whether the amount of chlorine gas present at equilibrium will increase, decrease, or remain unchanged when each of the following occurs:

i. Helium gas is added at constant volume.

ii. Oxygen gas is removed.
iii. The volume of the container is decreased.
iv. The temperature is increased.
v. A catalyst is added.
vi. Solid potassium metal is added.

i. Inert gas added with no volume change = no shift = amount of chlorine gas unchanged (guideline 7).

ii. Remove (g) reactant = shifts left = amount of chlorine gas increases (guideline 2a).

iii. Volume of container decreases = shifts to side with fewer (g) moles. There are fewer (g) moles on the right ($4 \rightleftharpoons 0$), so shifts right = amount of chlorine gas decreases (guideline 4b).

iv. Temperature increases = shifts in endothermic direction = shifts left = amount of chlorine gas increases (guideline 8a).

v. Add catalyst = no shift = amount of chlorine unchanged (guideline 6).

vi. Add (s) product = no shift = amount of chlorine gas unchanged (guideline 3a).

b. Of the changes above, which will change the value of K_c and K_p, and will K_c and K_p increase or decrease?

Only a temperature change will change the value of K_c and K_p. Reaction shifts left when temperature is increased, so K_c and K_p decrease.