

# 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  $\frac{1}{2}\text{I}_2(\text{s}) + \frac{1}{2}\text{Cl}_2(\text{g}) \rightleftharpoons \text{ICl}(\text{l})$ .
- b. If  $K_c = 1.19 \times 10^3$  for this reaction, calculate the equilibrium molarity of chlorine gas.

a.

$$K_c = \frac{1}{[\text{Cl}_2]^{\frac{1}{2}}}$$

$$K_p = \frac{1}{P_{\text{Cl}_2}^{\frac{1}{2}}}$$

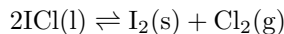
b.

$$1.19 \times 10^3 = \frac{1}{[\text{Cl}_2]^{\frac{1}{2}}}$$

$$[\text{Cl}_2] = 7.06 \times 10^{-7} \text{ M}$$

## 2

For the reaction  $\frac{1}{2}\text{I}_2(\text{s}) + \frac{1}{2}\text{Cl}_2(\text{g}) \rightleftharpoons \text{ICl}(\text{l})$ , the value of  $K_p = 241$ . Calculate the value of  $K_p$  for the following reaction:



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

## 3

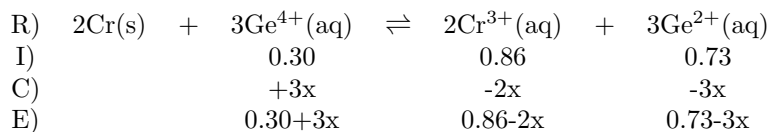
- a. Write the  $K_c$  expression for the reaction  $2\text{Cr}(\text{s}) + 3\text{Ge}^{4+}(\text{aq}) \rightleftharpoons 2\text{Cr}^{3+}(\text{aq}) + 3\text{Ge}^{2+}(\text{aq})$ .
- b. Solid chromium metal is added to a solution containing the initial concentrations 0.30 M  $\text{Ge}^{4+}$ , 0.86 M  $\text{Cr}^{3+}$ , and 0.73 M  $\text{Ge}^{2+}$ . When equilibrium is

reached, the molarity of  $\text{Cr}^{3+}$  is found to be 0.68 M. Calculate the equilibrium molarity of  $\text{Ge}^{2+}$  and  $\text{Ge}^{4+}$  as well as  $K_c$  for the reaction.

a.

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

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



$$[\text{Cr}^{3+}] = 0.68 = 0.86 - 2x$$

$$x = 0.090 \text{ M}$$

$$[\text{Ge}^{4+}] = 0.30 + 3(0.090) = 0.57 \text{ M}$$

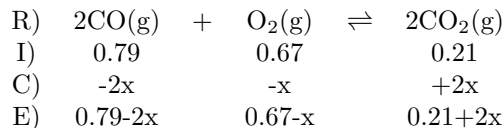
$$[\text{Ge}^{2+}] = 0.73 - 3(0.090) = 0.46 \text{ M}$$

$$K_c = \frac{(0.68)^2(0.46)^3}{(0.57)^3} = 0.24$$

## 4

For the reaction  $2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{CO}_2(\text{g})$ ,  $K_p = 7.7$ . If a mixture initially contains 0.79 atm CO, 0.67 atm  $\text{O}_2$ , and 0.21 atm  $\text{CO}_2$ , calculate the equilibrium pressure of each gas and the total pressure at equilibrium.

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



$$K_p = 7.7 = \frac{(0.21 + 2x)^2}{(0.79 - 2x)^2(0.67 - x)}$$

$$x = 0.22 \text{ atm}$$

$$P_{\text{CO}} = 0.79 - 2(0.22) = 0.35 \text{ atm}$$

$$P_{\text{O}_2} = 0.67 - (0.22) = 0.45 \text{ atm}$$

$$P_{\text{CO}_2} = 0.21 + 2(0.22) = 0.65 \text{ atm}$$

$$P_{\text{total}} = 0.35 + 0.45 + 0.65 = 1.45 \text{ atm}$$

## 5

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



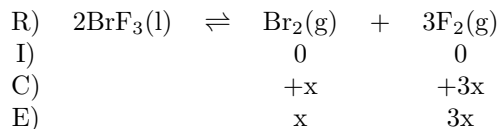
b. After a 0.85 gram sample of liquid bromine trifluoride was placed in a 225 mL container and heated to  $75^\circ\text{C}$ , the equilibrium pressure of fluorine gas was found to be 0.51 atm. Calculate the equilibrium pressure of bromine gas,  $K_p$  for this reaction, and the total pressure at equilibrium.

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

a.

$$K_p = P_{\text{Br}_2} P_{\text{F}_2}^3$$

b.



$$P_{\text{F}_2} = 0.51 = 3x$$

$$x = 0.17 \text{ atm} = P_{\text{Br}_2}$$

$$K_p = (0.17)(0.51)^3 = 0.023$$

$$P_{\text{total}} = 0.17 + 0.51 = 0.68 \text{ atm}$$

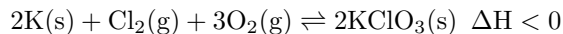
c.

$$\frac{0.51 \text{ atm} \times \frac{225}{1000} \text{ L}}{0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} \times (75 + 273) \text{ K}} = 0.00402 \text{ mol F}_2 \left( \frac{2 \text{ mol BrF}_3}{3 \text{ mol F}_2} \right) \left( \frac{136.9 \text{ g BrF}_3}{1 \text{ mol BrF}_3} \right) = 0.37 \text{ g BrF}_3 \text{ reacted}$$

$$0.85 - 0.37 = 0.48 \text{ g BrF}_3 \text{ at equilibrium}$$

## 6

Consider the reaction:



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.



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