

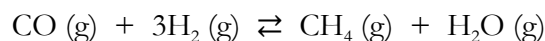
### Extra Problems for Chapter 16

1. The equilibrium constant for a particular reaction is given by:

$$K = \frac{[\text{H}_2\text{S}]_{\text{eq}}^2 [\text{CH}_4]_{\text{eq}}}{[\text{CS}_2]_{\text{eq}} [\text{H}_2]_{\text{eq}}^4}$$

What is the balanced chemical equation for this equilibrium?

2. The equilibrium constant for the following reaction is  $4.18 \text{ 1/M}^2$ :



The equilibrium concentrations are found to be as follows:  $[\text{CO}] = 0.212 \text{ M}$ ,  $[\text{H}_2] = 0.633 \text{ M}$ , and  $[\text{CH}_4] = 0.210 \text{ M}$ . What is the concentration of water vapor?

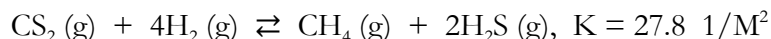
3. Given the information below, write each reaction as a one-way reaction if possible. If not, indicate which side the equilibrium is weighted toward:

- $\text{AgBr (s)} \rightleftharpoons \text{Ag}^+ \text{(aq)} + \text{Br}^- \text{(aq)}$   $K = 5.71 \times 10^{-7} \text{ M}^2$
- $\text{CS}_2 \text{(g)} + 4\text{H}_2 \text{(g)} \rightleftharpoons \text{CH}_4 \text{(g)} + 2\text{H}_2\text{S (g)}$   $K = 27.8 \text{ 1/M}^2$
- $\text{CO (g)} + \text{Cl}_2 \text{(g)} \rightleftharpoons \text{COCl}_2 \text{(g)}$   $K = 4.5 \times 10^9 \text{ 1/M}$
- $\text{CO}_2 \text{(g)} + \text{H}_2 \text{(g)} \rightleftharpoons \text{CO (g)} + \text{H}_2\text{O (g)}$   $K = 0.0049$

4. Write the equation for the equilibrium constants of the following reactions:

- $\text{AgBr (s)} \rightleftharpoons \text{Ag}^+ \text{(aq)} + \text{Br}^- \text{(aq)}$
- $2\text{Fe(OH)}_3 \text{(s)} + 3\text{H}_2\text{SO}_4 \text{(aq)} \rightleftharpoons \text{Fe}_2(\text{SO}_4)_3 \text{(aq)} + 6\text{H}_2\text{O (l)}$

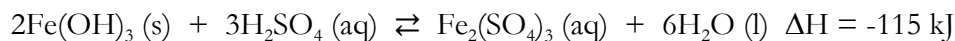
5. A chemist is studying the following chemical reaction at  $25^\circ\text{C}$ :



For each of the following situations, determine if the reaction is at equilibrium. If it isn't, indicate which way it must shift to reach equilibrium.

- $[\text{CS}_2] = 0.100 \text{ M}$ ,  $[\text{H}_2] = 0.100 \text{ M}$ ,  $[\text{CH}_4] = 0.050 \text{ M}$ ,  $[\text{H}_2\text{S}] = 0.050 \text{ M}$
- $[\text{CS}_2] = 1.1 \text{ M}$ ,  $[\text{H}_2] = 1.1 \text{ M}$ ,  $[\text{CH}_4] = 2.2 \text{ M}$ ,  $[\text{H}_2\text{S}] = 4.5 \text{ M}$
- $[\text{CS}_2] = 0.90 \text{ M}$ ,  $[\text{H}_2] = 0.90 \text{ M}$ ,  $[\text{CH}_4] = 7.1 \text{ M}$ ,  $[\text{H}_2\text{S}] = 7.1 \text{ M}$

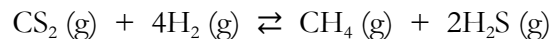
6. The following reaction reaches equilibrium:



- What will happen to the concentration of  $\text{Fe}_2(\text{SO}_4)_3$  if the temperature is increased?
- What will happen to the concentration of  $\text{H}_2\text{SO}_4$  if  $\text{Fe}_2(\text{SO}_4)_3$  is added?

- c. What will happen to the concentration of  $\text{Fe}_2(\text{SO}_4)_3$  if  $\text{Fe}(\text{OH})_3$  is removed?
- d. What will happen to the concentration of  $\text{Fe}_2(\text{SO}_4)_3$  if  $\text{H}_2\text{SO}_4$  is removed?

7. The following reaction reaches equilibrium:



- a. What will happen to the concentration of  $\text{H}_2$  if the pressure is increased?
  - b. What will happen to the concentration of  $\text{H}_2\text{S}$  if the pressure is decreased?
8. What is the equation for the acid ionization constant of  $\text{HCHO}_2$ ?
9. What is the equation for the base ionization constant of  $\text{C}_2\text{H}_7\text{N}$ ?
10. The  $K_a$  for oxalic acid is  $5.9 \times 10^{-2}$  M. The  $K_a$  for nitrous acid is  $4.6 \times 10^{-4}$  M. At the same concentration, which produces a solution with the higher pH?