Section 12.1
Equilibrium constant

Textbook, p. 318 and 319

1. Note: Question **1 d** should read:
"$2\ H_2O_{2\,(l)} \rightleftharpoons 2\ H_2O_{\,(l)} + O_2$."

a) $K_c = \dfrac{[CO] \cdot [H_2O]}{[CO_2] \cdot [H_2]}$

b) $K_c = \dfrac{[CO_2]^2}{[CO]^2}$

c) $K_c = \dfrac{[NO_2] \cdot [O_2]}{[NO] \cdot [O_3]}$

d) $K_c = [O_2]$

e) $K_c = [O_2]$

2. $K_c = \dfrac{[C]^c \cdot [D]^d}{[A]^a \cdot [B]^b} = \dfrac{[PCl_3] \cdot [Cl_2]}{[PCl_5]}$

$K_{c_{syn}} = \dfrac{(1.5 \times 10^{-2}) \cdot (1.5 \times 10^{-2})}{(1.2 \times 10^{-2})} = 1.875 \times 10^{-2}$

Answer: The value of the equilibrium constant at 250°C is 1.9×10^{-2}.

3. $K_c = \dfrac{[C]^c \cdot [D]^d}{[A]^a \cdot [B]^b} = \dfrac{[H_2]^2 \cdot [S_2]}{[H_2S]^2}$

$K_{c_{syn}} = \dfrac{(0.013)^2 \cdot (0.046)}{(0.18)^2} = 2.4 \times 10^{-4}$

Answer: The value of the equilibrium constant at 1400 K is 2.4×10^{-4}.

4. $K_c = \dfrac{[C]^c \cdot [D]^d}{[A]^a \cdot [B]^b} = \dfrac{[HF]^2}{[H_2] \cdot [F_2]}$

$K_{c_{syn}} = \dfrac{3^2}{4 \cdot 6} = 0.375$

Answer: The value of the equilibrium constant at 1400 K is 0.4.

5. $K_{c_{inv}} = \dfrac{1}{K_{c_{syn}}} = \dfrac{1}{1 \times 10^{-30}} = 1 \times 10^{30}$

Answer: The value of the equilibrium constant for the decomposition reaction of nitrogen oxide (NO) at 25°C is 1×10^{30}.

6. $K_c = \dfrac{[C]^c \cdot [D]^d}{[A]^a \cdot [B]^b} = \dfrac{[CO] \cdot [H_2O]}{[CO_2] \cdot [H_2]}$

$K_{c_{syn}} = \dfrac{5.9 \cdot 12}{18 \cdot 20} = 0.1967$

Answer: The value of the equilibrium constant for this reaction at 427°C is 0.20.

7. $K_c = \dfrac{[C]^c \cdot [D]^d}{[A]^a \cdot [B]^b} = \dfrac{[N_2O_4]}{[NO_2]^2}$

$[N_2O_4] = K_c \cdot [NO_2]^2 = 1.15 \cdot (0.05)^2$
$= 2.875 \times 10^{-3}$ mol/L

Answer: The concentration of the nitrogen tetroxide (N_2O_4) at equilibrium at 55°C is 3×10^{-3}.

8. *c), b), a).*

9. *a)* Complete reaction.

b) No reaction.

c) Complete reaction.

10. There is a very slim possibility that hydrogen (H_2) and chlorine (Cl_2) will form, and the equilibrium constant is very high, which means that there is a very large majority of products in the reaction at equilibrium.

11. *a)* High temperatures.

b) Low temperatures.

c) High temperatures.

d) Low temperatures.

12. The temperature should be kept as low as possible.

13. *a)* The equilibrium will shift toward the reactants.

b) The equilibrium will shift toward the products.

c) The equilibrium will shift toward the reactants.

d) The equilibrium will shift toward the reactants.