Practice Problems

16. 2.50 mol of oxygen and 2.50 mol of fluorine gas are placed in a 2.00 L glass container at room temperature. The container is heated to 400 K and the following equilibrium is established:

    $O_{2(g)} + 2F_{2(g)} \rightleftharpoons 2OF_{2(g)}$

    If 37.2% of the fluorine reacts, what is the value of the equilibrium constant?

17. When 0.846 mol/L of dinitrogen tetrachloride gas is placed in a closed reaction vessel, 73.5% of it decomposes into dinitrogen dichloride gas and chlorine gas. Calculate the equilibrium constant.

18. When 3.00 mol/L of phosphorus heptabromide gas is initially placed in a sealed 3.00 L container at 295 K, it is the only gas present. Upon heating the container to 500 K and maintaining the temperature, an equilibrium is established and phosphorus tribromide gas and bromine vapour are observed products. Calculate the equilibrium constant, given the fact that 85.2% of the $PBr_{7(g)}$ reacts.

19. Nitrogen gas is relatively unreactive at room temperature, but combines with oxygen at higher temperatures:

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

    When equilibrium is attained at a temperature of 1800 K, 5.3% of nitrogen will react with oxygen. What is the value of K_c at this temperature?

Qualitatively Interpreting the Equilibrium Constant

The value for a percent reaction indicates the extent of the reaction. It is linked to the size of K_c. As you know, the equilibrium expression is always written with the product terms over the reactant terms. Therefore, a large K_c means that the concentration of products is larger than the concentration of reactants at equilibrium. When referring to a reaction with a large K_c, chemists often say that the position of equilibrium lies to the right, or that it favours the products. Similarly, if K_c is small, the concentration of reactants is larger than the concentration of products. Chemists say that the position of equilibrium lies to the left, or that it favours reactants. Thus, the following general statements are true:

- *When $K > 1$, products are favoured.* The equilibrium lies far to the right. Reactions where K is greater than 10^{10} are usually regarded as going to completion.
- *When $K \approx 1$, there are approximately equal concentrations of reactants and products at equilibrium.*
- *When $K < 1$, reactants are favoured.* The equilibrium lies far to the left. Reactions in which K is smaller than 10^{-10} are usually regarded as not taking place at all.

Notice that the subscript "c" has been left off K in these general statements. This reflects the fact that there are other equilibrium constants that these statements apply to, not just equilibrium constants involving concentrations. You will learn about other types of equilibrium constants in the next two chapters. For the rest of this chapter, though, you will continue to see the subscript "c" used.

Check Your Solution

First, check your assumption that x is negligible compared with the initial concentrations. Your assumption is valid because, using the rules for subtracting measured quantities, $0.038 - (5.8 \times 10^{-6}) = 0.038$. Next, check the equilibrium values:

$$\frac{(1.2 \times 10^{-5})^2}{0.0085 \times 0.038} = 4.5 \times 10^{-8}$$

This is equal to the equilibrium constant, within rounding errors in the calculation.

Practice Problems

25. The following equation represents the equilibrium reaction for the dissociation of phosgene gas.

$COCl_{2(g)} \rightleftharpoons CO_{(g)} + Cl_{2(g)}$

At 100°C, the value of K_c for this reaction is 2.2×10^{-8}. The initial concentration of $COCl_{2(g)}$ in a closed container at 100°C is 1.5 mol/L. What are the equilibrium concentrations of $CO_{(g)}$ and $Cl_{2(g)}$?

26. Hydrogen sulfide is a poisonous gas with a characteristic, offensive odour. It dissociates at 1400°C, with K_c equal to 2.4×10^{-4}.

$H_2S_{(g)} \rightleftharpoons 2H_{2(g)} + S_{2(g)}$

4.0 mol of H_2S is placed in a 3.0 L container. What is the equilibrium concentration of $H_{2(g)}$ at 1400°C?

27. At a certain temperature, the value of K_c for the following reaction is 3.3×10^{-12}.

$2NCl_{3(g)} \rightleftharpoons N_{2(g)} + 3Cl_{2(g)}$

A certain amount of nitrogen trichloride, $NCl_{3(g)}$, is put in a 1.0 L reaction vessel at this temperature. At equilibrium, 4.6×10^{-4} mol of $N_{2(g)}$ is present. What amount of $NCl_{3(g)}$ was put in the reaction vessel?

28. At a certain temperature, the value of K_c for the following reaction is 4.2×10^{-8}.

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

0.45 mol of $N_{2(g)}$ and 0.26 mol of $O_{2(g)}$ are put in a 6.0 L reaction vessel. What is the equilibrium concentration of $NO_{(g)}$ at this temperature?

29. At a particular temperature, K_c for the decomposition of carbon dioxide gas is 2.0×10^{-6}.

$2CO_{2(g)} \rightleftharpoons 2CO_{(g)} + O_{2(g)}$

3.0 mol of CO_2 is put in a 5.0 L container. Calculate the equilibrium concentration of each gas.