Chemistry 12

K_{eq} Calculations Worksheet

Name:
Date:
Block:

1. Given the equilibrium equation below:

$$A_{2(g)} + B_{2(g)} \leftrightharpoons 2AB_{(g)}$$

If, at equilibrium, the concentrations are as follows:

$[A_2] = 3.45\ M$, $[B_2] = 5.67\ M$ and $[AB] = 0.67\ M$

a) Write the expression for the equilibrium constant, K_{eq}

b) Find the value of the equilibrium constant, K_{eq} at the temperature that the experiment was done.

2. For the reaction:

$$A_{2(g)} + B_{(g)} \leftrightharpoons 2C_{(g)}$$

it is found that by adding 1.5 moles of C to a 1.0 L container, an equilibrium is established in which 0.30 moles of B are found.

a) What is [A] at equilibrium?

b) What is [B] at equilibrium?

c) What is [C] at equilibrium?

d) Write the expression for the equilibrium constant, K_{eq}.

e) Calculate the value for the equilibrium constant at the temperature at the experiment was done.

3. Considering the following equilibrium:

$$2AB_{3(g)} \leftrightharpoons A_{2(g)} + + 3B_{2(g)}$$

If 0.87 moles of AB_3 are injected into a 5.0 L container at 25°C, at equilibrium the final $[A_2]$ is found to be 0.070 M.

a) Calculate the equilibrium $[AB_3]$.

b) Calculate the equilibrium $[A_2]$.

c) Calculate the equilibrium $[B_2]$.

4. Consider the reaction:

$$A_{(g)} + B_{(g)} \leftrightharpoons C_{(g)}$$

a) In an equilibrium mixture the following concentrations were found:

[A] = 0.45M, [B] = 0.63M and [C] = 0.30M. Calculate the value of the equilibrium constant for this reaction.

b) At the same temperature, another equilibrium mixture is analyzed and it is found that [B] = 0.21 M and [C] = 0.70 M. From this and the information above, calculate the equilibrium [A].

c) In another equilibrium mixture at the same temperature, it is found that [A] = 0.35 M and the [C] = 0.86 M. From this and the information above, calculate the equilibrium [B].

5. Two mole of gaseous NH_3 are introduced into a 1.0 L vessel and allowed to undergo partial decomposition at high temperature according to the reaction:

$$2NH_{3(g)} \leftrightharpoons N_{2(g)} + 3H_{2(g)}$$

At equilibrium, 1.0 mole of $NH_{3(g)}$ remains.

a) What is the equilibrium $[N_2]$?

b) What is the equilibrium $[H_2]$?

c) Calculate the value of the equilibrium constant at the temperature of the experiment.

6. At a high temperature, 0.50 mol of HBr was placed in a 1.0 L container and allowed to decompose according to the reaction:

$$2HBr_{(g)} \leftrightharpoons H_{2(g)} + Br_{2(g)}$$

At equilibrium the $[Br_2]$ was measured to be 0.13 M. What is K_{eq} for this reaction at this temperature?

7. When 1.0 mol of $NH_{3(g)}$ and 0.40 mol of $N_{2(g)}$ are placed in a 5.0 L vessel and allowed to reach equilibrium at a certain temperature, it is found that 0.78 mol of NH_3 is present. The reaction is:

$$2NH_{3(g)} \leftrightharpoons 3H_{2(g)} + N_{2(g)}$$

a) Calculate the equilibrium concentrations of all three species.

$[NH_3]$ = _____ $[H_2]$ = _____ $[N_2]$ = _____

b) Calculate the value of the equilibrium constant at this temperature.

8. When 0.40 mol of PCl_5 is heated in a 10.0 L container, an equilibrium is established in which 0.25 mol of Cl_2 is present. (Make a table and answer the questions below. Be sure to read all questions a-d before making your table!:)

$$PCl_{5(g)} \leftrightharpoons PCl_{3(g)} + Cl_{2(g)}$$

a) Calculate the equilibrium concentration of each species.

$[PCl_5]$ = _____ $[PCl_3]$ = _____ $[Cl_2]$ = _____

b) Calculate the value of the equilibrium constant, K_{eq} at the temperature of the experiment.

c) What amount (moles) of PCl_3 is present at equilibrium?

d) What amount (moles) of PCl_5 is present at equilibrium?

9. A mixture of H_2 and I_2 is allowed to react at 448°C. When equilibrium is established, the concentrations of the participants are found to be:

$$[H_2] = 0.46\ M, \quad [I_2] = 0.39\ M \quad \text{and} \quad [HI] = 3.0\ M.$$

The equation is:

$$H_{2(g)} + I_{2(g)} \leftrightharpoons 2HI_{(g)}$$

a) Calculate the value of K_{eq} at 448°C.

b) In another equilibrium mixture of the same species at 448°C, the concentrations of I_2 and H_2 are both 0.050 M. What is the equilibrium concentration of HI?

10. At a certain temperature the reaction:

$$CO_{(g)} + H_2O_{(g)} \leftrightharpoons CO_{2(g)} + H_{2(g)}$$

has a K_{eq} = 0.400. Exactly 1.00 mol of each gas was placed in a 100.0 L vessel and the mixture was allowed to react. Find the equilibrium concentration of each gas.

11. The reaction:

$$2XY_{(g)} \leftrightharpoons X_{2(g)} + Y_{2(g)}$$

has a $K_{eq} = 35$ at 25°C. If 3.0 moles of XY are injected into a 1.0 L container at 25°C, find the equilibrium $[X_2]$ and $[Y_2]$.

12. The equilibrium constant for the reaction:

$$H_{2(g)} + I_{2(g)} \leftrightharpoons 2HI_{(g)} \qquad \text{at 448°C is 50.}$$

a) If 1.0 mol of H_2 is mixed with 1.0 mol of I_2 in a 0.50 L container and allowed to react at 448°C , what is the equilibrium [HI]?

b) How many moles of HI are formed at equilibrium? (Actual yield)

13. Given K_{eq} for the reaction:

$$PCl_{5(g)} \leftrightharpoons PCl_{3(g)} + Cl_{2(g)}$$

is 0.042 at 250°C , what will happen if 2.50 mol of PCl_5, 0.600 mol of Cl_2 and 0.600 mol of PCl_3 are placed in a 1.00 flask at 250°C ? (Will the reaction shift left, right, or not occur at all?)

14. Given the equilibrium equation:

$$H_{2(g)} + I_{2(g)} \leftrightharpoons 2HI_{(g)}$$

at 448°C, K_{eq} = 50. If 3.0 mol of HI, 2.0 mol of H_2, and 1.5 mol of I_2 are placed in a 1.0 L container at 448°C, which way does the reaction shift?

15. Given the equilibrium equation:

$$H_{2(g)} + I_{2(g)} \leftrightharpoons 2HI(g)$$

at 448°C, Keq = 50. If 5.0 mol of HI, 0.7071 mol of H_2, and 0.7071 mol of I_2 are placed in a 1.0 L container at 448°C, which way does the reaction shift?

16. Determine the equilibrium constant for the reaction:

$$H_{2(g)} + I_{2(g)} \leftrightharpoons 2HI_{(g)}$$

given that an equilibrium mixture is analyzed and found to contain the following concentrations:

$[H_2] = 0.0075$ M, $[I_2] = 0.000043$ M and $[HI] = 0.0040$ M

17. Given the equilibrium equation:

$$3A_{(g)} + B_{(g)} \leftrightharpoons 2C_{(g)}$$

If 2.50 moles of A and 0.500 moles of B are added to a 2.00 L container, an equilibrium is established in which the [C] is found to be 0.250 M.

a) Find [A] and [B] at equilibrium.

b) Calculate the value of the equilibrium constant K_{eq}.

18. At 800°C, the equilibrium constant $K_{eq} = 0.279$ for the reaction:

$$CO_{2(g)} + H_{2(g)} \leftrightharpoons CO_{(g)} + H_2O_{(g)}$$

If 1.50 moles of CO_2 and 1.50 moles of H_2 are added to a 1.00 L container, what would the [CO] be at equilibrium?

19. Given that the equilibrium constant K_{eq} = 0.015 at 25°C for the reaction:

$$A_{(g)} + B_{(g)} \leftrightharpoons C_{(g)} + D_{(g)}$$

if 1.0 mole of each gas is added to a 1.0 L container at 25°C, which way will the equation shift in order to reach equilibrium?

20. Calculate the equilibrium constant K_{eq} for the following reaction:

$$2A_{2(g)} + 3B_{2(g)} \leftrightharpoons 2A_2B_{3(g)}$$

given that the partial pressure of each substance at equilibrium is as follows:
Partial Pressure of A_2 = 20.0 kPa, Partial Pressure of B_2 = 30.0 kPa, Partial Pressure of A_2B_3 = 5.00 kPa.

21. Given the reaction:

$$4HCl_{(g)} + O_{2(g)} \leftrightharpoons 2H_2O_{(g)} + 2Cl_{2(g)} \quad DH = -113 \text{ kJ}$$

How will the value of the equilibrium constant K_{eq} at 550°C compare with its value at 450°C? Explain your answer.

22. The following system is at equilibrium, in a closed container:

$$4NH_{3(g)} + 3O_{2(g)} \leftrightharpoons 6H_2O_{(g)} + 2N_{2(g)} + \text{heat}$$

a) How is the amount of N_2 in the container affected if the volume of the container is doubled?

b) How is the rate of the forward reaction affected if more water vapor is introduced into the container?

c) How is the amount of O_2 in the container affected if a catalyst is added?

23. Consider the following equilibrium system:

$$A_{(g)} + B_{(g)} \leftrightharpoons C_{(g)}$$

1.0 mole of A and 2.0 moles of B are simultaneously injected into an empty 1.0 L container. After 5.0 minutes, equilibrium is reached and [C] is found to be 0.20 M. Make calculations and draw graphs to show how each of [A], [B] and [C] change with time over a period of 10.0 minutes.
(HINT: You have to make a table first.)