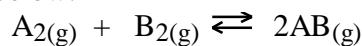


Chemistry 12
Worksheet 2-3

Calculations Involving the Equilibrium Constant K_{eq}

1. Given the equilibrium equation below:



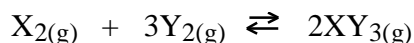
If, at *equilibrium*, the concentrations are as follows:

$$[A_2] = 3.45 \text{ M}, \quad [B_2] = 5.67 \text{ M} \quad \text{and} \quad [AB] = 0.67 \text{ M}$$

- 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.

Answer _____

2. Given the equilibrium equation:



at a temperature of 50°C , it is found that when equilibrium is reached that:

$$[X_2] = 0.37 \text{ M}, \quad [Y_2] = 0.53 \text{ M} \quad \text{and} \quad [XY_3] = 0.090 \text{ M}$$

- a) Write the **equilibrium constant expression** (K_{eq})
- b) Calculate the **value** of K_{eq} at 50°C .

Answer _____

Chemistry 12**Unit 2 - Chemical Equilibrium**

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. (*Hint: Make a table and use it to answer the questions below.*)

a) What is [A] at equilibrium? Answer _____

b) What is [B] at equilibrium? Answer _____

c) What is [C] at equilibrium? Answer _____

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

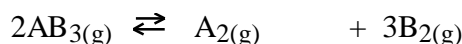
e) Calculate the **value** for the equilibrium constant at the temperature at the experiment was done.

Answer _____

Chemistry 12

Unit 2 - Chemical Equilibrium

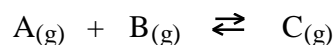
4. Considering the following equilibrium:



If 0.87 moles of AB_3 are injected into a 5.0 L container at 25°C , at equilibrium the final $[\text{A}_2]$ is found to be 0.070 M. (*Hint: Make a table and use it to answer the questions below.*)

- a) Calculate the equilibrium concentration of AB_3 . Answer _____
- b) Calculate the equilibrium $[\text{A}_2]$. Answer _____
- c) Calculate the equilibrium $[\text{B}_2]$. Answer _____

5. Consider the reaction:



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

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

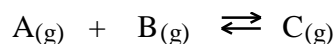
Answer _____

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

Answer _____

Chemistry 12**Unit 2 - Chemical Equilibrium**

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



Answer _____

6. 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:



At equilibrium, 1.0 mole of $\text{NH}_{3(g)}$ remains.

(Make a table and use it to answer the questions below:)

- a) What is the equilibrium $[\text{N}_2]$? Answer _____
- b) What is the equilibrium $[\text{H}_2]$? Answer _____
- c) Calculate the **value** of the equilibrium constant at the temperature of the experiment.

Answer _____

Chemistry 12

Unit 2 - Chemical Equilibrium

7. 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:



At equilibrium the $[\text{Br}_2]$ was measured to be 0.13 M. What is K_{eq} for this reaction at this temperature?

Answer _____

8. When 1.0 mol of $\text{NH}_3(g)$ and 0.40 mol of $\text{N}_2(g)$ 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:



- a) Calculate the **equilibrium concentrations** of all three species.

$[\text{NH}_3] =$ _____ $[\text{H}_2] =$ _____ $[\text{N}_2] =$ _____

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

Answer _____

- c) How many **moles** of H_2 are present at equilibrium?

Answer _____

- d) How many **moles** of N_2 are present at equilibrium?

Answer _____

Chemistry 12**Unit 2 - Chemical Equilibrium**

b) In another equilibrium mixture of the *same* participants at 448°C , the concentrations of I₂ and H₂ are both 0.050 M. What is the *equilibrium concentration* of HI?

Answer _____

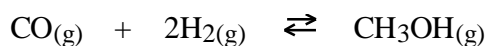
11. The K_{eq} for the reaction:



at 250°C is found to be **0.042**. In an *equilibrium mixture* of these species, it is found that [PCl₅] = 0.012 M, and [Cl₂] = 0.049 M. What is the equilibrium [PCl₃] at 250°C ?

Answer _____

12. At a certain temperature the reaction:



has a K_{eq} = **0.500**. If a reaction mixture at equilibrium contains 0.210 M CO and 0.100 M H₂ , what is the *equilibrium* [CH₃OH]?

Answer _____

Chemistry 12**Unit 2 - Chemical Equilibrium**

has a $K_{\text{eq}} = 0.400$. 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.

Answer _____

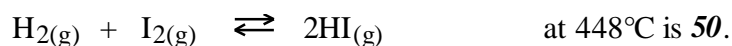


has a $K_{\text{eq}} = 35$ at 25°C . If 3.0 moles of XY are injected into a 1.0 L container at 25°C , find the equilibrium $[\text{X}_2]$ and $[\text{Y}_2]$.

Answer $[\text{X}_2] =$ _____ $[\text{Y}_2] =$ _____

Chemistry 12**Unit 2 - Chemical Equilibrium**

15. The equilibrium constant for the reaction:



- 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** $[\text{HI}]$?

Answer _____

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

Answer _____

16. Given K_{eq} for the reaction:



- 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?)

Answer _____

Chemistry 12

Unit 2 - Chemical Equilibrium



at 448°C, $K_{\text{eq}} = 50$. 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, will a reaction occur?

Answer _____

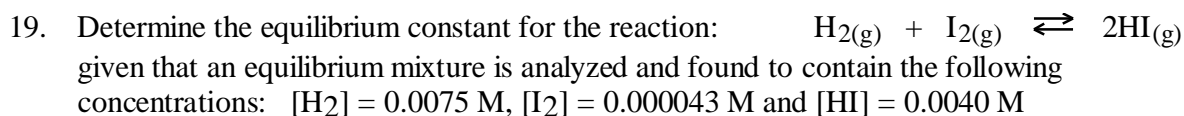
If so, which way does the reaction shift? _____



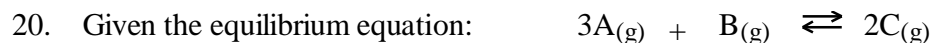
at 448°C, $K_{\text{eq}} = 50$. If 5.0 mol of HI, 0.7071 mol of H_2 , and 0.7071 mol of I_2 are placed in a 1.0 L container at 448°C, will a reaction occur? (Round any answers off to 3 significant digits!)

Answer _____

If so, which way does the reaction shift? _____



Answer _____

Chemistry 12**Unit 2 - Chemical Equilibrium**

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.

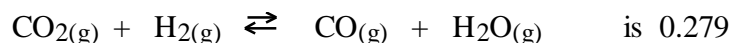
a) Find [A] and [B] at equilibrium.

Answer _____

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

Answer _____

21. At 800°C, the equilibrium constant K_{eq} , for the reaction:

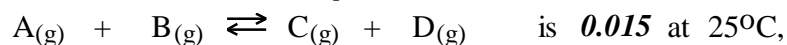


If 1.50 moles of CO_2 and 1.50 moles of H_2 are added to a 1.00 L container, what would the [CO] be at equilibrium?

Answer _____

Chemistry 12**Unit 2 - Chemical Equilibrium**

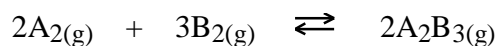
22. Given that the equilibrium constant K_{eq} for the reaction:



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?

Answer _____

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



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.

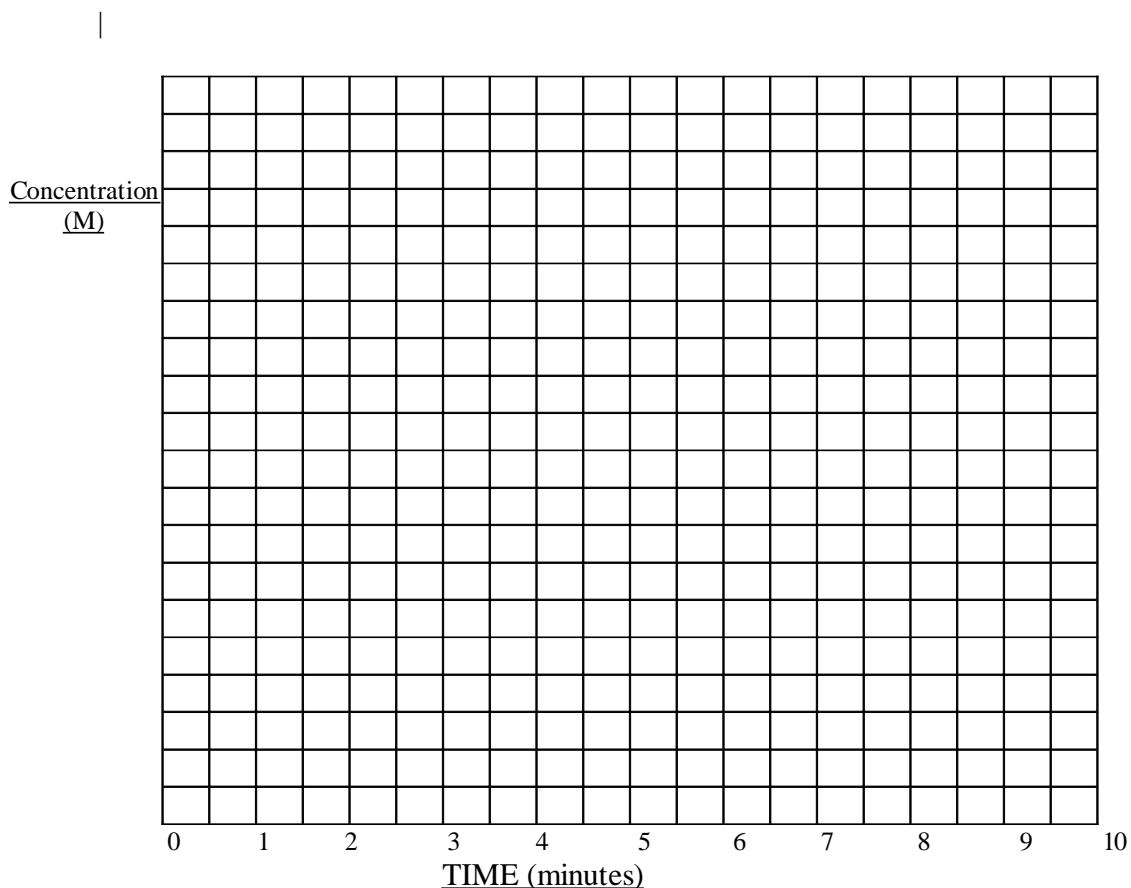
Answer _____

Chemistry 12

Unit 2 - Chemical Equilibrium

24. Consider the following equilibrium system: $A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)}$

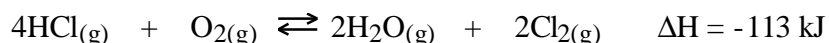
1.0 mole of A and 2.0 moles of B are simultaneously injected into an empty 1.0 L container. At equilibrium (after 5.0 minutes), [C] is found to be 0.20 M. Make calculations and draw graphs to show how each of [A], [B] and [C] change with time over a period of 10.0 minutes. (HINT: You have to make a table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



Chemistry 12

Unit 2 - Chemical Equilibrium

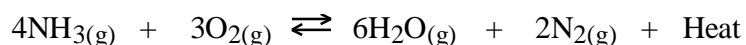
25. Given the reaction:



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

Explain your answer. _____

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

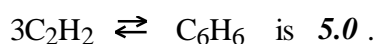


a) How is the *amount of* N_2 in the container affected if the *volume* of the container is *doubled*? _____

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? _____

27. At a certain temperature, K_{eq} for the reaction:



If the *equilibrium concentration* of C_2H_2 is 0.40 moles/L, what is the *equilibrium concentration* of C_6H_6 ?

Answer _____