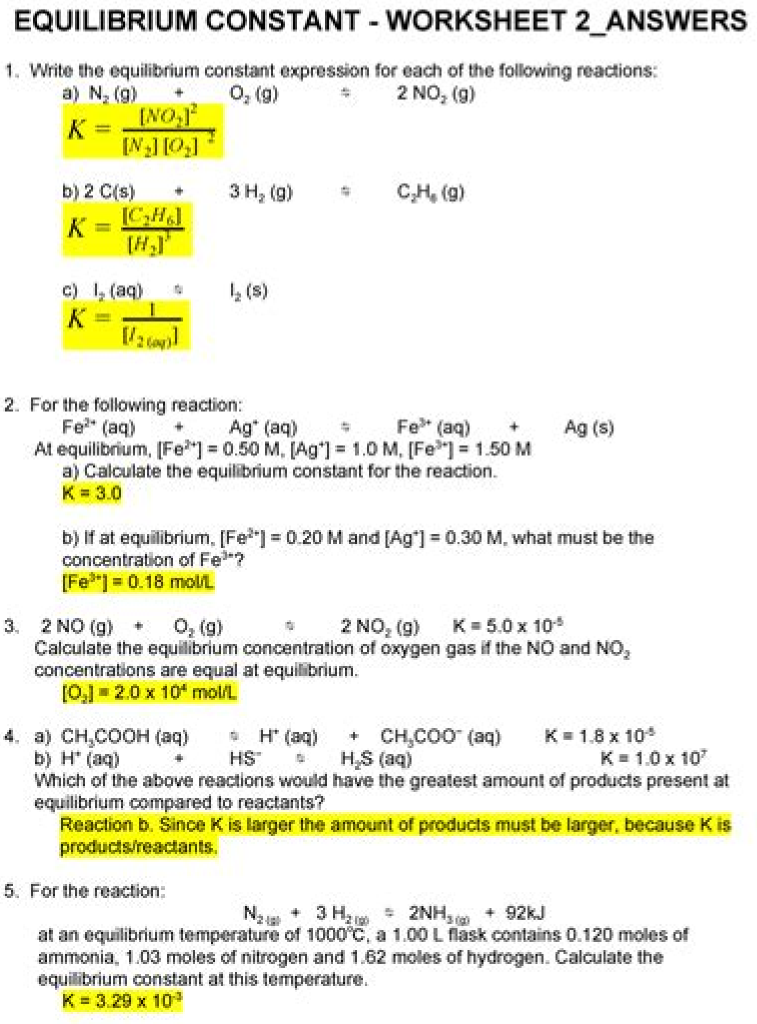
Worksheet 2 Equilibrium Expressions And Calculations Answers



EQUILIBRIUM CONSTANT - WORKSHEET 2_ANSWERS

1. Write the equilibrium constant expression for each of the following reactions:

   a) $N_2\,(g) + O_2\,(g) \rightleftharpoons 2\,NO_2\,(g)$

   $$K = \frac{[NO_2]^2}{[N_2]\,[O_2]^2}$$

   b) $2\,C(s) + 3\,H_2\,(g) \rightleftharpoons C_2H_6\,(g)$

   $$K = \frac{[C_2H_6]}{[H_2]^3}$$

   c) $I_2\,(aq) \rightleftharpoons I_2\,(s)$

   $$K = \frac{1}{[I_{2\,(aq)}]}$$

2. For the following reaction:

   $Fe^{2+}\,(aq) + Ag^{+}\,(aq) \rightleftharpoons Fe^{3+}\,(aq) + Ag\,(s)$

   At equilibrium, $[Fe^{2+}] = 0.50$ M, $[Ag^{+}] = 1.0$ M, $[Fe^{3+}] = 1.50$ M

   a) Calculate the equilibrium constant for the reaction.

   K = 3.0

   b) If at equilibrium, $[Fe^{2+}] = 0.20$ M and $[Ag^{+}] = 0.30$ M, what must be the concentration of Fe^{3+}?

   $[Fe^{3+}] = 0.18$ mol/L

3. $2\,NO\,(g) + O_2\,(g) \rightleftharpoons 2\,NO_2\,(g)$ $K = 5.0 \times 10^{-5}$

   Calculate the equilibrium concentration of oxygen gas if the NO and NO_2 concentrations are equal at equilibrium.

   $[O_2] = 2.0 \times 10^{4}$ mol/L

4. a) $CH_3COOH\,(aq) \rightleftharpoons H^{+}\,(aq) + CH_3COO^{-}\,(aq)$ $K = 1.8 \times 10^{-5}$

   b) $H^{+}\,(aq) + HS^{-} \rightleftharpoons H_2S\,(aq)$ $K = 1.0 \times 10^{7}$

   Which of the above reactions would have the greatest amount of products present at equilibrium compared to reactants?

   Reaction b. Since K is larger the amount of products must be larger, because K is products/reactants.

5. For the reaction:

   $$N_{2\,(g)} + 3\,H_{2\,(g)} \rightleftharpoons 2NH_{3\,(g)} + 92\text{kJ}$$

   at an equilibrium temperature of 1000°C, a 1.00 L flask contains 0.120 moles of ammonia, 1.03 moles of nitrogen and 1.62 moles of hydrogen. Calculate the equilibrium constant at this temperature.

   $K = 3.29 \times 10^{-3}$

Worksheet 2 equilibrium expressions and calculations answers can provide a solid foundation for understanding chemical equilibria and their practical applications. This worksheet typically encompasses various equilibrium expressions, calculations involving equilibrium concentrations, and the application of the equilibrium constant (K) in diverse scenarios. In the realm of chemistry, mastering these concepts is crucial for predicting the behavior of chemical systems and for applications in fields such as pharmaceuticals, environmental science, and industrial chemistry.

Understanding Equilibrium Expressions

Equilibrium in chemistry refers to the state where the concentrations of reactants and products remain constant over time. At this point, the rates of the forward and reverse reactions are equal. The equilibrium expression quantitatively describes this relationship.

Definition of Equilibrium Constant (K)

The equilibrium constant K is defined as the ratio of the concentrations of products to the concentrations of reactants, each raised to the power of their respective coefficients in the balanced chemical equation. For a general reaction:

$$aA + bB \rightleftharpoons cC + dD$$

The equilibrium constant expression is given by:

$$K = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

Where:
- $[C]$ and $[D]$ are the molar concentrations of the products.
- $[A]$ and $[B]$ are the molar concentrations of the reactants.
- $a, b, c,$ and d are the stoichiometric coefficients from the balanced equation.

Types of Equilibrium Constants

There are different types of equilibrium constants based on the state of the matter involved:

1. Kc: Used when dealing with concentrations (molarity).
2. Kp: Used when dealing with partial pressures of gases.
3. Ksp: The solubility product constant, used for sparingly soluble salts.

Each type of equilibrium constant has its specific application depending on the reaction context.

Calculating Equilibrium Concentrations

When given initial concentrations and changes at equilibrium, calculating concentrations involves the ICE (Initial, Change, Equilibrium) table method.

Using ICE Tables

An ICE table helps organize the initial concentrations, changes in concentrations, and the equilibrium concentrations. Here's how to set it up:

1. Initial Concentration: Start with the initial concentrations of reactants and products.
2. Change: Determine the changes in concentration based on the stoichiometry of the reaction.
3. Equilibrium Concentration: Calculate the equilibrium concentrations by adding the initial concentrations and the changes.

Example Reaction:

For the reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Assume the initial concentrations are:
- $[N_2] = 0.5$ M
- $[H_2] = 1.5$ M
- $[NH_3] = 0$ M

	N_2	H_2	NH_3
Initial	0.5	1.5	0
Change	-x	-3x	+2x
Equilibrium	0.5-x	1.5-3x	2x

Example Calculation

Let's say at equilibrium K_c is 0.5. The equilibrium expression becomes:

$$K_c = \frac{(2x)^2}{(0.5-x)(1.5-3x)}$$

Solving this equation will provide the value of x, which can then be substituted back to find the equilibrium concentrations.

Factors Affecting Equilibrium

The position of equilibrium can be influenced by several factors, commonly referred to as Le Chatelier's Principle.

1. Concentration Changes

- Increasing the concentration of reactants shifts the equilibrium to the right, favoring product formation.
- Increasing the concentration of products shifts the equilibrium to the left, favoring reactant formation.

2. Temperature Changes

- For exothermic reactions, increasing temperature shifts the equilibrium to the left (towards reactants).
- For endothermic reactions, increasing temperature shifts the equilibrium to the right (towards products).

3. Pressure Changes

For reactions involving gases, increasing pressure shifts the equilibrium towards the side with fewer moles of gas.

4. Catalysts

While catalysts speed up the attainment of equilibrium, they do not affect the position of the equilibrium itself.

Real-Life Applications of Equilibrium Expressions

Understanding equilibrium expressions has significant implications in various fields:

1. Chemical Manufacturing

In industrial chemistry, equilibrium principles help in optimizing reactions to maximize yield. For example, the Haber process for ammonia synthesis relies on equilibrium principles to ensure high efficiency.

2. Environmental Science

Equilibrium expressions are crucial in modeling environmental systems, such as predicting the behavior of pollutants in water and air.

3. Pharmaceuticals

In drug formulation and design, understanding the equilibrium between drug molecules and their receptors can influence the efficacy and potency of medications.

Conclusion

Mastering worksheet 2 equilibrium expressions and calculations answers is essential for any chemistry student or professional. The ability to understand and manipulate equilibrium expressions allows for predicting how chemical systems behave under varying conditions. As this article has demonstrated, the concepts of equilibrium constants, ICE tables, and the factors affecting equilibrium are not only fundamental to academic success but also to practical applications in various scientific fields. By practicing these calculations and applying the principles of equilibrium, one can develop a deep understanding of the dynamic nature of chemical reactions.

Frequently Asked Questions

What are equilibrium expressions in chemistry?

Equilibrium expressions are mathematical representations that relate the concentrations of reactants and products at equilibrium for a reversible reaction. They are derived from the balanced chemical equation and are used to calculate the equilibrium constant (K).

How do you write an equilibrium expression for the reaction A + B ⇌ C + D?

The equilibrium expression for the reaction A + B ⇌ C + D is written as $K = [C][D] / [A][B]$, where [A], [B], [C], and [D] represent the molar concentrations of the respective species at equilibrium.

What is the significance of the equilibrium constant (K)?

The equilibrium constant (K) indicates the ratio of the concentrations of products to reactants at equilibrium. A large K value (K >> 1) suggests that products are favored, while a small K value (K << 1) indicates that reactants are favored.

How do changes in concentration affect equilibrium expressions?

Changes in concentration can shift the position of equilibrium according to Le Chatelier's principle. If the concentration of reactants increases, the system will shift to favor products, and vice versa.

Can equilibrium expressions include pure solids and liquids?

No, equilibrium expressions do not include pure solids and liquids. Only the concentrations of reactants and products in the gaseous or aqueous states are included in the expression.

What is the first step in calculating equilibrium concentrations from an equilibrium expression?

The first step in calculating equilibrium concentrations is to set up an ICE table (Initial, Change, Equilibrium) to organize the initial concentrations, the changes that occur as the system reaches equilibrium, and the final equilibrium concentrations.

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