

- 4 EVALUATE** The value of K is small, which is consistent with more N_2 and O_2 being present at equilibrium than NO . The answer has the correct number of significant figures and is close to an estimated value of

$$8 \times 10^{-6}, \text{ calculated as } \frac{(1 \times 10^{-5})^2}{(6 \times 10^{-3})(2 \times 10^{-3})}.$$

PRACTICE

Answers in Appendix E

1. At equilibrium a mixture of N_2 , H_2 , and NH_3 gas at 500°C is determined to consist of 0.602 mol/L of N_2 , 0.420 mol/L of H_2 , and 0.113 mol/L of NH_3 . What is the equilibrium constant for the reaction $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ at this temperature?
2. The reaction $\text{AB}_2\text{C}(\text{g}) \rightleftharpoons \text{B}_2(\text{g}) + \text{AC}(\text{g})$ reached equilibrium at 900 K in a 5.00 L vessel. At equilibrium 0.084 mol of AB_2C , 0.035 mol of B_2 , and 0.059 mol of AC were detected. What is the equilibrium constant at this temperature for this system? (Don't forget to convert amounts to concentrations.)
3. A reaction between gaseous sulfur dioxide and oxygen gas to produce gaseous sulfur trioxide takes place at 600°C . At that temperature, the concentration of SO_2 is found to be 1.50 mol/L , the concentration of O_2 is 1.25 mol/L , and the concentration of SO_3 is 3.50 mol/L . Using the balanced chemical equation, calculate the equilibrium constant for this system.

extension

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Keyword: HC6EQUX

SECTION REVIEW

1. What is meant by *chemical equilibrium*?
2. What is an equilibrium constant?
3. How does the value of an equilibrium constant relate to the relative quantities of reactants and products at equilibrium?
4. What is meant by a *chemical equilibrium expression*?
5. Hydrochloric acid, HCl , is a strong acid that dissociates completely in water to form H_3O^+ and Cl^- . Would you expect the value of K for the reaction $\text{HCl}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{Cl}^-(\text{aq})$ to be 1×10^{-2} , 1×10^{-5} , or "very large"? Justify your answer.
6. Write the chemical equilibrium expression for the reaction $4\text{HCl}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{Cl}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$.
7. At equilibrium at 2500 K , $[\text{HCl}] = 0.0625 \text{ mol/L}$ and $[\text{H}_2] = [\text{Cl}_2] = 0.00450 \text{ mol/L}$ for the reaction $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2\text{HCl}(\text{g})$. Find the value of K .
8. An equilibrium mixture at 425°C is found to consist of $1.83 \times 10^{-3} \text{ mol/L}$ of H_2 , $3.13 \times 10^{-3} \text{ mol/L}$ of I_2 , and $1.77 \times 10^{-2} \text{ mol/L}$ of HI . Calculate the equilibrium constant, K , for the reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$.
9. For the reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ at 425°C , calculate $[\text{HI}]$, given $[\text{H}_2] = [\text{I}_2] = 4.79 \times 10^{-4} \text{ mol/L}$ and $K = 54.3$.

Critical Thinking

10. **INFERRING RELATIONSHIPS** Use the data from Experiment 1 in **Table 1** to calculate the value of K for the reaction $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$. Do you see a relationship between the value you obtained and the value in the table?