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AP Chemistry – Equilibrium and K_{eq} – 41

Name _____Per ___

1. Explain what is <u>incorrect</u> about the following statements:

(a) At equilibrium no more reactants are transformed into products.

(b) At equilibrium the rate constant for the forward reaction equals that of the reverse reaction.

(c) At equilibrium there are equal amounts of reactants and products.

2. Consider the reaction A + B ↔ C + D. Assume that both the forward and reverse reactions are elementary processes and that the value of the equilibrium constant is very large. (a) Which species predominate at equilibrium, reactants or products?
(b) Which reaction has the larger rate constant, the forward or the reverse? Explain.

3. Write the expressions for K_{eq} for the following reactions. In each case indicate whether the reaction is homogeneous or heterogeneous.

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

(b) $Ti_{(s)} + 2Cl_{2(g)} \leftrightarrow TiCl_{4(l)}$

(c) $2C_2H_{4(g)} + 2H_2O_{(g)} \leftrightarrow 2C_2H_{6(g)} + O_{2(g)}$

(d) $Co_{(s)} + 2H^+_{(aq)} \leftrightarrow Co^{2+}_{(aq)} + H_{2(g)}$

(e) $NH_{3(aq)} + H_2O_{(l)} \leftrightarrow NH_4^+{}_{(aq)} + OH^-_{(aq)}$

4. Which of the following reactions lies to the right, favoring the formation of products, and which lies to the left, favoring the formation of reactants?
(a) $2NO_{(g)} + O_{2(g)} \leftrightarrow 2NO_{2(g)}$ $K_{eq} = 5.0 \times 10^{12}$

(b) $2HBr_{(g)} \leftrightarrow H_{2(g)} + Br_{2(g)}$ $K_{eq} = 5.8 \times 10^{-18}$

5. The equilibrium constant for the reaction $2NO_{(g)} + Br_{2(g)} \leftrightarrow 2NOBr_{(g)}$ is $K_{eq} = 1.3 \times 10^{-2}$ at 1000 K.
(a) Calculate K_{eq} for the reaction written in reverse.

(b) At this temperature does the equilibrium favor the reactants or the product?

6. Consider the following equilibrium, for which $K_{eq} = 0.0752$ at $480^{\circ C}$:
$2Cl_{2(g)} + 2H_2O_{(g)} \leftrightarrow 4HCl_{(g)} + O_{2(g)}$
(a) What is the value of K_{eq} for the reaction written in reverse?

(b) What is the value of K_{eq} for the reaction $Cl_{2(g)} + H_2O_{(g)} \leftrightarrow 2HCl_{(g)} + \frac{1}{2}O_{2(g)}$?

(c) What is the value of K_{eq} for the reaction in question (b) written in reverse?

7. Consider the reactions $A_{(aq)} + B_{(aq)} \leftrightarrow C_{(aq)}$ ($K_{eq} = 1.9 \times 10^{-4}$) and $C_{(aq)} + D_{(aq)} \leftrightarrow E_{(aq)} + A_{(aq)}$ for which the $K_{eq} = 8.5 \times 10^{2}$. What is the value of K_{eq} for the reaction $B_{(aq)} + D_{(aq)} \leftrightarrow E_{(aq)}$?

8. Consider the equilibrium $Na_2O_{(s)} + SO_{2(g)} \leftrightarrow Na_2SO_{3(s)}$
(a) Write an expression for K_{eq} that includes all the reactants and products.

(b) Explain why we normally exclude pure solids and liquids from equilibrium-constant expressions.

(c) Write an expression for K_{eq} that excludes the pure solids from the equilibrium expression.

9. Using the activity series, write balanced chemical equations for the following reactions. If no reaction occurs, simply write NR. (a) Iron metal is added to a solution of copper(II) nitrate.

(b) Zinc metal is added to a solution of magnesium sulfate.

(c) Hydrobromic acid is added to tin metal.

(d) Hydrogen gas is bubbled through an aqueous solution of nickel(II) chloride.

(e) aluminum metal is added to a solution of cobalt(II) sulfate.

10. Determine the empirical formula of each of the following compounds if a sample contains:
(a) 0.104 moles of K, 0.052 moles of C and 0.156 moles of O

(b) 5.28 g of Sn and 3.37 g of F

(c) 87.5% N and 12.5% H by mass

11. If 1.5 moles of each of the following compounds, C_2H_5OH, C_3H_8 and $CH_3CH_2COCH_3$ is completely combusted in oxygen, which one will produce the largest number of moles of H_2O? Which will produce the least? Explain.