CHEM 112 Equilibrium review

QUESTION 1

For a chemical reaction at equilibrium, the relationship between the rate constants for the forward and reverse reactions ($k_f$ and $k_r$) and the equilibrium constant for the process ($K_{eq}$) is

$$
\frac{k_f}{k_r} = A \quad B
$$

A. $K_{eq} = k_f k_r$
B. $K_{eq} = k_f - k_r$
C. $K_{eq} = k_f + k_r$
D. $K_{eq} = k_f / k_r$
E. $K_{eq} = k_f / k_r$

QUESTION 2

Which of the following will change the value of an equilibrium constant?

1. changing temperature
2. adding a catalyst
3. varying the initial concentration of reactants

A. 1 only
B. 2 only
C. 1 and 2
D. 1 and 3
E. all three

QUESTION 3

Write the correct expression for the equilibrium constant for the reactions below.

I. $\text{NO}(g) + \text{O}_3(g) \rightleftharpoons \text{NO}_2(g) + \text{O}_2(g)$
II. $\text{CaCO}_3(s) \rightleftharpoons \text{CaO}(s) + \text{CO}_2(g)$

QUESTION 4

For the following reaction, $K_p = 1.96$ at 700 K.

$\text{NOCl}(g) \rightleftharpoons \text{NO}(g) + \frac{1}{2} \text{Cl}_2(g)$

What is $K_p$ for the reaction below at this same temperature?

$\text{Cl}_2(g) + 2 \text{NO}(g) \rightleftharpoons 2 \text{NOCl}(g)$

A. 1.96
B. 3.85
C. 0.260
D. 0.509
E. None of the above is within 5% of the correct answer.

QUESTION 5

At 50°C, $K_c = 2.2 \times 10^3$ for the reaction

$3 \text{Fe}(s) + 4 \text{H}_2\text{O}(g) \rightleftharpoons \text{Fe}_3\text{O}_4(s) + 4 \text{H}_2(g)$

What is the value of $K_p$ at 200°C for this reaction?

A. $8.8 \times 10^3$
B. $2.2 \times 10^3$
C. $5.5 \times 10^2$
D. $3.5 \times 10^4$
E. This question cannot be answered with the information provided
QUESTION 6
The value of $K_{eq}$ for the following reaction is $1.1 \times 10^{-10}$.

$$\text{BaSO}_4(s) \rightleftharpoons \text{Ba}^{2+}(aq) + \text{SO}_4^{2-}(aq)$$

What statement is most correct about the equilibrium reaction mixture?

A. products dominate
B. reactants dominate
C. There is a reasonable mixture of reactants and products
D. only products exist.
E. only reactants exist.

QUESTION 7
At a certain temperature, 0.300 moles of NO, 0.200 moles of Cl$_2$, and 0.500 moles of ClNO were placed in a 25.0 L vessel and allowed to reach equilibrium:

$$2 \text{NO}(g) + \text{Cl}_2(g) \rightleftharpoons 2 \text{ClNO}(g).$$

At equilibrium, 0.600 moles of ClNO were present. The number of moles of Cl$_2$ present at equilibrium is

A. 0.100
B. 0.150
C. 0.200
D. 0.250
E. 0.300

QUESTION 8
For the reaction $\text{N}_2(g) + \text{O}_2(g) \rightleftharpoons 2 \text{NO}(g)$ $K_c = 4.0$ at a particular temperature. Suppose we begin an experiment by mixing 1.0 mol of N$_2$ and 1.0 mol of O$_2$ in a 1.0-liter container. What will be the concentration of NO once equilibrium is reached at the given temperature?

A. $[\text{NO}] = 0.25 \text{ M}$
B. $[\text{NO}] = 0.50 \text{ M}$
C. $[\text{NO}] = 1.0 \text{ M}$
D. $[\text{NO}] = 0.67 \text{ M}$
E. None of the above is within 5% of the correct answer

QUESTION 9
At high temperatures, one mole of hydrogen gas reacts with one mole of bromine gas to form hydrogen bromide. At a given temperature the equilibrium constant is 57.6. If at the same temperature, a mixture of $4.67 \times 10^{-3} \text{ M}$ bromine gas, $2.14 \times 10^{-3} \text{ M}$ hydrogen gas, and $2.40 \times 10^{-2} \text{ M}$ hydrogen bromide gas is made, then

A. the system is at equilibrium.
B. the system is far from equilibrium and will shift to form more hydrogen gas.
C. the system is far from equilibrium and will shift to form more hydrogen bromide gas.
D. nothing can be deduced since we do not know whether the reaction is endothermic or exothermic.
E. nothing can be deduced since we do not know whether the equilibrium constant is $K_c$ or $K_p$.

QUESTION 10
Nickel (II) oxide can be reduced to nickel metal by treatment with carbon monoxide as indicated in the reaction

$$\text{CO}(g) + \text{NiO}(s) \rightleftharpoons \text{CO}_2(g) + \text{Ni}(s) \quad K_p = 20 \text{ at 500°C}$$

If the reaction chamber contains some solid Ni and NiO, 400 mm Hg of CO$_2$ and 20 mm Hg of CO, all at equilibrium, which one of the following changes will lead to the reduction of more nickel oxide at 500°C?

A. Doubling the amount of NiO(s) present.
B. Adding CO$_2$ to raise its pressure to 700 mm Hg.
C. Adding CO to raise its pressure to 40 mm Hg.
D. Removal of half of the NiO(s) present.
E. Doubling the volume of the reaction chamber at 500°C.
Consider the following reaction at equilibrium.

$$2 \text{NH}_3(g) \rightleftharpoons \text{N}_2(g) + 3 \text{H}_2(g) \quad \Delta H^\circ = +92.4 \text{ kJ}$$

Adding N$_2$(g) to the reaction vessel will

A. decrease the concentration of NH$_3$(g) at equilibrium.
B. decrease the concentration of H$_2$(g) at equilibrium.
C. increase the value of the equilibrium constant.
D. cause the reaction to shift to the right.
E. have no effect on the concentration of NH$_3$(g).