Chemistry 202: Quiz #3

1. Consider two systems at equilibrium. These are represented by:

   I. $H_2(g) + F_2(g) \rightleftharpoons 2HF(g)$
   II. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

   In both systems the gaseous mixtures are in containers fitted with massless, frictionless pistons. Which of the following correctly describes the effect on equilibrium if helium gas is added to both systems?

   a) Neither equilibrium will shift.
   b) System I will not shift, but System II will shift to the right.
   c) System I will not shift, but System II will shift to the left.
   d) System I will shift to the left but System II will not shift.
   e) System I will shift to the right but System II will not shift.

2. How many of the following statements concerning chemical equilibrium are **true**?

   I. For a given reaction at a given temperature, there is one set of equilibrium conditions for the reactants and products.
   II. The value of the equilibrium constant cannot change for a given equation under any conditions.
   III. Adding an inert gas to a system at equilibrium cannot change the equilibrium position.
   IV. Once a chemical system has reached equilibrium, no new product molecules are formed.

   a) 0 b) 1 c) 2 d) 3 e) 4

3, 4. Consider the reaction between nitrogen and oxygen gases to form nitrogen monoxide gas in a sealed, rigid container:

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$$

The container initially has an equimolar (same number of moles) mixture of nitrogen and oxygen gases at a certain temperature. The equilibrium constant (K) at this temperature for this reaction is equal to 36.0.

3. Determine the percent of the nitrogen gas that has reacted when equilibrium is reached.

   a) 33.3% b) 42.9% c) 75.0% d) 85.7% e) 100.%

4. Given that all of the molecules are close to the same size and assuming the temperature is constant, which of the following is closest to the ratio of intermolecular collision frequencies in the original mixture (before any reaction has occurred) to that in the final mixture at equilibrium?

   a) 1:1 b) 1:2 c) 2:1 d) 2:3 e) 3:2

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5. Consider an initial mixture of $SO_2(g)$ and $O_2(g)$ in which the partial pressure of $SO_2(g)$ is 6.28 atm and the partial pressure of $O_2(g)$ is 3.14 atm. The gases react as follows:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The value of the equilibrium constant, K_p, at this temperature is equal to 1.23×10^{-9}. Determine the partial pressure of $SO_3(g)$ at equilibrium. Assume constant volume and temperature.

a) 1.52×10^{-7} atm
b) 7.79×10^{-5} atm
c) 1.56×10^{-4} atm
d) 1.95×10^{-4} atm
e) 3.90×10^{-4} atm

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6. In the following question you will be given two scenarios and the goal in both is to determine the initial pressure of the reactant gas. Please **show and explain** all work. Assume constant volume and temperature in both cases.

a. Consider the decomposition of dinitrogen tetroxide as follows: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$. The value of the equilibrium constant, K_p, at a certain temperature is 0.500. The equilibrium mixture of $N_2O_4(g)$ and $NO_2(g)$ at this temperature has a total pressure of 6.00 atm. **Determine the initial pressure of dinitrogen tetroxide**.

b. Consider the decomposition of ammonia as follows: $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$. The value of the equilibrium constant, K_p, at a certain temperature is 10.00. When pure ammonia is placed in an otherwise empty vessel at this temperature, equilibrium is reached when the partial pressure of ammonia is equal to the partial pressure of hydrogen gas. **Determine the initial pressure of ammonia.**

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KEY:
MC: 1. c, 2. a, 3. c, 4. a, 5. e

6. $P(N_2O_4)_0$ = 5.25 atm, $P(NH_3)_0$ = 9.129 atm