1-10. Multiple Choice [2 points each]

1. Which of the following correctly pairs the molecule with the strongest intermolecular attraction?

   a) Li₂O: dipole-dipole; F₂: London dispersion; SO₂: dipole-dipole
   b) Li₂O: dipole-dipole; F₂: dipole-dipole; SO₂: dipole-dipole
   c) Li₂O: ion-ion; F₂: London dispersion; SO₂: dipole-dipole
   d) Li₂O: dipole-dipole; F₂: London dispersion; SO₂: ion-ion
   e) Li₂O: ion-ion; F₂: dipole-dipole; SO₂: London-dispersion

2. Which of the following correctly ranks the boiling points from highest to lowest?

   a) C₂H₆ > CH₄ > CH₃OH
   b) CH₃OH > CH₄ > C₂H₆
   c) CH₄ > C₂H₆ > CH₃OH
   d) C₂H₆ > CH₃OH > CH₄
   e) CH₃OH > C₂H₆ > CH₄

3. Consider two pure gaseous substances A and B each made of molecules of approximately the same size. Substance A consists of molecules which are more polar than those of substance B. How many of the following statements is/are true?

   I. Substance A has a higher vapor pressure than substance B.
   II. Substance A has a higher boiling point than substance B.
   III. Substance A is a more ideal gas than substance B.
   IV. The bonds in molecule A must be more polar than the bonds in molecule B.

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

4. How many of the following statements is/are false?

   I. For a given reaction at a given temperature, there are an infinite number of equilibrium positions and only one equilibrium constant, K.
   II. At equilibrium, the concentration(s) of the reactant(s) must be equal to the concentration(s) of the product(s).
   III. The rate of the reverse reaction is equal to the rate of the forward reaction and both rates are equal to zero.
   IV. Heating any chemical system at equilibrium drives the reaction to the right.

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

5. Choose the correct equilibrium expression for the equation 2H₂O(l) ⇌ 2H₂(g) + O₂(g).

   a) \[ \frac{[H₂]^2[O₂]}{[H₂O]^2} \]  b) \[ \frac{[H₂][O₂]}{[H₂O]} \]  c) \[ [H₂]^2[O₂] \]  d) \[ \frac{1}{[H₂]^2[O₂]} \]  e) None of these

TURN OVER – MORE ON THE BACK
6. Consider the reaction represented by the equation \(2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g)\). For the system at chemical equilibrium, which of the following explains what happens after the addition of oxygen gas (assume constant volume and temperature)?

a) The amount of \(\text{SO}_3(g)\) increases and the value for \(K\) increases.
b) The amount of \(\text{SO}_3(g)\) decreases and the value for \(K\) increases.
c) The amount of \(\text{SO}_3(g)\) stays the same and the value for \(K\) decreases.
d) The amount of \(\text{SO}_3(g)\) stays the same and the value for \(K\) stays the same.
e) The amount of \(\text{SO}_3(g)\) increases and the value for \(K\) stays the same.

7. Consider the following balanced equation \(2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g)\). You notice a tank at equilibrium and the concentrations are: \([\text{SO}_2]\) = 2.00 \(M\) \hspace{1cm} [\text{O}_2] = 3.00 \(M\) \hspace{1cm} [\text{SO}_3] = 6.00 \(M\)

A friend fills another tank at the same temperature with the following initial concentrations:

\([\text{SO}_2]\) = 2.00 \(M\) \hspace{1cm} [\text{O}_2] = 2.00 \(M\) \hspace{1cm} [\text{SO}_3] = 5.00 \(M\)

To reestablish equilibrium, the concentration of \(\text{SO}_3\) in your friend’s tank will

a. decrease  
b. increase  
c. remain at 5.00 \(M\)

8. Consider a reaction of all gases (all reactants and products are gases) for which \(K = K_p\) at a given temperature. Is the following statement true or false?: Changing the volume at constant temperature will not shift the equilibrium position of the system.

a) False. There will be a shift because a change in volume at constant temperature always shifts the equilibrium position.
b) False. There will be a shift, but there would not be a shift if \(K \neq K_p\).
c) True. There is no shift because a change in volume at constant temperature never shifts the equilibrium position.
d) True. There is no shift, but there would be a shift if \(K \neq K_p\).

9, 10. Consider the endothermic reaction \(\text{H}_2(g) + \text{I}_2(g) \rightleftharpoons 2\text{HI}(g)\), for which \(K = 9.00\) at 425°C.

9. An equimolar (equal numbers of moles) mixture of reactants gives a concentration for \(\text{HI}(g)\) of 12.0 \(M\) at equilibrium. Determine the concentration of \(\text{H}_2(g)\) at equilibrium, at 425°C.

a) 3.00 \(M\)  
b) 4.00 \(M\)  
c) 6.00 \(M\)  
d) 9.00 \(M\)  
e) 12.0 \(M\)

10. Which of the following statements about the equilibrium is false?

a) Adding more \(\text{H}_2(g)\) increases the equilibrium constant.
b) Removing \(\text{HI}(g)\) as it forms forces the equilibrium to the right.
c) The value of \(K\) decreases as the system is cooled.
d) If the system is heated, the right side is favored.
e) If the pressure on the system is increased by changing the volume, the equilibrium position remains the same.