# Chapter 18 WS

**Rates, Le Chatelier, & $K_{eq}$**

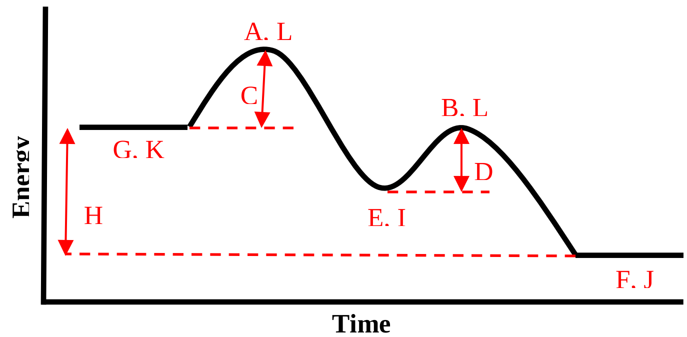
**Name: ________________________________**

**Period: _______ Date: ____________________**

**Answer each of the following questions. Be specific and thorough.**

1) According to Collision Theory, reactions will react to form products as long as they meet which requirements?
   a. Particles physically collide with one another within the system
   b. They have the minimum amount of energy required to convert into products

2) Label the 2-step reaction to the right with each of the following:
   a. Activated Complex #1
   b. Activated Complex #2
   c. Activation Energy #1
   d. Activation Energy #2
   e. Energy of Intermediates
   f. Energy of Products
   g. Energy of Reactants
   h. Energy of Reaction
   i. Intermediates
   j. Products
   k. Reactants
   l. Transition State




3) What are the factors that affect reaction rates and how do they speed up reactions?
   a. Temperature – Increases speed of particles, which causes more collisions and increases the energy of each collision within the system.
   b. Concentration – More particles means more frequent interactions, which increased the number of collisions within the system.
   c. Particle Size – Smaller particles have an increased surface area, allowing for more collisions between particles in less time.
   d. Catalyst – A catalyst lowers the activation energy requirement to convert reactants into products, which increases the efficiency of collisions that result in production of products.

4) What is a reversible reaction and how do we indicate that a reaction is reversible?
   A reaction in which Reactants turn into Products as well as Products turn into Reactions at the same time.
   We indicate a reversible reaction as a double-sided-arrow or a right and left arrow on top of one another.

5) At chemical equilibrium, there is no net change in the amounts of products or reactants, but you CANNOT say that there is no more reaction. Explain why there are still reactions occurring, yet no change can be observed.
   Reactants are ALWAYS being converted into products
   Products are ALWAYS being converted into reactants
   At equilibrium, both of these happen at the exact same rate, which means there is no net change that can be observed

6) What are the factors that affect equilibrium position and what are the rules for determining which direction those changes till push the equilibrium?
   a. Temperature – Increasing pushes away from heat within the equation, or to products for endothermic reactions and toward reactants for exothermic reactions.

   b. Concentration – Increasing concentration of any substance will push the equilibrium away from the substance, while decreasing concentration of any substance will push the equilibrium toward the substance.

   c. Pressure – Increasing pressure will push the equilibrium toward the side with less moles of gas, while decreasing the pressure will push the equilibrium toward the side with more moles of gas.

   d. Catalyst/Inhibitor – A catalyst will push the equilibrium toward the products, while and inhibitor will push the equilibrium toward the reactants.

7) For the reaction below, describe which way the equilibrium would shift and explain why.

$$CH_{4\,(g)} + 2H_2S_{(g)} + 232.6\ kJ \leftrightarrow CS_{2\,(g)} + 4H_{2\,(g)}$$

a. Decrease the concentration of dihydrogen sulfide
Toward Reactants (Left) – Decreasing a reactant pushes the equilibrium toward that substance

b. Increase the pressure on the system
Toward Reactants (Left) – Increasing Pressure pushes the equilibrium toward the side with less moles of gas. The reactants contain 3 moles of gas, while the products contain 5 moles of gas.

c. Increase the temperature of the system
Toward the Products (Right) – Endothermic reactions place heat as a reactant, which means increasing the temperature increases the heat, pushing it away from it.

d. Increase the concentration of carbon disulfide
Toward Reactants (Left) – Increasing a product pushes the equilibrium away from that substance

e. Increase the concentration of methane
Toward Products (Right) – Increasing a reactant pushes the equilibrium away from that substance

8) $N_{2\,(g)} + 3H_{2\,(g)} \leftrightarrow 2NH_{3\,(g)}$
At equilibrium, a 1 L flask has 0.15 mol $H_2$, 0.25 mol $N_2$, and 0.10 mol $NH_3$. Calculate the $K_{eq}$ for the reaction. Are the reactants or products favored?
In a 1 L flask, the concentrations will be equal to the number of moles (M = mol/1L)

$$K_{eq} = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{[0.10]^2}{[0.25][0.15]^3} = 11.9 \qquad K_{eq} > 1\ so\ the\ products\ are\ favored$$

9) $N_{2\,(g)} + O_{2\,(g)} \leftrightarrow 2NO_{(g)}$
At equilibrium, a 2 L flask has 1 mol $N_2$, 1 mol $O_2$, and 0.040 mol NO. Calculate the $K_{eq}$ for the reaction. Are the reactants or products favored?
In a 2 L flask, the concentrations will be half of the number of moles (M = mol/2L)

$$K_{eq} = \frac{[NO]^2}{[N_2][O_2]} = \frac{[0.020]^2}{[0.50][0.50]} = 0.0016 \qquad K_{eq} < 1\ so\ the\ reactants\ are\ favored$$

10) $2BrCl_{(g)} \leftrightarrow Br_{2\,(g)} + Cl_{2\,(g)}$
If the $K_{eq}$ is 11.1, what would be the concentrations of $Br_2$ and $Cl_2$ if the concentration of BrCl is 2.40 M?

$$K_{eq} = \frac{[Br_2][Cl_2]}{[BrCl]^2} \qquad 11.1 = \frac{x \cdot x}{[2.40]^2} \qquad x^2 = 64 \qquad \sqrt{x^2} = \sqrt{64} \qquad x = 8.00\ M$$

11) $4HCl_{(g)} + O_{2\,(g)} \leftrightarrow 2Cl_{2\,(g)} + 2H_2O_{(g)}$
If the $K_{eq}$ is 2.00, what would be the concentration of HCl if the concentration of $O_2$ is 2.25 M, the concentration of $Cl_2$ is 3.00 M, and concentration of water is 2.00 M?

$$K_{eq} = \frac{[Cl_2]^2[H_2O]^2}{[HCl]^4[O_2]} \qquad 2.00 = \frac{[3.00]^2[2.00]^2}{[x]^4[2.25]} \qquad x^4 = 8.00 \qquad \sqrt[4]{x^4} = \sqrt[4]{8.00} \qquad x = 1.68\ M$$