WKS
Equilibrium Constants

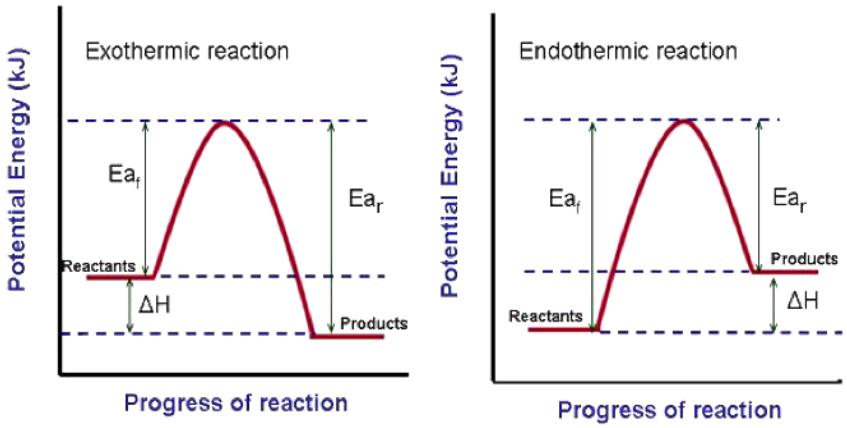
Name_____
Period _____Date_____

1) Explain what is incorrect about the following statements:
   a) At equilibrium no more reactants are transformed into products.

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

2) A flask contains a saturated aqueous NaCl solution that is in contact with 10.0 g of undissolved **NaCl powder**. The flask is stoppered and left undisturbed. A year later it is observed that the system contains a **single, large 10.0 g crystal of NaCl** in contact with the solution.
   *Explain how this observation can be used to support the notion that equilibrium is a **dynamic** process.*

3) Look at the two energy diagrams at the right (one is exothermic and the other is endothermic). Which reaction would favor reactants at equilibrium? Why?



4) Write the K_{eq} expressions for the following reactions. *Remember:* $K_{eq} = \frac{[\text{products}]}{[\text{reactants}]}$ *No numbers!!!*

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

   b) $2\,N_2O_5\,(g) \rightleftharpoons 4\,NO_2\,(g) + O_2\,(g)$

   c) $4\,H_3O^+\,(aq) + 2\,Cl^-\,(aq) + MnO_2\,(s) \rightleftharpoons Mn^{2+}\,(aq) + 6\,H_2O\,(l) + Cl_2\,(g)$

   d) $2\,PbO\,(s) + 3\,O_2\,(g) + C\,(s) \rightleftharpoons 2\,Pb\,(l) + CO_2\,(g) + 2\,SO_2\,(g)$

5) A system is described by the equation: $2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$
At equilibrium, the concentrations of reactants and products are as follows:
$[SO_2] = 0.75$ M $\quad [O_2] = 0.30$ M $\quad [SO_3] = 0.15$ M
Write the K_{eq} expression and then solve for the value of K_{eq} for this reaction.

6) A system is described by this equation: $PCl_5(g) \rightleftarrows PCl_3(g) + Cl_2(g)$
The equilibrium constant (K_{eq}) for this reaction is 0.0896
If at one equilibrium position, $[PCl_5] = 0.015$ M and $[PCl_3] = 0.78$, what must be the concentration of Cl_2?

"Q" Questions:

7) A vial contains 0.150 M NO_2 ad 0.300 M N_2O_4. Calculate Q for the reaction, $2\ NO_2(g) \rightleftharpoons N_2O_4(g)$.
HINT: Write the K_{eq} expression, but substitute "Q" for "K_{eq}". Then, put in numbers and solve for "Q".

8) A system is described by this equation: $COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$, where $K_{eq} = 2.19 \times 10^{-10}$
If the following concentrations are present, the system is not at equilibrium. Which direction must the reaction proceed to achieve equilibrium?
$[COCl_2] = 3.50 \times 10^{-3}$ M, $[CO] = 1.11 \times 10^{-5}$ M, AND $[Cl_2] = 1.56 \times 10^{-6}$ M
HINT: Write the K_{eq} expression, but substitute "Q" for "K_{eq}". Then, put in numbers and solve for "Q". Finally, compare your "Q" value with the given "K_{eq}" value.

9) At 448°C, $K_{eq} = 50.5$ for the reaction $H_2(g) + I_2(g) \rightleftharpoons 2\ HI(g)$
Solve for Q and predict how the reaction proceeds if $[H_2] = 0.150$ M, $[I_2] = 0.175$ M and $[HI] = 0.950$ M

Answers: 5) $K_{eq} = 0.13$; 6) $[Cl_2] = 0.0017$ M; 7) $Q = 13.3$; 8) $Q = 4.95 \times 10^{-9}$; 9) $Q = 34.4$