AP Chemistry

Name CALVIN

Period ___ Date ___/___/___

13 • Chemical Equilibria

PROBLEM SET #1

1. Consider the equilibrium: $2\ SO_2(g) + O_2(g) \leftrightarrows 2\ SO_3(g)$ $K_c = 4.36\ \underline{M}^{-1}$
   Calculate the value of "Q" for a situation in which the concentrations are $[SO_2] = 2.00\ \underline{M}$, $[O_2] = 1.50\ \underline{M}$, and $[SO_3] = 1.25\ \underline{M}$.

   $$Q = \frac{[SO_3]^2}{[SO_2]^2[O_2]} = \frac{(1.25M)^2}{(2.00M)^2(1.50M)} = \boxed{0.260\ M^{-1}}$$

   Does this mixture shift toward the reactants or products to reach equilibrium? ________________

2. Study the discussion in your textbook about converting K_c and K_p. Write the K_p expression for the reaction in question 1 and calculate its value at 0°C. Remember, R = 0.0821 L·atm/mol·K.

   OMIT

3. Consider the equilibrium $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$.
   How would the following changes affect the partial pressures of each gas at equilibrium?

	$PCl_3(g)$	$Cl_2(g)$		$PCl_5(g)$
a) addition of PCl_3	↑	↓	→	↑
b) removal of Cl_2	↑	↓	←	↓
c) removal of PCl_5	↓	↓	→	↓
d) decrease in the volume of the container	↓	↓	→	↑
e) addition of He without change in volume	–	–		–

4. How will each of the changes in question 3 affect the K_{eq}? (-=increase; ¯=decrease; ¾ = unchanged)

   a – b – c – d – e –

   Only temp. affects K

5. Indicate how each of the following changes affects the amount of each gas in the system below, for which $DH_{reaction}$ = +9.9 kcal.

	heat +	$H_2(g)$ + $CO_2(g)$		$H_2O(g)$	+ $CO(g)$
a) addition of CO_2	↓	↑	→	↑	↑
b) addition of H_2O	↑	↑	←	↑	↓
c) addition of a catalyst	–	–		–	–
d) increase in temperature	↓	↓	→	↑	↑
e) decrease in the volume of the container	–	–		–	–

6. How will each of the changes in question 5 affect the equilibrium constant?

   a – b – c – d ↑ e –

7. Consider the equilibrium: $2N_2O(g) + O_2(g) \rightleftharpoons 4NO(g)$
How will the amount of chemicals at equilibrium be affected by

	$2N_2O(g)$	$O_2(g)$	shift	$4NO(g)$
a) adding N_2O	↑	↓	→	↑
b) removing O_2	↑	↓	←	↓
c) increasing the volume of the container	↓	↓	→	↑
d) adding a catalyst	–	–		–

8. For the reaction, $4NH_3(g) + 3O_2(g) \rightleftharpoons 2N_2(g) + 6H_2O(l)$
How will the concentration of each chemical be affected by

	$4NH_3(g)$	$3O_2(g)$	shift	$2N_2(g)$	$6H_2O(l)$
a) adding O_2 to the system	↓	↑	→	↑	–
b) adding N_2 to the system	↑	↑	←	↑	–
c) removing H_2O from the system	–	–		–	–
d) decreasing the volume of the container	↓	↓	→	↑	–

9. Consider the equilibrium: $2N_2O(g) + O_2(g) \rightleftharpoons 4NO(g)$
3.00 moles of NO(g) are introduced into a 1.00-Liter evacuated flask. When the system comes to equilibrium, 1.00 mole of $N_2O(g)$ has formed. Determine the equilibrium concentrations of each substance. Calculate the K_c for the reaction based on these data.

	$2\ N_2O$	O_2	$4\ NO$
initial	0 M	0 M	3.00 M
change	+1.00 M	+0.50 M	−2.00 M
equilibrium	1.00 M	0.50 M	1.00 M

Remember: The "ice" table may be used with moles, molarity, or Liters (for gaseous equilibria)… never grams
Go Vikings!!.

$$K_c = \frac{[NO]^4}{[N_2O]^2[O_2]} = \frac{(1.00)^4}{(1.00)^2(.50)} = 2.0M$$