Dougherty Valley HS AP Chemistry
Equilibrium – Study Questions and Problems
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WORKSHEET #7

Name: **Date:** **Period:** **Seat #:**

1. Write the expressions for the equilibrium constant Kc for the following reactions:

a. $4\ NH_3(g) + 7\ O_2(g) \rightleftharpoons 4\ NO_2(g) + 6\ H_2O(l)$

b. $HCN\ (aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CN^-(aq)$

c. $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

d. $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$

e. $3\ O_2(g) \rightleftharpoons 2\ O_3(g)$

f. $2\ H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$

g. $3\ Zn(s) + 2\ Fe^{3+}(aq) \rightleftharpoons 2\ Fe(s) + 3\ Zn^{2+}(aq)$

2. Write the equilibrium constant expressions for the following reactions. How are they related to one another?

a. $2\ N_2O(g) + 3\ O_2(g) \rightleftharpoons 4\ NO_2(g)$

b. $N_2O(g) + 3/2\ O_2(g) \rightleftharpoons 2\ NO_2(g)$

c. $4\ NO_2(g) \rightleftharpoons 2\ N_2O(g) + 3\ O_2(g)$

3. Chlorine molecules will dissociate at high temperatures into chlorine atoms. At 3000°C for example Kc for the equilibrium shown is 0.55. If the partial pressure of chlorine molecules is 1.5 atm calculate the partial pressure of the chlorine atoms: (14.9 atm)

$Cl_2(g) \rightleftharpoons 2\ Cl(g)$

4. If the mechanism of a chemical equilibrium consists of two reversible elementary steps each with its own equilibrium constant K_{c1} and K_{c2} what expression relates the equilibrium constant Kc for the overall equilibrium to the two constants K_{c1} and K_{c2}?

5. 3.0 moles each of carbon monoxide hydrogen and carbon are placed in a 2.0 Liter vessel and allowed to come to equilibrium according to the equation: **$CO(g) + H_2(g) \rightleftharpoons C(s) + H_2O(g)$** If the equilibrium constant at the temperature of the experiment is 4.0 what is the equilibrium concentration of water vapor? (1.0)

6. Sulfuryl chloride decomposes at high temperatures to produce sulfur dioxide and chlorine gases:

$SO_2Cl_2(g) \rightleftharpoons SO_2(g) + Cl_2(g)$

At 375 °C, the equilibrium constant K_c is 0.045. If there are 2.0 grams of sulfuryl chloride, 0.17 gram of sulfur dioxide, and 0.19 gram of chlorine present in a 1.0 Liter flask,

a. What is the value of the reaction quotient? ($4.93E^{-4}$)

b. Is the system at equilibrium?

c. In which direction will the system move to reach equilibrium?

7. Bromine and chlorine react to produce bromine monochloride according to the equation. Kc = 36.0 under the conditions of the experiment. **$Br_2(g) + Cl_2(g) \rightleftharpoons 2\ BrCl(g)$**

If 0.180 moles of bromine gas and 0.180 moles of chlorine gas are introduced into a 3.0 Liter flask and allowed to come to equilibrium, what is the equilibrium concentration of the bromine monochloride? How much BrCl is produced?
(0.090M, 31 grams)

[8] The following reaction is exothermic:

$Ti(s) + 2\ Cl_2(g) \rightleftharpoons TiCl_4(g)$

List all the ways the yield of the product $TiCl_4$ could be increased.