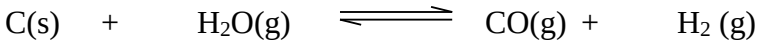
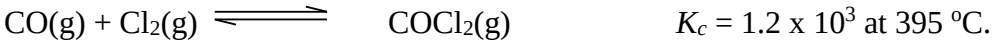
Equilibrium/Practice **Name:**_____

1) The reaction of steam and coke (a form of carbon) produces a mixture of carbon monoxide and hydrogen (water gas). The reaction is given below; write the K_c expression for the reaction.



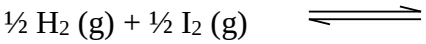
$$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$$

2) If the equilibrium concentrations of Cl_2 and $COCl_2$ are the same at 395 ^oC, find the equilibrium concentration of CO in the reaction shown below: (ans: 8.3×10^{-4}M)



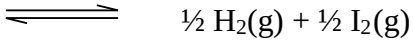
$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g) \qquad K_c = 1.2 \times 10^3 \text{ at } 395\ ^oC.$$

3) The equilibrium constant for the reaction given below is 7.07 at 718 K.



$$\tfrac{1}{2} H_2(g) + \tfrac{1}{2} I_2(g) \rightleftharpoons HI(g)$$

What is the K_c value at 718 K for the two reactions given below?

a) 

$$HI(g) \rightleftharpoons \tfrac{1}{2} H_2(g) + \tfrac{1}{2} I_2(g)$$

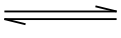
b) 

$$H_2 + I_2 \rightleftharpoons 2HI(g)$$

4) Consider the equilibrium between dinigrogen tetraoxide and nitrogen doxide:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad K_p = 0.660 \text{ at } 319 \text{ K}$$

a) What is the value of K_c for this reaction? (ans: 0.0252)

b) What is value of K_p for the reaction  $2NO_2(g) \rightleftharpoons N_2O_4(g)$ (ans: 1.52)

c) If the equilibrium partial pressure of NO_2 (g) is 0.332 atm, what is the equilibrium partial pressure of $N_2O_4(g)$? (ans:0.167 atm)

5) If a 2.50 L vessel at 1000 ^{o}C containes 0.525 mol CO_2, 1.25 mol CF_4, and 0.75 mol COF_2, in what direction will a net reaction occur to reach the equilibrium? (*P50* – ans: 0.857,left)

CO_2 (g) + CF_4 (g) $\rightleftharpoons$ 2COF_2 (g) K_c = 0.50 at 1000 K

6) In a 10.0 L vessel at 1000 K, 0.250 mol SO_2 and 0.200 mol O_2 react to from 0.162 mol SO_3 at equilibrium. What is the K_c, at 1000 K for the reaction shown below? (ans: 8.92 x 10^3)

2SO_2(g) + O_2 (g) $\rightleftharpoons$ 2SO_3 (g)

7) The following substances are added to a 7.25 L flask at 773 ^{o}C contains 0.103 mol CO, 0.205 mol H_2, 2.10 mol CH_4 and 3.15 mol H_2O. In what direction will a net reaction occur to reach the equilibrium? (*P51*; ans: 97-forward)

CO(g) + 3H_2 $\rightleftharpoons$ CH_4 + H_2O K_p = 102 at 773 K

8) Starting with 0.100 mol each of CO and H_2O in a 5.00 L flask, equilibrium is established in the following reaction at 600K:

$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$ $\quad K_c = 23.2$ at 600K

What is the concentration of hydrogen at equilibrium? (*P12A*; ans: 0.0165M)

9) Starting with 0.100 mol CO and 0.200 mol CO_2 in a 25.0 L flask, how many mols of $COCl_2$ will be present at equilibrium? (*P13A*; ans: 8.5×10^{-2}mol)

$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$ $\quad K_c = 1.2 \times 10^3$

10) The reaction between carbon monoxide and steam is given below.

$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$ $\Delta H = -41KJ$; $K_c = 9.03$ at 698 K

Using LeChatlier's principles predict which direction the equilibrium will proceed when the following changes are made.

a) Carbon monoxide is added

b) Carbon dioxide is removed

c) The reaction is heated up

d) The reaction vessel is compressed to half its volume

e) A catalyst is added

f) A 1 L of argon is added to the reaction vessel