CHEM 1423
Chapter 17
Homework Questions

TEXTBOOK HOMEWORK

17.29 At 425 ^oC, $K_p = 4.18 \times 10^{-9}$ for the reaction $2HBr(g) \rightleftharpoons H_2(g) + Br_2(g)$
In one experiment, 0.20 atm of HBr(g), 0.010 atm of $H_2(g)$, and 0.010 atm of $Br_2(g)$ are introduced into a container. Is the reaction at equilibrium? If not, in which direction will it proceed?

17.38 For the following reaction, $K_p = 6.5 \times 10^4$ at 308 K:
$2NO(g) + Cl_2(g) \rightleftharpoons 2NOCl(g)$
At equilibrium, $P_{NO} = 0.35$ atm and $P_{Cl2} = 0.10$ atm. What is the equilibrium partial pressure of NOCl(g)?

17.41 Hydrogen sulfide decomposes according to the following reaction, for which $K_c = 9.30 \times 10^{-8}$ at 700 ^oC: $2\ H_2S(g) \rightleftharpoons 2\ H_2(g) + S_2(g)$
If 0.45 mol of H_2S is placed in a 3.0-L container, what is the equilibrium concentration of $H_2(g)$ at 700 ^oC?
Note: Assume that very little H_2S dissociates.

17.44 In an analysis of interhalogen reactivity, 0.500 mol of ICl was placed in a 5.00 L flask, where it decomposed at a high T: $2\ ICl(g) \rightleftharpoons I_2(g) + Cl_2(g)$. Calculate the equilibrium concentrations of I_2, Cl_2, and ICl ($K_c = 0.110$ at this temperature).

17.46 The first step in HNO production is the catalyzed oxidation of NH_3. Without a catalyst, a different reaction predominates:

$4\ NH_3(g) + 3\ O_2(g) \rightleftharpoons 2\ N_2(g) + 6\ H_2O(g)$

When 0.0150 mol of $NH_3(g)$ and 0.0150 mol of $O_2(g)$ are placed in a 1.00 L container at a certain temperature, the N_2 concentration at equilibrium is 1.96×10^{-3} M. Calculate Kc.

17.47 A key step in the extraction of iron from its ore is
$FeO(s) + CO(g) \rightleftharpoons Fe(s) + CO_2(g)$ Kp = 0.403 at 1000 ºC
This step occurs in the 700 ºC to 1200 ºC zone within a blast furnace. What are the equilibrium partial pressures of CO(g) and $CO_2(g)$ when 1.00 atm of CO(g) and excess FeO(s) react in a sealed container at 1000 ºC?

17.56 Predict the effect of increasing the container volume on the amounts of each reactant and product in the following reactions:

(a) $F_2(g) \rightleftharpoons 2\ F(g)$

(b) $2\ CH_4(g) \rightleftharpoons C_2H_2(g) + 3\ H_2(g)$

17.61 Predict the effect of decreasing the temperature on the amounts of reactants in the following reactions:

(a) $C_2H_2(g) + H_2O(g) \rightleftharpoons CH_3CHO(g)$ $\Delta H^o_{rxn} = -151$ kJ

(b) $CH_3CH_2OH(l) + O_2(g) \rightleftharpoons CH_3CO_2H(l) + H_2O(g)$ $\Delta H^o_{rxn} = -451$ kJ

(c) $2\ C_2H_4(g) + O_2(g) \rightleftharpoons 2\ CH_3CHO(g)$ (exothermic)

(d) $N_2O_4(g) \rightleftharpoons 2\ NO_2(g)$ (endothermic)

SUPPLEMENTARY HOMEWORK

S1. If a catalyst is added to a chemical reaction, the equilibrium yield of a product will be_____, and the time taken to come to equilibrium will be _____than before.

a. higher; less
b. lower; the same
c. higher; the same
d. the same; less
e. lower; less

S2. Consider the reaction $NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$.

If an equilibrium mixture of these three substances is compressed, equilibrium will _____, because _____.

a. shift to the right; higher pressure favors fewer moles of gas
b. shift to the right; higher pressure favors more moles of gas
c. shift to the left; higher pressure favors fewer moles of gas
d. shift to the left; higher pressure favors more moles of gas
e. be unchanged; solid NH_4Cl does not appear in the equilibrium constant expression.

S3. An endothermic reaction which results in an increase in moles of gas will be most product-favored under conditions of _____ pressure and _____ temperature.

a. high; high
b. high; moderate
c. high; low
d. low; high
e. low; low

S4. Consider the equilibrium system $C(s) + CO_2(g) \rightleftharpoons 2CO(g)$.

If more C(s) is added, the equilibrium will ____; if CO is removed the equilibrium will ____.

a. shift to the left; shift to the left
b. shift to the right; shift to the right
c. shift to the right; shift to the left
d. be unchanged; shift to the left
e. be unchanged; shift to the right

S5. Consider the exothermic reaction at equilibrium:

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

If the system is cooled, the equilibrium will _____, because _____.

a. be unchanged; temperature has no effect on equilibrium
b. shift to the left; decreased temperature favors an exothermic reaction
c. shift to the right; decreased temperature favors an exothermic reaction
d. shift to the right; decreased temperature favors an endothermic reaction
e. shift to the left; decreased temperature favors an endothermic reaction

S6. Consider the equilibrium: $N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$. $\Delta H^o = -92.2$ kJ. Determine whether the ratio, $[NH_3]/[H_2]$ will increase, decrease, or remain the same for the following changes.

a. N_2 is added to the mixture at constant volume.

b. NO(g) is added to the mixture at constant volume.

c. NO(g) is added to the mixture at constant total pressure.

d. The volume of the container is halved.

e. The temperature is decreased.

S7. The equilibrium constant for the reaction $NO(g) + 1/2\ O_2(g) \rightleftharpoons NO_2(g)$ has a value of $K_c = 1.23$ at a certain temperature. What is the value of K_c for the reaction

$2\ NO_2(g) \rightleftharpoons 2\ NO(g) + O_2(g)$?

S8. The equilibrium constant for the reaction $4\ NO(g) + 2\ Br_2(g) \rightleftharpoons 4\ NOBr(g)$ has a value of $K_c = 39$ at a certain temperature. What is the value of K_c for the reaction

$2\ NOBr(g) \rightleftharpoons 2\ NO(g) + Br_2(g)$?

S9. For the reaction $N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$

$K_c = 0.060$ at a certain temperature. In an equilibrium mixture of the three gases, $[NH_3] = 0.24$ M and $[H_2] = 1.03$ M. What is the concentration of N_2 in this system?

S10. Consider the reaction, $Br_2(g) + 2\ NO(g) \rightleftharpoons 2\ NOBr(g)$.

A sample of pure NOBr is isolated at low temperature. It is placed in a flask at a concentration of 0.200 M and warmed up to 50°C. When the reaction has come to equilibrium, the concentration of NOBr is 0.176 M. What is the value of K_c at 50°C for this reaction?

S11. Consider the reaction, $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

The equilibrium constant, K_c, for this reaction is 10.0 at 420 °C and 45.0 at 300 °C.

a. Calculate the Enthalpy Change (ΔH^o) for this reaction (in kJ/mol).

b. Calculate the value of K_c for this reaction at 350 °C.

c. Calculate the temperature (in °C) at which the value of the equilibrium constant is 2.0

S12. Consider the gas phase equilibrium, $2\ A(g) \rightleftharpoons B(g) + 2\ C(g)$, $K_c = 800.$

2.0 mol of B(g) and 1.5 mol of C(g) are placed in a 5.0 L container and the mixture is allowed to come to equilibrium.

Calculate the concentration of A(g) at equlibrium.

NOTE: You can assume that very little B(g) and C(g) react to form A(g).

S13. Consider the aqueous solution equilibrium, A(aq) + 2 B(aq) $\rightleftharpoons$ 2 C(aq).
The product, C, has an absorption in the UV range of the spectrum at 320 nm, with a Molar Absorptivity, $\varepsilon = 15{,}500\ M^{-1}\ cm^{-1}$

A solution is prepared in a 0.50 cell with initial concentrations of A and B, $[A]_o = 4.00 \times 10^{-4}$ M and $[B]_o = 6.00 \times 10^{-4}$ M, and the solution is allowed to reach equilibrium. At equilibrium, the percent transmission is %T = 32.0%.

Calculate the equilibrium constant, K_c, for this reaction.