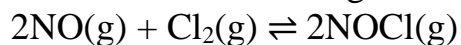


CHEM 1423
Chapter 17
Homework Questions

TEXTBOOK HOMEWORK

17.29 At 425 °C, $K_p = 4.18 \times 10^{-9}$ for the reaction $2\text{HBr}(g) \rightleftharpoons \text{H}_2(g) + \text{Br}_2(g)$. In one experiment, 0.20 atm of $\text{HBr}(g)$, 0.010 atm of $\text{H}_2(g)$, and 0.010 atm of $\text{Br}_2(g)$ 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:



At equilibrium, $P_{\text{NO}} = 0.35$ atm and $P_{\text{Cl}_2} = 0.10$ atm. What is the equilibrium partial pressure of $\text{NOCl}(g)$?

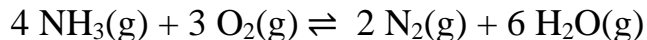
17.41 Hydrogen sulfide decomposes according to the following reaction, for which $K_c = 9.30 \times 10^{-8}$ at 700 °C: $2 \text{H}_2\text{S}(g) \rightleftharpoons 2 \text{H}_2(g) + \text{S}_2(g)$

If 0.45 mol of H_2S is placed in a 3.0-L container, what is the equilibrium concentration of $\text{H}_2(g)$ at 700 °C?

Note: Assume that very little H_2S dissociates.

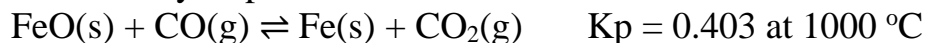
17.44 In an analysis of interhalogen reactivity, 0.500 mol of ICl was placed in a 5.00 L flask, where it decomposed at a high T: $2 \text{ICl}(g) \rightleftharpoons \text{I}_2(g) + \text{Cl}_2(g)$. Calculate the equilibrium concentrations of I_2 , Cl_2 , and ICl ($K_c = 0.110$ at this temperature).

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



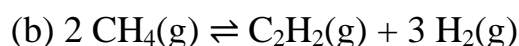
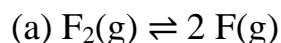
When 0.0150 mol of $\text{NH}_3(g)$ and 0.0150 mol of $\text{O}_2(g)$ are placed in a 1.00 L container at a certain temperature, the N_2 concentration at equilibrium is 1.96×10^{-3} M. Calculate K_c .

17.47 A key step in the extraction of iron from its ore is

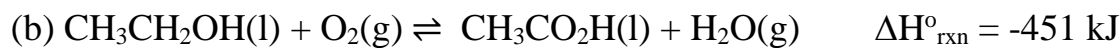
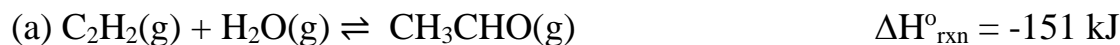


This step occurs in the 700 °C to 1200 °C zone within a blast furnace. What are the equilibrium partial pressures of CO(g) and CO₂(g) when 1.00 atm of CO(g) and excess FeO(s) react in a sealed container at 1000 °C?

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



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



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 $\text{NH}_4\text{Cl}(\text{s}) \rightleftharpoons \text{NH}_3(\text{g}) + \text{HCl}(\text{g})$.

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.

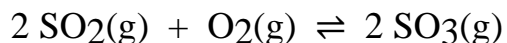
- a. high; high
- b. high; moderate
- c. high; low
- d. low; high
- e. low; low

S4. Consider the equilibrium system $\text{C}(\text{s}) + \text{CO}_2(\text{g}) \rightleftharpoons 2\text{CO}(\text{g})$.

If more $\text{C}(\text{s})$ 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:



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: $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$. $\Delta H^\circ = -92.2 \text{ kJ}$.

Determine whether the ratio, $[\text{NH}_3]/[\text{H}_2]$ will increase, decrease, or remain the same for the following changes.

- a. N_2 is added to the mixture at constant volume.
- b. $\text{NO}(\text{g})$ is added to the mixture at constant volume.
- c. $\text{NO}(\text{g})$ 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 $\text{NO}(\text{g}) + 1/2 \text{O}_2(\text{g}) \rightleftharpoons \text{NO}_2(\text{g})$

has a value of $K_C = 1.23$ at a certain temperature. What is the value of K_C for the reaction



S8. The equilibrium constant for the reaction $4 \text{NO}(\text{g}) + 2 \text{Br}_2(\text{g}) \rightleftharpoons 4 \text{NOBr}(\text{g})$ has a value of $K_C = 39$ at a certain temperature. What is the value of K_C for the reaction



S9. For the reaction $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$

$K_c = 0.060$ at a certain temperature. In an equilibrium mixture of the three gases, $[\text{NH}_3] = 0.24 \text{ M}$ and $[\text{H}_2] = 1.03 \text{ M}$. What is the concentration of N_2 in this system?

S10. Consider the reaction, $\text{Br}_2(\text{g}) + 2 \text{NO}(\text{g}) \rightleftharpoons 2 \text{NOBr}(\text{g})$.

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, $\text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}_2(\text{g}) + \text{H}_2(\text{g})$

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

- Calculate the Enthalpy Change (ΔH°) for this reaction (in kJ/mol).
- Calculate the value of K_c for this reaction at 350 °C.
- Calculate the temperature (in °C) at which the value of the equilibrium constant is 2.0

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

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 equilibrium.

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, $\epsilon = 15,500 \text{ M}^{-1} \text{ cm}^{-1}$

A solution is prepared in a 0.50 cell with initial concentrations of A and B,
 $[A]_o = 4.00 \times 10^{-4} \text{ M}$ and $[B]_o = 6.00 \times 10^{-4} \text{ M}$, 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.