Use enthalpies of combustion for C_2H_2 and CH_3CHO to compute the enthalpy of the above reaction.

$$C_2H_2(g) + 2O_2(g) \rightarrow 2CO_2(g) + H_2O(l)$$

$\Delta H = -1299.6$ kJ/mol

$$CH_3CHO(l) + 2O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$$

$\Delta H = -1166.9$ kJ/mol

495. Calculate the enthalpy for the combustion of decane. ΔH_f^0 for liquid decane is -300.9 kJ/mol.

$$C_{10}H_{22}(l) + 15O_2(g) \rightarrow 10CO_2(g) + 11H_2O(l)$$

496. Find the enthalpy of the reaction of magnesium oxide with hydrogen chloride:

$$MgO(s) + 2HCl(g) \rightarrow MgCl_2(s) + H_2O(l)$$

Use the following equations and data.

$$Mg(s) + 2HCl(g) \rightarrow MgCl_2(s) + H_2(g)$$

$\Delta H = -456.9$ kJ/mol

$$Mg(s) + O_2(g) \rightarrow MgO(s)$$

$\Delta H = -601.6$ kJ/mol

$$H_2O(l) \rightarrow H_2(g) + O_2(g)$$

$\Delta H = +285.8$ kJ/mol

497. What is the free energy change for the following reaction at 25°C?

$$2NaOH(s) + 2Na(s) \xrightarrow{\Delta} 2\,Na_2O(s) + H_2(g)$$

$\Delta S = 10.6$ J/mol•K $\qquad \Delta H^0_{f\,NaOH} = -425.9$ kJ/mol

498. The following equation represents the reaction between gaseous HCl and gaseous ammonia to form solid ammonium chloride:

$$NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$$

Calculate the entropy change in J/mol•K for the reaction of hydrogen chloride and ammonia at 25°C using the following data and the table following item 500.

$\Delta G = -91.2$ kJ/mol

499. The production of steel from iron involves the removal of many impurities in the iron ore. The following equations show some of the purifying reactions. Calculate the enthalpy for each reaction. Use the table following item 500 and the data given below.

a. $3C(s) + Fe_2O_3(s) \rightarrow 3CO(g) + 2Fe(s)$
$\Delta H^0_{f\,CO(g)} = -110.53$ kJ/mol

b. $3Mn(s) + Fe_2O_3(s) \rightarrow 3MnO(s) + 2Fe(s)$
$\Delta H^0_{f\,MnO(s)} = -384.9$ kJ/mol

c. $12P(s) + 10Fe_2O_3(s) \rightarrow 3P_4O_{10}(s) + 20Fe(s)$
$\Delta H^0_{f\,P_4O_{10}(s)} = -3009.9$ kJ/mol

d. $3Si(s) + 2Fe_2O_3(s) \rightarrow 3SiO_2(s) + 4Fe(s)$
$\Delta H^0_{f\,SiO_2(s)} = -910.9$ kJ/mol

e. $3S(s) + 2Fe_2O_3(s) \rightarrow 3SO_2(g) + 4Fe(s)$

For problems 498–499

Substance	ΔH_f^0 (kj/mol)	Substance	ΔH_f^0 (kj/mol)
$NH_3(g)$	−45.9	$HF(g)$	−273.3
$NH_4Cl(s)$	−314.4	$H_2O(g)$	−241.82
$NH_4F(s)$	−125	$H_2O(l)$	−285.8
$NH_4NO_3(s)$	−365.56	$H_2O_2(l)$	−187.8
$Br_2(l)$	0.00	$H_2SO_4(l)$	−813.989
$CaCO_3(s)$	−1207.6	$FeO(s)$	−825.5
$CaO(s)$	−634.9	$Fe_2O_3(s)$	−1118.4
$CH_4(g)$	−74.9	$MnO_2(s)$	−520.0
$C_3H_8(g)$	−104.7	$N_2O(g)$	+82.1
$CO_2(g)$	−393.5	$O_2(g)$	0.00
$F_2(g)$	0.00	$Na_2O(s)$	−414.2
$H_2(g)$	0.00	$Na_2SO_3(s)$	−1101
$HBr(g)$	−36.29	$SO_2(g)$	−296.8
$HCl(g)$	−92.3	$SO_3(g)$	−395.7

Equilibrium: Chap. 18, Sec. 1

500. Calculate the equilibrium constants for the following hypothetical reactions. Assume that all components of the reactions are gaseous.

a. $A \rightleftarrows C + D$

At equilibrium, the concentration of A is 2.24×10^{-2} M and the concentrations of both C and D are 6.41×10^{-3} M.

b. $A + B \rightleftarrows C + D$

At equilibrium, the concentrations of both A and B are 3.23×10^{-5} M and the concentrations of both C and D are 1.27×10^{-2} M.

c. $A + B \rightleftarrows 2C$

At equilibrium, the concentrations of both A and B are 7.02×10^{-3} M and the concentration of C is 2.16×10^{-2} M.

d. $2A \rightleftarrows 2C + D$

At equilibrium, the concentration of A is 6.59×10^{-4} M. The concentration of C is 4.06×10^{-3} M, and the concentration of D is 2.03×10^{-3} M.

e. $A + B \rightleftarrows C + D + E$

At equilibrium, the concentrations of both A and B are 3.73×10^{-4} M and the concentrations of C, D, and E are 9.35×10^{-4} M.

f. $2A + B \rightleftarrows 2C$

At equilibrium, the concentration of A is 5.50×10^{-3} M, the concentration of B is 2.25×10^{-3}, and the concentration of C is 1.02×10^{-2} M.

501. Calculate the concentration of product D in the following hypothetical reaction:

$$2A(g) \rightleftarrows 2C(g) + D(g)$$

At equilibrium, the concentration of A is 1.88×10^{-1} M, the concentration of C is 6.56 M, and the equilibrium constant is 2.403×10^2.

502. At a temperature of 700 K, the equilibrium constant is 3.164×10^3 for the following reaction system for the hydrogenation of ethene, C_2H_4, to ethane, C_2H_6:

$$C_2H_4(g) + H_2(g) \rightleftarrows C_2H_6(g)$$