Homework Thermodynamics

1. What is the change in internal energy of a system that absorbs 455 J of heat and does 325 J of work?

2. At high temperatures, water is decomposed to hydrogen and oxygen.

   $$H_2O(g) \longrightarrow H_2(g) + 1/2O_2(g)$$

   Decomposition of 10.0 g H_2O at constant pressure requires that 134 kJ of heat be absorbed by the system. Is the reaction endothermic or exothermic? What is the value of q for the reaction, per mole of water? Is the value of q equal to ΔU or ΔH? Explain.

3. Calcium oxide (lime) reacts with water to form calcium hydroxide (slaked lime).

   $$CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(s) \qquad \Delta H = -65.2 \text{ kJ}$$

   How many kilojoules of heat are evolved in the reaction of 0.500 kg CaO(s) with an excess of water?

4. A 48.7-g block of lead initially at 27.0 ^{O}C absorbs 93.5 J heat. What is the final temperature of the lead? (Specific heat of lead is 0.128 $Jg^{-1}\,{}^{O}C^{-1}$)

5. A 1.108-g sample of naphthalene, $C_{10}H_8(s)$, is burned in a bomb calorimeter assembly and a temperature increase of 5.92 ^{O}C is noted. When a 1.351-g sample of thymol, $C_{10}H_{14}O(s)$ (a preservative and mold and mildew inhibitor), is burned in the same bomb calorimeter assembly, the temperature increase is 6.74 ^{O}C. If the heat of combustion of naphthalene is –5153.5 kJ/mol $C_{10}H_8$, ehat is the heat of combustion of thymol, in kJ/mol $C_{10}H_{14}O$?

6. Use the following equations

   $$N_2(g) + 2O_2(g) \longrightarrow N_2O_4(g) \qquad \Delta H = +9.2 \text{ kJ}$$
   $$N_2(g) + 2O_2(g) \longrightarrow 2NO_2(g) \qquad \Delta H = +33.2 \text{ kJ}$$

   To calculate the enthalpy change for the reaction

   $$2NO_2(g) \longrightarrow N_2O_4(g) \qquad \Delta H = ?$$

7. When it undergoes complete combustion in oxygen, a 1.050-g sample of the industrial solvent, diethylene glycol, $C_4H_{10}O_3$, gives off 23.50 kJ of heat to the surroundings. Calculate the standard enthalpy of formation of liquid diethylene glycol. Assume that the initial reactants and the products of the combustion are at 25 ^{O}C and 1 atm pressure. (ΔH_f^o $CO_2(g)$ = -393.5 kJ/mol, $H_2O(g)$ = -241.8 kJ/mol and $H_2O(l)$ = -285.8 kJ/mol)

8. Estimate the normal boiling point of heptane, C_7H_{16} ($\Delta S^o_{vap} \approx 87 \, J/mol \cdot K$), given that at this temperature ΔH^o_{vap} = 31.69 kJ/mol.

9. The normal boiling point of 1-butanol, $CH_3(CH_2)_2CH_2OH(l)$, is 117.8 ^{O}C.

$CH_3(CH_2)_2CH_2OH(l, 1\ atm) \rightleftharpoons CH_3(CH_2)_2CH_2OH(g, 1atm) \quad \Delta H^{O} = 43.82\ kJ$

Calculate the boiling point of 1-butanol when the barometric pressure is 747 mmHg.