REVIEW QUESTIONS
Chapter 6

1. What is the change in internal energy (in J) of a system that releases 575 J of heat to its surroundings and has 425 cal of work done on it?

2. If an athlete expends 1700 kJ/h playing tennis, how long would she have to play to work off 1.0 lb of body fat? (One pound of body fat is equivalent to 4100 nutritional Calories)

3. A 27.7 g sample of ethylene glycol, a car radiator coolant, absorbs 588 J of heat from the car engine. What is the initial temperature of the engine, if its final temperature is 30.5°C? (C_s of ethylene glycol = 2.42 J/g°C)

4. When 155 mL of water at 20.0°C is mixed with 75.0 mL of water at 80.0°C, what is the final temperature? (Assume specific heat of hot and cold water are the same, and density of water = 1.00 g/mL)

5. A 1.500-g sample of a hydrocarbon is placed in a bomb calorimeter and undergoes combustion. The temperature of the calorimeter rises from 20.00°C to 23.55°C. If the calorimeter has a heat capacity of 40.3 J/°C, what is the heat of combustion (q_v) for this hydrocarbon in kJ/g?

6. The heat of sublimation for iodine is 62.4 kJ/mol, at 25°C and 1.00 atm. What is ΔE for the sublimation of iodine (shown below) under these conditions?

$$I_2\,(s) \rightleftharpoons I_2\,(g)$$

7. A bomb calorimeter with heat capacity of 1.500×10^3 J/°C was used to study combustion of terbium (Tb) in excess oxygen:

$$4\,Tb\,(s) + 3\,O_2\,(g) \rightarrow 2\,Tb_2O_3\,(s)$$

When 1.000-g of terbium was burned, a temperature increase of 3.908°C was observed. What is the ΔE for the reaction, in kJ/mol of Tb_2O_3?

8. One mole of nitrogen gas confined in a cylinder with a piston is heated from 0°C to 819°C at 1.00 atm.
   a) Calculate the work of expansion in Joules.

   b) What would have been the temperature change if the gas had been heated with the same amount of energy in a container of fixed volume. (Assume the specific heat of N_2 is 1.00 J/g°C)

9. How many kJ of heat is produced when 5.00 g of Al reacts with excess chlorine, as shown below:

$$2\ Al\ (s)\ +\ 3\ Cl_2\ (g)\ \rightarrow\ 2\ AlCl_3\ (s) \qquad \Delta H = -1408\ kJ$$

10. Consider the following reaction:

$$2\ N_2\ (g) + O_2\ (g)\ \rightarrow\ 2\ NO_2\ (g) \qquad \Delta H = +163.2\ kJ$$

   a) How many grams of N_2 must react to produce an enthalpy change of 5.00 kJ?

   b) How much heat is transferred when 25.0 g of NO_2 is produced in this reaction?

11. When 6.50 g of solid NaOH is dissolved in 100.0 g of water in a calorimeter, the temperature rises from 21.6 °C to 37.8 °C. Calculate the change in enthalpy of solution in kJ/mol of NaOH. Assume specific heat of solution is the same as water.

12. When 1.025 g of naphthalene ($C_{10}H_8$) is burned in a bomb calorimeter, the temperature rises from 24.25°C to 32.33°C. Find ΔE_{rxn} for combustion of naphthalene in kJ/mol. Heat capacity of the calorimeter is 5.11 kJ/°C.

13. When 10.0 g of phosphorus is burned in oxygen gas to form solid P_4O_{10}, enough heat is generated to raise the temperature of 2960 g of water from 18.0°C to 38.0°C. Calculate the enthalpy of formation of solid P_4O_{10} under these conditions.

14. Calculate the enthalpy change for the reaction below:

$$C_2H_4\,(g) + 6\,F_2\,(g) \rightarrow 2\,CF_4\,(g) + 4\,HF\,(g) \qquad \Delta H^0 = ???$$

based on the following reactions:

$$H_2\,(g) + F_2\,(g) \rightarrow 2\,HF\,(g) \qquad \Delta H = -537\ kJ$$
$$C\,(s) + 2\,F_2\,(g) \rightarrow CF_4\,(g) \qquad \Delta H = -680\ kJ$$
$$2\,C\,(s) + 2\,H_2\,(g) \rightarrow C_2H_4\,(g) \qquad \Delta H = +52.3\ kJ$$

15. Determine the enthalpy change for the reaction below:

$$C\,(s) + H_2O\,(g) \rightarrow CO\,(g) + H_2\,(g) \qquad \Delta H = ???$$

based on the following reactions:

$$C\,(s) + O_2\,(g) \rightarrow CO_2\,(g) \qquad \Delta H = -393.5\ kJ$$
$$2\,CO\,(g) + O_2\,(g) \rightarrow 2\,CO_2\,(g) \qquad \Delta H = -566.0\ kJ$$
$$2\,H_2\,(g) + O_2\,(g) \rightarrow 2\,H_2O\,(g) \qquad \Delta H = -483.6\ kJ$$

16. Use enthalpies of formation given to determine the standard enthalpy of reaction for the following:

	$2\ Al\ (s)$	+	$Fe_2O_3\ (s)$	→	$Al_2O_3\ (s)$	+	$2\ Fe$	$\Delta H° = ???$
$\Delta H°_f$ (kJ/mol)	0		–825.5		–1676		0	

17. Use the enthalpies of formation and the enthalpy of reaction given below to determine the enthalpy of formation for solid CaC_2.

	$CaC_2\ (s)$	+	$2\ H_2O\ (l)$	→	$Ca(OH)_2\ (s)$	+	$C_2H_2\ (g)$	$\Delta H° = –127$ kJ
$\Delta H°_f$ (kJ/mol)	???		–286		–986		+227	

18. The heat of vaporization of a liquid (ΔH_{vap}) is the heat required to vaporize 1.00 g of a liquid. In one experiment, 60.0 g of liquid nitrogen (b.p. –196 °C) are poured into a Styrofoam cup containing 200. g of water at 55.3 °C. Calculate the molar heat of vaporization of liquid nitrogen if the final temperature of the water is 41.0 °C.

19. Ice at 0 °C is placed in a Styrofoam cup containing 361 g of a soft drink at 23.0 °C. Some ice remains after the ice and the soft drink reach an equilibrium temperature of 0 °C. Determine the mass of the ice that has melted. Assume the specific heat of the drink to be the same as pure water. (It requires 334 J of heat to melt 1 g of ice at 0 °C)

20. A quantity of 200. mL of 0.862 M HCl is mixed with 200. mL of 0.431 M $Ba(OH)_2$ in a Styrofoam cup. The initial temperature of both solutions is 20.48 °C. Calculate the heat of neutralization in kJ/mol if the final temperature of the solution is 26.30°C. Assume specific heat and density of solution to be the same as water.

21. Determine the enthalpy change for the reaction below:

$$2\ XO_2\ (s)\ +\ CO\ (g)\ \rightarrow\ X_2O_3\ (s)\ +\ CO_2\ (g) \qquad \Delta H=???$$

based on the following reactions:

$$XO_2\ (s)\ +\ CO\ (g)\ \rightarrow\ XO\ (s)\ +\ CO_2\ (g) \qquad \Delta H=-26.8\ kJ$$

$$X_3O_4\ (s)\ +\ CO\ (g)\ \rightarrow\ 3\ XO\ (s)\ +\ CO_2\ (g) \qquad \Delta H=+7.3\ kJ$$

$$3\ X_2O_3\ (s)\ +\ CO\ (g)\ \rightarrow\ 2\ X_3O_4\ (s)\ +\ CO_2\ (g) \qquad \Delta H=-10.6\ kJ$$