CHAPTER 0

ENERGY AND TEMPERATURE

0.1 Answer the following questions: (a) What is the name of the energy associated with the motion of particles in a substance? (b) What is the name of the energy stored in heigh?

0.2 Discuss the changes in potential and kinetic energy in the following scenarios: (a) When water falls down a waterfall (b) When a person throughs away an object high up in the air

0.3 Indicate whether the following statement describes kinetic or potential energy: (a) Water on top of a waterfall (b) Hitting a wall with a hammer

0.4 Indicate whether the following statement describes kinetic or potential energy: (a) a car moving in the road (b) Water on the bottom of a waterfall

0.5 Carry the following conversions: (a) 100°C to K (b) 200°F to K (c) 500K to °F

0.6 Carry the following conversions: (a) 20°C to °F (b) 300K to °C (c) 41°F to °C

0.7 Carry the following conversions: (a) 100 Cal into kcal (b) 10000 cal into J (c) 4565J into Cal

0.8 Carry the following conversions: (a) 650J into calories (b) 50 kcal into Cal (c) 3.25 kcal into joules

FROM ENERGY TO TEMPERATURE

0.9 A 50g piece of aluminum ($c_e = 0.214 \frac{cal}{g°C}$) initially at 25°C absorbs 100cal. Calculate the final temperature of the aluminum piece.

0.10 A 200g piece of iron ($c_e = 0.1 \frac{cal}{g°C}$) initially at 15°C absorbs 1000cal. Calculate the final temperature of the metal piece.

0.11 How many calories are required to raise the temperature of a 35 g sample of iron from 25°C to 35°C? Iron has a specific heat of $0.108 \frac{cal}{g°C}$.

0.12 What is the final temperature of a 35 g sample of iron at 25°C after receiving 50cal? Iron has a specific heat of $0.108 \frac{cal}{g°C}$.

0.13 What is the initial temperature of a 50 g sample of aluminum that after receiving 50cal reaches a temperature of 50°C? Al has a specific heat of $0.2 \frac{cal}{g°C}$.

0.14 What is the specific heat of a metal if a 100 g sample at 25°C warms up until 50°C after receiving 100cal?

THE FIRST LAW OF THEMRODYNAMICS

0.15 A sample of gas expands from 3 to 4 L at constant pressure. Using $1L \cdot atm = 101.3J$, calculate the work done in J under the following conditions: (a) The gas expands against the vacuum. (b) The gas expands against a constant pressure of 5atm

0.16 A sample of gas expands carrying out 120J of work to its surroundings while absorbing 150J of heat also from its surroundings. Calculate the change of the internal energy of the system in J.

CALORIMETRY

0.17 A 3 moles sample of C(s) is burned in a constant-volume calorimeter containing 40g of water. The temperature inside the calorimeter increases from 25.0°C to 25.89 °C. The calorimeter constant is 9.90 $\frac{kJ}{°C}$. Calculate the molar heat of the reaction.

0.18 A 10 grams sample of fructose (MW=180g/mol) is burned in a constant-volume calorimeter containing 50g of water. The temperature inside the calorimeter increases 7°C . The calorimeter constant is 10.8 $\frac{kJ}{°C}$. Calculate the molar heat of the reaction.

0.19 When a 0.09-g sample of trinitrotoluene (TNT, MW=213g/mol), is burned in a bomb calorimeter, the temperature increases from 23.5 °C to 27.1°C. The heat capacity of the calorimeter is 400 $\frac{J}{°C}$, and it contains 100 mL of water. Calculate the molar heat of the reaction. Remember that the density of water is 1g/mL.

0.20 We mix 50mL of 2M HCl with 100mL of 1.5M NaOH in a coffee-cup calorimeter. Both solutions are initially at 20°C. Calculate the final temperature of the solution in the calorimeter considering that the specific heat of the mixture is $4.184\frac{J}{g^\circ C}$ and the density of the solution is 1g/mL. The molar heat of the reaction is -56kJ/mol.

0.21 A potato contains 20 g of carbohydrate. If carbohydrate has a caloric value of 4 $kcal/g$, how many kcal are obtained from the carbohydrate in the potato?

0.22 A diet has a total caloric intake of 1400 kcal. The diet consists of 50.% carbohydrate, 35% protein, and 15% fat. The number of kcal of protein in the diet is

0.23 A serving of fish contains 50 g of protein and 4 g of fat. If protein has a caloric value of 4.0 $kcal/g$ and fat has 9 $kcal/g$, how many kcal are in the serving?

ENTHALPY

0.24 Identify the following reaction as endothermic or exothermic.

$$C_6H_{12}O_6(s) + 6\,O_{2(g)} \longrightarrow 6\,CO_{2(g)} + 6\,H_2O_{(g)} \qquad \Delta H_R^\circ = -2800KJ/mol$$

0.25 Identify the following reaction as endothermic or exothermic.

$$B_2O_3(s) + 3\,H_2O_{(g)} \longrightarrow 3\,O_{2(g)} + B_2H_{6(g)} \qquad \Delta H_R^\circ = 2035KJ/mol$$

0.26 For the following reaction:

$$C_6H_{12}O_6(s) + 6\,O_{2(g)} \longrightarrow 6\,CO_{2(g)} + 6\,H_2O_{(g)} \qquad \Delta H_R^\circ = -2800KJ/mol$$

Fill the conversion factor:

$$\frac{\text{\_\_\_\_\_ moles of } O_2}{\text{-2800 KJ}}$$

0.27 In the following combustion reaction:

$$C_6H_{12}O_6(s) + 6\,O_{2(g)} \longrightarrow 6\,CO_{2(g)} + 6\,H_2O_{(g)} \qquad \Delta H_R^\circ = -2800KJ/mol$$

glucose ($C_6H_{12}O_6$) burns to produce carbon dioxide and water. Calculate the heat involved in the combustion of 3 moles of glucose.

0.28 Calculate the enthalpy of reaction for:

$$2\,OF_{2(g)} \longrightarrow O_{2(g)} + 2\,F_{2(g)}$$

given:

$$\Delta H_f^\circ(OF_{2(g)}) = 24.5KJ$$

0.29 Calculate the enthalpy of reaction for:

$$2\,ClF_{(g)} + O_{2(g)} \longrightarrow Cl_2O_{(g)} + OF_{2(g)}$$

given:

$$\Delta H_f^\circ(ClF_{(g)}) = -56KJ$$
$$\Delta H_f^\circ(Cl_2O_{(g)}) = 88KJ$$
$$\Delta H_f^\circ(OF_{2(g)}) = 25KJ$$

0.30 Calculate the enthalpy of reaction for:

$$ClF_{3(g)} + O_{2(g)} \longrightarrow Cl_2O_{(g)} + \tfrac{3}{2}\,OF_{2(g)}$$

given:

$$\Delta H_f^\circ(ClF_{3(g)}) = -156KJ$$
$$\Delta H_f^\circ(Cl_2O_{(g)}) = 88KJ$$
$$\Delta H_f^\circ(OF_{2(g)}) = 25KJ$$

HESS'S LAW

0.31 Using the following reactions:

$$2\,OF_{2(g)} \longrightarrow O_{2(g)} + 2\,F_{2(g)} \qquad \Delta H_1 = -49KJ$$
$$2\,ClF_{(g)} + O_{2(g)} \longrightarrow Cl_2O_{(g)} + OF_{2(g)} \qquad \Delta H_2 = 225KJ$$
$$ClF_{3(g)} + O_{2(g)} \longrightarrow \tfrac{1}{2}\,Cl_2O_{(g)} + \tfrac{3}{2}\,OF_{2(g)} \qquad \Delta H_3 = 324KJ$$

Determine the enthalpy change for:

$$ClF_{(g)} + F_{2(g)} \longrightarrow ClF_{3(g)}$$

0.32 Using the following reactions:

$$N_{2(g)} + 3\,H_{2(g)} \longrightarrow 2\,NH_{3(g)} \qquad \Delta H_1 = -92KJ$$
$$C(s) + 2\,H_{2(g)} \longrightarrow CH_{4(g)} \qquad \Delta H_2 = -75KJ$$
$$H_{2(g)} + 2\,C(s) + N_{2(g)} \longrightarrow 2\,HCN_{(g)} \qquad \Delta H_3 = 270KJ$$

Determine the enthalpy change for:

$$CH_{4(g)} + NH_{3(g)} \longrightarrow HCN_{(g)} + 3\,H_{2(g)}$$

0.33 Using the following reactions:

$$3\,C(s) + 3\,H_{2(g)} + \tfrac{1}{2}\,O_{2(g)} \longrightarrow C_3H_6O_{(l)} \qquad \Delta H_1 = -285KJ$$

$$C(s) + O_{2(g)} \longrightarrow CO_{2(g)} \qquad \Delta H_2 = -394KJ$$

$$H_{2(g)} + \tfrac{1}{2}\,O_{2(g)} \longrightarrow H_2O_{(l)} \qquad \Delta H_3 = -286KJ$$

Determine the enthalpy change for:

$$C_3H_6O_{(l)} + 4\,O_{2(g)} \longrightarrow 3\,CO_{2(g)} + 3\,H_2O_{(l)}$$

0.34 Using the following reactions:

$$2\,C_2H_6 + 7\,O_2 \longrightarrow 4\,CO_2 + 6\,H_2O \qquad \Delta H_1 = -3120KJ$$

$$2\,H_2 + O_2 \longrightarrow 2\,H_2O \qquad \Delta H_2 = -479KJ$$

$$2\,CO + O_2 \longrightarrow 2\,CO_2 \qquad \Delta H_3 = -566KJ$$

Determine the enthalpy change for:

$$C_2H_6 + O_2 \longrightarrow 3\,H_2 + 2\,CO$$