**In-Class Assignment/Exercise** *with solutions*

**Thermochemistry**

***Declaration*:** This set of questions has been adapted for a science-major General Chemistry course from Chemistry: Atom First ([Openstax](https://openstax.org/)) and its supporting information .

**Time: 60 minutes**

Report the results with the correct number of significant figures and show your calculations to receive full credit.

Student Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. How much heat, in joules and in calories, must be added to a 75.0‑g iron block with a specific heat of 0.449 J/g °C to increase its temperature from 25 °C to its melting temperature of 1535 °C?

Solution:

*q* = *cp m* Δ*T*; *q* = 0.449 J/g °C × 75.0 g × (1535 – 25) °C= 5.08 × 104 J;

the conversion is 4.184 J = 1 cal;

1. How much will the temperature of a cup (180 g) of coffee at 95 °C be reduced when a 45‑g silver spoon (specific heat 0.24 J/g °C) at 25 °C is placed in the coffee and the two are allowed to reach the same temperature? Assume that the coffee has the same density and specific heat as water.

Solution:

Because of the law of conservation of energy, we write:

*q*spoon + *q*coffee = 0; *q*spoon = –*q*coffee

*c*spoon × *m*spoon × Δ*T* = –*c*coffee × *m*coffee × Δ*T*

0.24 J/g °C × 45 g × (*T*f – 25 °C) = 4.184 J/g °C × 180 g × (*T*f – 95 °C)

10.8*T*f – 270 = –753.1*T*f + 71546.4

763.9 *T*f = 71816.4

*T*f = 94 °C.

The temperature of the coffee will drop 1 degree.

1. How much heat is produced when 100 mL of 0.250 *M* HCl (density, 1.00 g/mL) and 200 mL of 0.150 *M* NaOH (density, 1.00 g/mL) are mixed?



If both solutions are at the same temperature and the heat capacity of the products is 4.19 J/g °C, how much will the temperature increase? What assumption did you make in your calculation?

Solution

*for HCl: 0.100 L × 0.250 M = 0.0250 mol;*

*for NaOH, 0.200 L × 0.150 M = 0.0300 mol;*

*Only a total of 0.0250 mol of NaCl can be produced. To find the heat produced, multiply the moles of product times the heat produced per mole:*

*0.0250 mol × 58 kJ/mol = 1.5 kJ.*

*This solution assumes that ΔH° is not different from ΔH under the conditions of the reaction (1 °C temperature increase and assuming volumes are additive).*

*Assuming the overall mass of the final system is approximately 300 g, the increase of temperature will be .*

1. Joseph Priestly prepared oxygen in 1774 by heating red mercury(II) oxide with sunlight focused through a lens. How much heat is required to decompose exactly 1 mole of red HgO(*s*) to Hg(*l*) and O2(*g*) under standard conditions?

Solution

*The reaction  under standard state conditions is the reverse of the reaction that forms 1 mol HgO(s) from the elements in their most stable states under standard state conditions.*

*Thus,.*

1. Using the data in Appendix G, calculate the standard enthalpy change for each of the following reactions:

(a) 

(b) 

(c) 

(d) 

Solution

*(a)*

*;*

*(b) ;*

*(c) ;*

*(d) *

Describe the following terms:

1. The first law of thermodynamic:   
   Several (equivalent) statements can describe the first law of thermodynamic:
   1. *The internal energy of an isolated system is constant;*
   2. *The internal energy of a closed system changes through heat flow into or out of the system or work done on or by the system.*
   3. *The perpetual motion of first kind are impossible, i.e. a machine cannot perform work indefinitely without an energy source.*
2. internal energy and variation of internal energy:
   1. *internal energy is the sum of the potential energy and kinetic energy of the atoms, molecules, or ions that constitute the system. It is a state function.  
      Internal potential energy includes, but it is not limited to, the energy of the chemical bonds, molecule-molecule interaction, the energy that hold together the subatomic particles in atoms, etc…  
      Internal kinetic energy is the sum of the energy due the motions of all the system's particles with respect to the center-of-mass of the system its self: transitional movement of the molecules, vibrations between molecules hold together by molecule-molecule interaction. etc…  
      U does not include kinetic energy due to the motion of the system as a whole and potential energy due the location of the system.   
      The internal energy of a closed system changes through heat flow into or out of the system or work done on or by the system. In a physical or chemical change occurring at constant volume, the variation of internal energy is equal to the amount of heat that the system exchange with the surroundings*
3. enthalpy and variation of enthalpy:
   1. *enthalpy is defined as the sum of a system’s internal energy and the mathematical product of its pressure and volume. It represents the internal energy of a system minus the amount of work that the system can perform/exchange by expansion/compression. It is a state function.*
   2. *In a physical or chemical change occurring at constant pressure, the variation of enthalpy is equal to the amount of heat that the system exchange with the surroundings*