CHE1031 Lecture 8 examples: Thermochemistry

8.1: Energy basics

1. You push a watermelon off out of a third-floor window. How is energy transferred or transformed?

2. Calculate the heat capacity of two cast-iron frying pans, one large and one small. The temperature of each pan is increased by 50 degrees. That requires an input of 18,150 J of energy for the small pan, and 90,700 J for the large pan.

3. Calculate the specific heat of two cast-iron frying pans, one large and one small. The temperature of each pan is increased by 50 degrees. That requires an input of 18,150 J of energy for the small pan, and 90,700 J for the large pan. The mass of the small pan is 808 g and the large pan is 4040 g.

4. A flask containing 8.0 E2 g of water is heated and the temperature of the water increases from 21 to 85°C. How much heat was used?

5. A piece of metal has a mass of 348 g and absorbs 6.64 kJ of heat as its temperature increases from 22.4 to 43.6°C. Calculate the specific heat of the metal and try to identify it.

6. A piece of metal weighs 217 g and absorbs 1.43 kJ of heat. Its temperature increases from 24.5 to 39.1°C. Calculate the metal's specific heat.

7. A solar power plant stores energy overnight by melting salt: a mixture of sodium nitrate and potassium nitrate. If one ton of this salt, with a heat capacity of 1.53 J/g-°C, is heated from 260 to 550°C, how much energy can be stored?

8.2: Calorimetry

8. A 360-g piece of steel rebar is dropped into 425 mL of water at 24°C. Water temperature increased to 42.7°C. The specific heat of iron is 0.449 J/g-°C. What was the initial temperature of the rebar?

9. A 59.7-g piece of metal was submerged in boiling water and then quickly transferred into 60.0 mL of water whose Initial temperature was 22.0C. The final temperature is 28.5C. What is the specific heat of the metal? Its identity?

10. When 50.0 mL of 1.00 M HCl and 50.0 mL of 1.00 M NaOH, both at initial temperatures of 22.0C, are mixed in a calorimeter, the temperature of the solution increases to 28.9C. How much heat is produced by the reaction?

11. When 3.00 g of KCl is added to 3.00 E2 g of water in a calorimeter, the temperature decreased by 1.05°C. How much heat is involved in dissolution of KCl?

8.3: Enthalpy

12. How much energy is produced when 28.5 g of water are made?

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286$ kJ

13. When 0.0500 mol of HCl reacts with 0.0500 mol of NaOH to form 0.0500 mol of NaCl, 2.9 kJ of heat are produced.What is ΔH per mole of acid?

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

14. When 1.34 g of Zn reacts with 60.0 ml of 0.750 M HCl, 3.14 kJ of heat are produced. Determine the enthalpy change per mole of Zn:

$Zn(s) + HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

15. Use reactions 1-3 to calculate the enthalpy for this reaction:

$ClF(g) + F_2(g) \rightarrow ClF_3(g)$	ΔH = ______
(1) $2OF_2(g) \rightarrow O_2(g) + 2F_2(g)$	ΔH = - 49.4 kJ
(2) $2ClF(g) + O_2(g) \rightarrow Cl_2O(g) + OF_2(g)$	ΔH = +205.6 kJ
(3) $ClF_3(g) + O_2(g) \rightarrow 1/2Cl_2O(g) + 3/2OF_2(g)$	ΔH = +266.7 kJ

16. Aluminum chloride can be formed from its elements:

$2Al(s) + 3Cl_2(g) \rightarrow 2AlCl_3(s)$	$\Delta H =$ _______
(1) $HCl(g) \rightarrow HCl(aq)$	$\Delta H = -74.8$ kJ
(2) $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$	$\Delta H = -185.0$ kJ
(3) $AlCl_3(aq) \rightarrow AlCl_3(s)$	$\Delta H = +323$ kJ
(4) $2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2(g)$	$\Delta H = -1049$ kJ