A student is given the task of determining the enthalpy of reaction for the reaction between HCl(aq) and NaOH(aq).

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| Glassware Items | Precision |
| 250 mL Erlenmeyer flasks | ± 25 mL |
| 100 mL beakers | ± 10 mL |
| 100 mL graduated cylinders | ± 0.1 mL |

The following materials are available. *2013 practice #2*

1.00 M HCl(aq) 1.00 M NaOH(aq) distilled water

2.00 M HCl(aq) 2.00 M NaOH(aq) goggles insulated cups with covers gloves thermometer (± 0.1°C)

stirring rod lab coat

The student may select from the glassware listed in the table:

a) The student selects two 100 mL beakers, uses them to measure 50 mL each of 1.00 M HCl(aq) solution and 1.00 M NaOH(aq) solution, and measures an initial temperature of 24.5°C for each solution. Then the student pours the two solutions into an insulated cup, stirs the mixture, covers the cup, and records a maximum temperature of 29.9°C.

(i) Is the experimental design sufficient to determine the enthalpy of reaction to a precision of two significant figures? Justify your answer. *(1pt)*

(ii) List two specific changes to the experiment that will allow the student to determine the enthalpy of reaction to a precision of three significant figures. Explain. *(2pts)*

b) A second student is given two solutions, 75.0 mL of 1.00 M HCl and 75.0 mL of 1.00 M NaOH, each at 25.0°C. The student pours the solutions into an insulated cup, stirs the mixture, covers the cup, and records the maximum temperature of the mixture.

(i) The student calculates the amount of heat evolved in the experiment to be 4.1 kJ.

Calculate the student’s experimental value for the enthalpy of reaction, in kJ/mol*rxn*. *(2pts)*

(ii) The student assumes that the thermometer and the calorimeter do not absorb energy during the reaction. Does this assumption result in a calculated value of the enthalpy of reaction that is higher than, lower than, or the same as it would have been had the heat capacities of the thermometer and calorimeter been taken into account? Justify your answer. *(2pts)*

c) A third student calculates a value for the enthalpy of reaction that is significantly higher than the accepted value.

(i) Identify a specific error in procedure made by the student that will result in a calculated value for the enthalpy of reaction that is higher than the accepted value. (Vague statements like “human error” or “incorrect calculations” will not earn credit.) *(1pt)*

(ii) Explain how the error that you identified in part (c)(i) leads to a calculated value for the enthalpy of reaction that is higher than the accepted value. *(1pt)*

Aluminum metal can be recycled from scrap metal by melting the metal to evaporate impurities. 2015 #7

a) Calculate the amount of heat needed to purify 1.00 mole of Al originally at 298 K by melting it.

The melting point of Al is 933 K. The molar heat capacity of Al is 24 J/(mol⋅K), and the heat of fusion of Al is 10.7 kJ/mol. *(1-3pts)*

b) The equation for the overall process of extracting Al from Al2O3 is shown below. Which requires less energy, recycling existing Al or extracting Al from Al2O3 ? Justify your answer with a calculation.

Al2O3(s) → 2Al(s) + 3/2 O2(g) ∆Ho = 1675kJ/mole*rxn* *(2pts)*

The heat of combustion of ethanol (C2H5OH) is -1367kJ/mole.

a) Determine the ***C****alories* in a 6oz ***(177mL)*** glass of wine if the wine is 10.6% ethanol by mass. Assume the density of the wine is 1.00g/mL and all Calories come from the ethanol. (1 cal = 4.184 J)

b) Ethanol has an energy content of about 7 Cal/g. Does your calculation in “a” make sense? Justify your answer.

A student investigates the enthalpy of solution, Δ*Hsoln*, for two alkali metal halides, LiCl and NaCl. In addition to the salts, the student has access to a calorimeter, a balance with a precision of ±0.1 g, and a thermometer with a precision of ±0.1°C.

2016 #1 part a

a) To measure Δ*Hsoln* for LiCl, the student adds 100.0 g of water initially at 15.0°C to a calorimeter and adds 10.0 g of LiCl(*s*), stirring to dissolve. After the LiCl dissolves completely, the maximum temperature reached by the solution is 35.6°C.

i) Calculate the magnitude of the heat absorbed by the solution during the dissolution process, assuming that the specific heat capacity of the solution is 4.18 J/(g·°C). Include units with your answer. *(2pts)*

ii) Determine the value of Δ*Hsoln* for LiCl in kJ/mol*rxn*. *(2pts)*

Answer the following questions about glucose, C6H12O6 , an important biochemical energy source. 2011B #3 a,b

a) Write the empirical formula of glucose. *(1pt)*

In many organisms, glucose is oxidized to carbon dioxide and water, as represented by the following equation.

C6H12O6(*s*) + 6 O2(*g*) → 6 CO2(*g*) + 6 H2O(*l*)

A 2.50 g sample of glucose and an excess of O2(*g*) were placed in a calorimeter. After the reaction was initiated

and proceeded to completion, the total heat released by the reaction was calculated to be 39.0 kJ.

b) Calculate the value of Δ*H*°, in kJ mol−1, for the combustion of glucose. *(1pt)*

c) When oxygen is not available, glucose can be oxidized by fermentation. In that process, ethanol and carbon dioxide are produced, as represented by the following equation.

C6H12O6(*s*) → 2 C2H5OH(*l*) + 2 CO2(*g*) Δ*H*° = −68.0 kJ mol−1 at 298 K

Using your answer for part (b) and the information provided above, calculate the value of Δ*H*° for the following reaction. C2H5OH(*l*) + 3 O2(*g*) → 2 CO2(*g*) + 3 H2O(*l*) *(2pts)*

Hydrogen gas burns in air according to the equation: 2 H2(*g*) + O2(*g*) → 2 H2O(*l*) 2001 #3

a) Calculate the standard enthalpy change, Δ*Ho*298, for the reaction represented by the equation above.

(The molar enthalpy of formation, Δ*Hf o*, for H2O(*l*) is −285.8 kJ mol−1 at 298 K.) *(1pt)*

b) Calculate the amount of heat, in kJ, that is released when 10.0 g of H2(*g*) is burned in air. *(1pt)*

c) Given that the molar enthalpy of vaporization, Δ*Hovap*, for H2O(*l*) is 44.0 kJ mol−1 at 298 K, what is the standard enthalpy change, Δ*Ho*298, for the reaction 2 H2(*g*) + O2(*g*) → 2 H2O(*g*) ? *(1pt)*

Answer the following questions about thermodynamics. 2005B #7

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| Substance | Combustion Reaction | ∆*Hocomb*, at 298 K  (kJ mol−1) |
| H2(*g*) | H2(*g*) + ½ O2(g) → H2O(*l*) | −290 |
| C(*s*) | C(*s*) + O2(g) → CO2(g) | −390 |
| CH3OH(*l*) |  | −730 |

a) Write a balanced chemical equation for the complete combustion of one mole of CH3OH(*l*).

Assume products are in their standard states at 298 K. Coefficients do not need to be whole numbers. *(2pts)*

b) On the basis of your answer to part (a) and the information in the table, determine the enthalpy change for the reaction

C(*s*) + H2(*g*) + H2O(*l*) → CH3OH(*l*) *(2pts)*

c) Write the balanced chemical equation that shows the reaction that is used to determine the enthalpy of formation for one mole of CH3OH(*l*). *(1pt)*