HEATS OF REACTION: USING HESS' LAW

Introduction:
One of the simplest ways to measure the amount of heat produced by an exothermic reactions is to perform a reaction in solution in a calorimeter. In this experiment, three related reactions will be performed in order to determine a relationship between their heats of reaction and appropriate reactions equations.

Prelab Assignment:
Write a **net ionic** equation for each of the following reactions:
   a) Solid sodium hydroxide dissolves in water to form ions.

   b) Solid sodium hydroxide reacts with hydrochloric acid solution to form water and aqueous sodium chloride.

   c) Aqueous sodium hydroxide reacts with hydrochloric acid solution to form water and aqueous sodium chloride.

Apparatus and Materials:

25 mL graduated cylinder	0.80 g solid sodium hydroxide
balance	10.0 mL - 1.00 mol/dm³ NaOH (aq)
thermometer	20.0 mL – 0.500 mol/dm³ HCl (aq)
2 x 25 mL plastic cups	10.0 mL – 1.00 mol/dm³ HCl (aq)
small elastic band	

Safety: All solutions and the solid sodium hydroxide are very corrosive. Handle with care. Flush any contacted area with running water.

Procedure:

Part I: Reaction of Solid Sodium Hydroxide and Water
   1. Place the elastic band around one of the small plastic cups. Place this cup inside the other cup. This forms a calorimeter as shown below.

2 plastic cups

elastic band
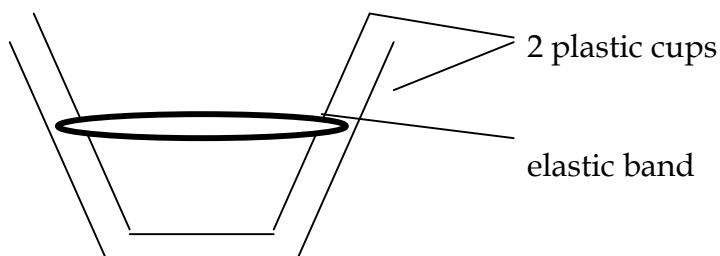
2. Using the graduated cylinder, pour exactly 20.0mL of distilled water into the bottom plastic cup (the one without the elastic). Stir with the thermometer and record the temperature.
3. Measure about 0.40g of solid sodium hydroxide into the cup with the elastic band. Record exact amount measured.
4. Pour the water into the cup with the sodium hydroxide and quickly place the reaction vessel into the plastic cup. Stir gently and record the maximum temperature reached by the solution.
5. Pour the solution down the sink and clean the calorimeter.

Part II: Reaction of Solid Sodium Hydroxide and Hydrochloric Acid Solution
1. Repeat the above steps but replace the tap water with 20.0mL of a 0.500 mol/dm³ solution of hydrochloric acid.

Part III: Reaction of Sodium Hydroxide Solution and Hydrochloric Acid Solution
1. Pour exactly 10.0mL of a 1.00 mol/dm³ solution of hydrochloric acid into the calorimeter.
2. In the other plastic cup, measure exactly 10.0 mL of 1.00 mol/dm³ of sodium hydroxide solution.
3. Record the temperature of each solution. Clean the thermometer bfore each measurement
4. Mix the two solutions in the elasticized calorimeter, making sure to place one cup in the other. Recorde the maximum temperature reached.

Observations:

	Part I	Part II	Part III
mass of NaOH (s) (± g)			N/A
Volume of HCl (aq) (± mL)	N/A		

Volume of NaOH (aq) (± mL)	N/A	N/A	
Volume of H₂O (aq) (± mL)		N/A	N/A
Initial Temperature (± °C)			
Final Temperature (± °C)			

Analysis:

1. Complete the following table. Assume the density of the solutions is 1.0g/mL and the specific heat capacity is 4.18 J/g°C

	Part I	Part II	Part III
ΔT (± °C)			
Q (± kJ)			
n_{NaOH} (± mol)			
ΔH (± kJ/mol)			

Sample Calculation:

2. Compare the enthalpy for each reaction in order to determine a simple mathematical relationship among the three values.
3. Compare the three net ionic equations for the three reactions in order to determine a relationship between them.
4. Suppose you had used ten times as much sodium hydroxide in the first reaction.

a) What effect would this have had on the temperature change and thus the heat produced?
b) What effect would this have had on the heat evolved per mole of sodium hydroxide?
5. What would happen to the temperature if an endothermic reaction had occurred?