LAB [12 pts]
Hess's Law

Name _____
Lab Partner(s) _____
Period _____ ***Date*** _____

Purpose: *To determine the heats of reactions for the following three reactions and obtain experimental support for Hess's Law.*

Reaction #1*:* $NaOH\ (s) \xrightarrow{H_2O} NaOH\ (aq)$ $\Delta H_1 = ?$

Reaction #2: $NaOH\ (aq) + HCl\ (aq) \longrightarrow NaCl\ (aq) + HOH\ (l)$ $\Delta H_2 = ?$

Reaction #3: $NaOH\ (s) + HCl\ (aq) \longrightarrow NaCl\ (aq) + HOH\ (l)$ $\Delta H_3 = ?$

Procedure: **Safety: Wear goggles at all times!!** NaOH and HCl are corrosive.
Equipment: It is best to use a good digital thermometer to get more precise temperature readings.

Reaction #1*:* **$NaOH\ (s) \xrightarrow{H_2O} NaOH\ (aq)$**

a) With a graduated cylinder, measure out 100.0 mL of cold tap water and put it into a polystyrene cup. Once a constant temperature is reached, record this initial temperature in data chart below.
b) Mass out approximately 2.0 g of NaOH solid. (1.8g - 2.2g is fine.) Record its exact value in data chart.
c) Pour the NaOH solid into the water in the polystyrene cup. Stir the solution gently, but continuously. The temperature should increase. When all of the solid has dissolved and the temp begins to decrease, record maximum temperature.
d) *Before proceeding to next reaction, discard the solution into the sink and rinse the cup thoroughly with water.*

Reaction #2 : $NaOH\ (aq) + HCl\ (aq) \longrightarrow NaCl\ (aq) + HOH\ (l)$

a) With a graduated cylinder, measure out 50.0 mL of 1.00 M HCl (aq) and pour it into the polystyrene cup. Record its temperature here: **Initial temp of HCl solution =** _____
b) With a graduated cylinder, measure out 50.0 mL of 1.00 M NaOH (aq). Rinse and dry the thermometer, and place it into the NaOH solution. Record its temperature: **Initial temp of NaOH solution =**_____
c) Average the HCl and NaOH initial temperatures and record the average initial temp in the chart below.
d) Pour the HCl solution into the NaOH solution in the polystyrene cup. Stir the solution gently but continuously with the thermometer. Record the highest temperature reached in the data chart.
e) *Discard the solution into the sink and rinse the cup thoroughly with water.*

Reaction #3*:* **$NaOH\ (s) + HCl\ (aq) \longrightarrow NaCl\ (aq) + HOH\ (l)$**

a) With a graduated cylinder, measure out 100.0 mL of 0.50 M HCl and put it into a polystyrene cup. Stir with a thermometer. Record initial temperature.
b) Mass out approximately 2.0 g of NaOH (s). (1.8g - 2.2g is fine.) Record its exact value in data chart.
c) Pour the NaOH solid into the HCl solution in the polystyrene cup. Stir the solution continuously with the thermometer until all of the solid NaOH dissolves. Keep stirring and record the highest temperature reached in data chart.
d) *Discard the solution into the sink and rinse the cup thoroughly with water. Do not throw out!*

DATA TABLE: [2 pts]

Measurements	Reaction #1	Reaction #2	Reaction #3
mass of solid NaOH (g)			
Total volume of solution (in mL)			
Initial temp (°C)		Avg. temp =	
Final (highest) temp (°C)			
change in temp (ΔT)			

Calculations: [6 pts] Make the following calculations in the table-- show work. Be VERY careful with sig figs. Keep as many sig figs as allowed by your data in each step. **Every number must have units**.

Calculations	Reaction #1	Reaction #2	Reaction #3
Calculate the heat absorbed by the solution (in J) • *Use* q = mcΔT • *c of H_2O = 4.184J/g·°C* • *To find "m": You always used 100.0 mL of an aqueous solution. Assume density of solution =1g/mL.*			
Heat released by reaction (in kJ) *(Just give answer.)*			
Moles of NaOH used.		HINT:You used 50.0 mL of 1.00 M NaOH (not solid NaOH)	
Δ*H* of Rxn in kJ/mole of NaOH. *(Put in the +/- sign on the ΔH values)*	ΔH_1= _____	ΔH_2= _____	ΔH_3= _____

Post Lab questions: [4 pts]

1) What is your value for $\Delta H_1 + \Delta H_2$? (Show calculation.)_____
2) What is your value of ΔH_3? _____
3) Calculate the percent difference between your values of $(\Delta H_1 + \Delta H_2)$ and ΔH_3.

$$\frac{\Delta H_3 - (\Delta H_1 + \Delta H_2)}{\Delta H_3} \times 100 =$$

4) Ideally, your values of $(\Delta H_1 + \Delta H_2)$ and ΔH_3 should be the same. In the diagram, label the arrows with ΔH_1, ΔH_2 , or ΔH_3 and then write in the values for ΔH_1, ΔH_2 and ΔH_3. **Also, in a sentence, define Hess's Law and use it to explain why in this particular lab ($\Delta H_1 + \Delta H_2$) should equal ΔH_3.**

Definition of Hess's Law (in a sentence): ***Explanation for why $(\Delta H_1 + \Delta H_2) = \Delta H_3$***
(You must discuss what occurs in each reaction.)