Chemistry 30: Lab to Test Hess's Law

Name _____ **Partner**_____

Purpose: Compare the heat released when two processes are done separately to the heat released when two processes are done together. Processes will be dissolving and neutralizing.

1. **Dissolve** $NaOH_{(s)}$ in water to form $NaOH_{(aq)}$ Find ΔH for the reaction
2. Use the $NaOH_{(aq)}$ and **neutralize** with $HCl_{(aq)}$ Find ΔH for the reaction
3. Find the sum of the heat released for reaction 1 & 2.
4. Allow $NaOH_{(s)}$ to be **dissolved and to be neutralized in one reaction.** Find the ΔH for the reaction and compare it to the sum found in step 3.

Prelab: Write a balanced reaction for the reactions described above.

Dissolving only: _____

Neutralizing only: _____

Dissolving and Neutralizing: _____

Materials:

- graduated cylinder
- Several clean Styrofoam cups
- Stir rod
- Thermometer
- $NaOH_{(s)}$
- 1.0 mol/L $HCl_{(aq)}$
- 1.0 mol/L $NaOH_{(aq)}$
- 0.50 mol/L $HCl_{(aq)}$

Procedure:

1. Record the ambient temperature of the lab.

2. **Process ONE:** Dissolve $NaOH_{(s)}$ in water to form $NaOH_{(aq)}$

    - Measure exactly 100 mL of distilled water using a graduated cylinder
    - Place the water in a Styrofoam cup.
    - Measure and record the initial temperature of the water (to the nearest 0.1 °C)
    - Measure out 2.0 g (or as close as you can get) of $NaOH_{(s)}$. Be sure to put the lid back on the jar containing the $NaOH_{(s)}$ as soon as possible since this is a deliquescent compound.
    - Put the $NaOH_{(s)}$ into the 100 mL of water and stir until dissolving has occurred. Record the highest temperature (to the nearest 0.1 °C) that is achieved by this reaction.
    - Flush the solution down the drain with lots of water.

3. **Process TWO:** Use the $NaOH_{(aq)}$ and **neutralize** with $HCl_{(aq)}$

    - Measure exactly 50 mL of 1.0mol/L $NaOH_{(aq)}$ and place it in a stryofoam cup. Measure and record the temperature
    - Measure exactly 50 mL of 1.0 mol/L $HCl_{(aq)}$ and place it in a second stryofoam cup. Measure and record the temperature.
    - Pour the contents of the two cups together. Stir. Record the highest temperature (to the nearest 0.1 °C) that is achieved by this reaction.
    - Flush the solution down the drain with lots of water.

4. **Process THREE:** Allow $NaOH_{(s)}$ to be **dissolved and to be neutralized in one reaction.**

    - Measure exactly 100 mL of 0.50 mol/L $HCl_{(aq)}$ using a graduated cylinder
    - Place the water in a Styrofoam cup.
    - Measure and record the temperature of the acid to the nearest 0.1 °c
    - Measure out 2.0 g (or as close as you can get) of $NaOH_{(s)}$. Be sure to put the lid back on the jar containing the $NaOH_{(s)}$ as soon as possible since this is a deliquescent compound.
    - Put the $NaOH_{(s)}$ into the 100 mL of acid and stir until dissolving has occurred. Record the highest temperature (to the nearest 0.1 °C) that is achieved by this reaction.
    - Flush the solution down the drain with lots of water.

Observations:

Make a table to summarize the observations for this lab. Remember to include units with all observations!

Analysis:

1. Using the first law of thermodynamics, find the ΔH for each reaction. (assume that the specific heat capacity of the acid and base solutions is identical to water) Use the concept that GAIN + LOSS = 0

2. Identify control variables for this lab.

3. Compare the sum of the heat values found when the processes are done separately to the heat value found when the processes are done together. **Hess's law would support the fact that the two values should be identical.** What reasons(s) can you give to explain any difference in the two values?