Molar Heat of Solution (ΔH)

Prelab assignment: You will do the usual, Title, purpose, storyboard, and data table in your lab notebook before doing the lab. You will then complete the rest for a postlab assignment.

Introduction: Whenever bonds are formed or broken in a chemical reaction, energy is transferred. As a solid dissolves in water, its bonds are broken, and a change in temperature is usually observed. If energy is absorbed from the solvent when a solid dissolves, the system gets colder – the reaction is endothermic, and it has a positive enthalpy change. On the other hand, if energy is released, the system gets warmer – the reaction is exothermic, and it has a negative enthalpy change. The **molar heat of solution** of a compound is the heat transferred when one mole of the compound (the solute) dissolves in a solvent.

In this investigation, you will explore the energy changes that take place when two solids (the solutes) dissolve in water (the solvent). You will dissolve known quantities in 100.0 ml samples of water and measure the temperature change as they dissolve. From these data, the **molar heat of solution** for each solid will be found.

Materials:

safety goggles and lab apron
graduated cylinder
balance
stirring rod
water
ammonium chloride (NH_4Cl)
2 styrofoam cups (calorimeter)
calcium chloride ($CaCl_2$)

Procedure:

1. Put on your goggles and lab apron.
2. Measure exactly (use a graduated cylinder) 50.0 ml of water at room temperature and pour it into one of the Styrofoam cups. Since water has a density of 1 g/mL you can record this volume as the Mass of water for NH_4Cl reaction.
3. Using your laboratory balance and a weighing boat, measure out approximately 4 grams of ammonium chloride (NH_4Cl). Record the exact mass used to 0.01 grams in your data table as mass of NH_4Cl.
4. Measure the temperature of the water and record it in your data table as $T_{initial}$ for NH_4Cl.
5. Without removing the temperature probe, shake the ammonium chloride into the cup and stir gently using the temperature probe, until the solid is completely dissolved. If the temperature rises, record the highest temperature reached by the solution as T_{final} for NH_4Cl. If the temperature falls, record the lowest temperature reached by the solution as T_{final} NH_4Cl.
6. After recording the temperature, you may dispose of the solution by pouring it down the drain and flushing it with water. Rinse the cup out 2 - 3 times with water.
7. Repeat steps 1 to 6 using calcium chloride ($CaCl_2$) and labeling your data as for $CaCl_2$.
8. Clean up your lab desk and wash your hands

Data Table:

Solute	Solute Mass	H_2O Mass	Initial Temperature	Final Temperature
NH_4Cl				
$CaCl_2$				

Post Lab Calculations: Show the set-up of the problem (work) and your answer circled or highlighted.

1. Calculate the energy (in joules) that was absorbed or released by the water in each reaction. (**The specific heat capacity of water is 4.184 J/g°C**)
    a. NH_4Cl
    b. $CaCl_2$
2. In any calorimetry experiment the energy lost or gained by the surroundings equals the energy gained or lost by the reaction. How much energy was lost/gained by each of the **reactions** in this experiment?
    a. NH_4Cl
    b. $CaCl_2$
3. Using the periodic table, calculate the molar mass of each of the solutes and then calculate the number of moles of solute used.
    a. NH_4Cl
    b. $CaCl_2$
4. Calculate the molar heat of solution for each solute (ΔH).
    a. NH_4Cl
    b. $CaCl_2$
5. Covert this amount from J/mole to kJ/mole.
    a. NH_4Cl
    b. $CaCl_2$
6. The accepted values for the molar heat of solution for each solute is given below:
    NH_4Cl = + 14.8 kJ/mol $CaCl_2$ = - 81.3 kJ/mole
    Using these values, calculate your percent error for each solute.
    a. NH_4Cl
    b. $CaCl_2$

Post Lab Questions: Answer in complete sentences.

1. Is the change in enthalpy positive or negative for an exothermic reaction? Explain completely.

2. When sodium chloride dissolves in water, the ions **dissociate**. The **dissociation equation** for this reaction is NaCl (s) → Na+ (aq) + Cl (aq). Write similar ionic equations to show the dissociation in water of each of the solutes used.
    a. NH_4Cl
    b. $CaCl_2$
3. Rewrite each of the ionic equations from question #2 showing the molar heat of solution (calculated in #4) as a reactant or product.

a. NH_4Cl
b. $CaCl_2$

Conclusions: What did you learn and what are some reasonable sources of error?