HEAT OF SOLUTION

Reminder – Goggles must be worn at all times in the lab

PRE-LAB DISCUSSION:

When salts are dissolved in water, there is often a temperature change associated with the process. Some salt dissolve, releasing heat in the process. Others dissolve while absorbing heat. As you may remember, processes that proceed with a release of heat energy are called "exothermic" processes, while those that absorb heat are called "endothermic" processes.

Because energy is released to the surroundings in an exothermic process, the heat of solution would be given a negative value because the energy of the system is **decreasing.**

$$NaOH(s) \rightarrow Na^+(aq) + OH^-(aq) \quad \Delta H_{solution} = -44.51 \text{ kJ}$$

Because energy is absorbed from the surroundings in endothermic processes, the heat of solution would be given a positive value because the energy of the system is **increasing**.

$$KNO_3(s) \rightarrow K^+(aq) + NO_3^-(aq) \quad \Delta H_{solution} = +34.89 \text{ kJ}$$

In this experiment you will start with a known mass of potassium nitrate, and a known volume of water. You will determine the magnitude of the temperature change associated with the dissolving process, and use the masses of the solute and solvent, the temperature change (called ΔT), and the known heat capacity (specific heat) of water, 4.18 J/(g·°C), to calculate the heat of solution of potassium nitrate.

PURPOSE:

To apply the concepts of specific heat and temperature change in the experimental determination of the heat of solution of a soluble salt, potassium nitrate.

PROCEDURE:

1. Obtain a Styrofoam cup "calorimeter" and add to it 40.0 mL of distilled water.
2. Secure a thermometer to stand up in the calorimeter, using your ring stand (your instructor will show you how.)
3. Weigh out 4.000 grams of potassium nitrate.
4. Record the initial temperature of the water in the calorimeter.
5. Add the potassium nitrate to the water in the calorimeter, all at once, and begin stirring the solution to dissolve the salt as rapidly as possible. Stir by swirling the cup with your hand. DO NOT use a glass stir rod, as it will effect your results. Watch out for the fragile thermometer! Record the lowest temperature achieved during the dissolving of the salt.
6. Cleanup: Rinse the solution down the sink with LOTS of water. Rinse the Styrofoam cup, and return it to the side counter. DO NOT throw the Styrofoam cup away – we re-use them. Rinse the thermometer and return it to your lab drawer.

RESULTS

Observations and Data:

1. Mass potassium nitrate used _____g
2. Volume of water used _____mL
3. Initial temperature (T_1) _____°C
4. Final (lowest) temperature (T_2) _____°C

Calculations: Show your work!

1. Calculate the amount of energy absorbed as the potassium nitrate dissolved. In order to do this, we must assume that the solution has the same specific heat (c_p) as pure water, and that the density of the water was 1.00 gram/mL. Express your final answer in kilojoules, kJ!

$$q = c_p \times m \times \Delta T$$

2. Calculate the number of moles of potassium nitrate used.
3. Divide the heat absorbed (in kJ) by the moles of potassium nitrate dissolved. This is the heat of solution, expressed in kJ/mol of solute.
4. Using the known value of the heat of solution of potassium nitrate (see first page of this lab) calculate the absolute error in your experimental result.
5. Calculate your relative error (PERCENT ERROR).