Name:	Class Period:
Lab Partner	Lab Partner

Calorimetry: Heat of Solution of $CaCl_2$ or NH_4Cl

When a chemical or physical change takes place, heat is given off or absorbed. The most common chemical compound whose heat of solution is positive or endothermic is ammonium nitrate (NH_4NO_3), used in instant ice packs. An exothermic reaction known by many people is lye which is present in Drano, and water. Chemists can measure the heat given off or absorbed by the water. Measurements of this sort are made in a device called a calorimeter. The technique used in making these measurements is called Calorimetry.

All physical and chemical changes are accompanied by an associated change in energy. This can be referred to in many ways.

$\triangle$ H is called the **heat of reaction** and is the change in potential energy associated with a change.

A positive change in potential energy (+$\triangle$ H) results when kinetic energy from the surroundings is absorbed into the change, resulting in greater stored energy and lower temperature in the surroundings. This is an **ENDOTHERMIC** change.

A negative change in potential energy (-$\triangle$H) results when potential energy stored in the substance undergoing the change is released into the surroundings as kinetic energy, resulting in lower amounts of stored energy and higher temperature in the surroundings. This is an **EXOTHERMIC** change.

Table I
Heats of Reaction at 101.3 kPa and 298 K

Reaction	ΔH (kJ)*
$LiBr(s) \xrightarrow{H_2O} Li^+(aq) + Br^-(aq)$	−48.83

Dissolving lithium bromide crystals into water results in the breakup of those crystals into lithium ions and bromide ions. This physical change results in the release of 48.33 kj/moles of PE, which is converted into KE and released into the surroundings, causing the temperature to rise.

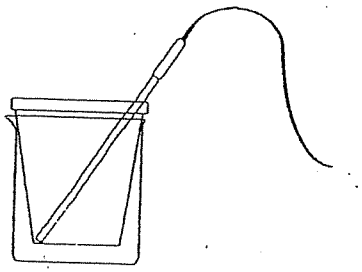
If the change were reversed, and the water was evaporated away so that the ions could come back together and reform the original crystal, the reaction would absorb the 48.83 kJ of heat that were released when the compound was originally dissolved. The $\triangle$ H which was - when the compound was dissolved, will now be a + $\triangle$H.

In this experiment the heat of solution or reaction will be found. The salt will be placed directly into a measured amount of water. The heat of solution or reaction will be found by measuring the temperature change of water and using the following relationship

$Q = m\,c\,\triangle T$

You will be using a simple calorimeter which is an insulated container or Styrofoam cup. The basic principle on which the calorimeter works is that when two bodies at different temperatures are in contact with one another, the heat will flow from the warmer body to the colder body. Thus the heat lost by one body will be gained by the other. This exchange of heat will continue until the two bodies are at the same temperature. In a calorimeter, heat is exchanged between the water and the materials undergoing change. The experimenter makes a direct measurement of the temperature change of the water. From this information, the heat gained or lost by the water can be calculated. The experimenter then uses this data to determine the heat lost or gained by the materials undergoing change.

Safety: wear safety glasses at all times



Materials:

Styrofoam Cups
Scoopula
Balance
Temperature probe
250 ml beaker
100 ml graduated cylinder
Salt ($CaCl_2$ or NH_4Cl)
beaker

Procedure:

1. Obtain a Styrofoam cup and a 250 ml beaker which will be used to make a calorimeter, and a temperature probe
2. Weigh the cup empty and record the mass.
3. Weigh the cup with 75 ml of water in it and record the mass.
4. Mass out 2 g of salt ($CaCl_2$ or NH_4Cl) Set aside
5. Lower the temperature probe into the water.
6. Wait 30 seconds for temperature probe to warm up to its surroundings.
7. Click collect button to begin data collection.
8. Pour all of the salt into the water at once, stir with the temperature probe and observe any change.
9. When the temperature no longer changes (1 to 2 minutes) click on the stop button. Choose statistics from the analyze menu and record minimum (t1) and maximum (t2) temperatures.
10. Calculate the heat of solution of $CaCl_2$ in joules. Divide by the number of grams of the salt to get joules per gram.

Questions for discussion:

1. List possible sources of error in this experiment
2. In what ways does calorimetry make use of the Law of Conservation of Energy?
3. What is the difference between heat and temperature?
4. Using Table I , give an example of a physical reaction that is exothermic and a chemical reaction that is exothermic.

1) How many grams of water will absorb a total of 2,510 joules of energy when the temperature of the water changes from 10.0 °C to 30.0 °C?

A) 126 g B) 83.6 g C) 20.0 g D) 30.0 g

2) A 5.0 gram sample of water is heated and the temperature rises from 10 °C to 15 °C. What is the total amount of heat energy absorbed by the water?

A) 42 J B) 105 J C) 21 J D) 84 J

3) How many joules of heat energy are released when 50 grams of water are cooled from 70 °C to 60 °C?

A) 2,090 joules B) 10 joules C) 50 joules D) 4,180 joules

4) Calculate the heat released when 25.0 grams of water freezes at 0 °C. [*Show all work. Record your answer with an appropriate unit.*]

5) What is the total number of joules of heat energy absorbed when the temperature of 200 grams of water is raised from 10 °C to 40 °C?

A) 200 joules B) 33,440 joules C) 25,080 joules D) 30 joules

6) When 20. calories of heat are added to 2.0 grams of water at 15 °C, the temperature of the water increases to

A) 50. °C B) 15 °C C) 5.0 °C D) 25 °C

7) A 7.0 gram sample of water is heated and the temperature rises from 10 °C to 15 °C. What is the total amount of heat energy absorbed by the water?