**Enthalpy of Solution**
Developed by Nicole Hume, 07/2017

Teacher background:

This calorimetry lab looks for a value that is different from the typical experiment, ΔHhydration. The lab can be conducted as a second calorimetry experiment. Students gain experience determining ∆H values from q values, and learn the quantitative aspects of ∆Hsolution.

This lab makes use of the Vernier temperature probe and interface.

<http://www.chemguide.co.uk/physical/energetics/solution.html>

<https://chem.libretexts.org/Core/Physical_and_Theoretical_Chemistry/Physical_Properties_of_Matter/Solutions_and_Mixtures/Solution_Basics/Enthalpy_of_Solution>

**2016 Chemistry Standards:**

C.3.5 Use laboratory observations and data to compare and contrast ionic… substances with respect to… strength of bonds.

C.6.4 Perform calculations involving heat flow and temperature changes.

*This lab is also appropriate for use in an AP / Dual Credit chemistry or Honors chemistry course.*

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| **Science Express equipment to order** | **Other Materials** |
| Set of 6 Scout Pro Balances | Calorimeter (2 nested Styrofoam cups) |
| Set of 12 Vernier Temperature probes | 25mL Graduated cylinder |
| Vernier Interface (Choose ONE): | Small weigh boats or cupcake papers |
|  Set of 12 Laptops AND Set of 12 Go Links | Ring stand, ring clamp, and clamp for probe |
|  Set of 12 LabQuests | Distilled water (≈120mL per group) |
|  Set of 12 LabQuest 2’s | Ionic compounds (1-3 g per trial per group) LiCl, NaC2H3O2, KCl, NaCl, CsCl, NaClO3, or NaI |

## Enthalpy of Solution

**Purpose:** From ΔHsolution and the ΔHdissociation of the ionic compound, determine the ΔHhydration for ionic compounds.

ΔHsolution has two parts: breaking apart solute molecules and surrounding them by water

ΔHsolution = ΔHdissociation + ΔHhydration

**Materials:**

Calorimeter (2 nested Styrofoam cups supported by a ring clamp on a ring stand)

Vernier temperature probe and interface

25mL Graduated cylinder

Balance

Small weigh boats or cupcake papers

Ring stand, ring clamp, and clamp for temperature probe

Distilled water; Each group will need approximately 25mL

Ionic Compound (LiCl, NaC2H3O2, KCl, NaCl, CsCl, NaClO3, or NaI); Each group will need 1-3 grams per trial

# Procedure:

1. Set up your Vernier temperature probe. The data collection should be set to collect data for 8 minutes, (60 samples per minute). You can stop recording data when the experiment is over.
2. The temperature probe can be clamped to a ring stand to avoid tipping over the Calorimeter.
3. Measure out between 1 and 3 g of salt in a weigh boat. Record this mass and the name/formula of the salt used in your data table.
4. Measure between 10-25 mL of distilled water. Record the volume of water measured in the data table and add this water to the Calorimeter.
5. Place the temperature probe in the Calorimeter, but do not start data collection yet.
6. When the temperature stabilizes, record the starting temperature in the data table.
7. One partner will pour the measured salt sample into the Calorimeter. The other partner will click “collect” (green arrow) on the Vernier interface to begin recording data.
8. If the temperature increases when the salt is added, record your final temperature as the highest temperature before the water starts cooling back down. If the temperature decreases when the salt is added, record the lowest temperature as your final temperature.

# Data Table:

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| --- | --- | --- | --- | --- |
| **Salt Used** | **Mass Salt (g)** | **Volume of water (mL)** | **Initial water Temperature (°C)** | **Final water Temperature (°C)** |
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# Calculations:

1. Find q for each solution: q=mCΔT ‘m’ is the mass of water (density of water is 1 gram/mL); ‘C’ is the heat capacity of water, and ‘ΔT’ is the temperature change of the water. Record the calculated qsolution values in the results table.
2. Calculate the number of moles of each salt used. Record these values in the results table.
3. Calculate ΔHsolution for each solution. ΔHsolution = qsolution /moles salt

Record your answers in the results table.

1. Using the ΔHdissociation values listed below under “Enthalpy of Solutions of Electrolytes”, determine the ∆Hhydration for each solution. Record your answers in the results table.

**Enthalpy of Solutions of Electrolytes** (Parker, V. B., *Thermal Properties of Uni-Univalent Electrolytes*, Natl. Stand. Ref. Data Series – Natl. Bur. Stand.(U.S.), No.2, 1965.)

LiCl = -37.03 kJ/mol KCl = 17.22 kJ/mol NaCl = 3.88 kJ/mol CsCl = 17.78 kJ/mol NaClO3 = 21.72 kJ/mol NaI = -7.53 kJ/mol

 NaC2H3O2 = -17.32 kJ/mol

R**esults:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Salt** | **ΔT (℃)** | **qsolution (J)** | **Moles salt** | **ΔHsolution****(kJ/mol)** | **∆Hhydration (kJ/mol)** |
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Question:

1. Why doesn’t it matter how much salt and water you use, as long as you know the amount?
2. Compare data from classmates that used different salts. Which salt had the highest heat of solution?
3. What would happen to the calculated ∆Hhydration value (too high or too low) if all of the salt did not dissolve?
4. Is the ∆Hhydration an endothermic or exothermic process?
5. What does it mean if you have a large negative ∆Hhydration value?
6. What does it mean if a salt has a high ΔHdissociation value?
7. The heat of solution for sodium hydroxide is -44 kJ/mol. Is this process endothermic or exothermic?