Energy Changes and Transfers

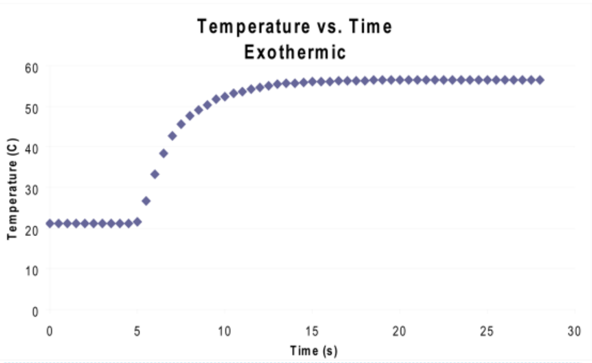
Objective

- Determine the identity of an unknown metal using specific heat
- Determine the heat transfer and enthalpy for a group of salts

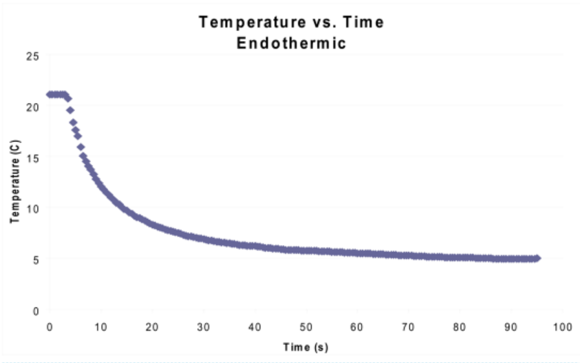
The Calorimeter and Heat

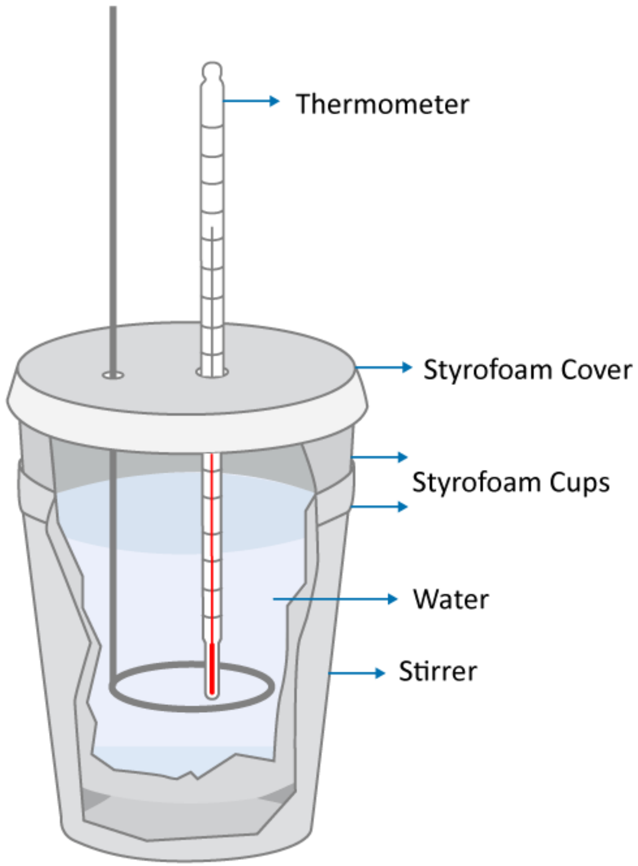
- Heat is the energy associated with molecular motion.
- Heat always moves from the warmer object to the cooler one.
- What happens when ice is added to a drink?
- Heat transfer can be described as
  - Endothermic (+)
  - Exothermic (-)

Exothermic Change



Endothermic Change





A **calorimeter** measures heat transfer.

Specific Heat

The energy (heat) required to change the temperature of 1 g of a substance by 1°C is the **Specific Heat** (C_s) of that substance.

$$C_s(\text{J/g °C}) = \frac{Energy\ (J)}{Mass\ (g) \times \ \Delta T°\text{C}}$$

$$q(\text{J}) = C_s(\text{J/g°C}) \times m(\text{g}) \times \Delta T\ (°\text{C})$$

Specific Heat

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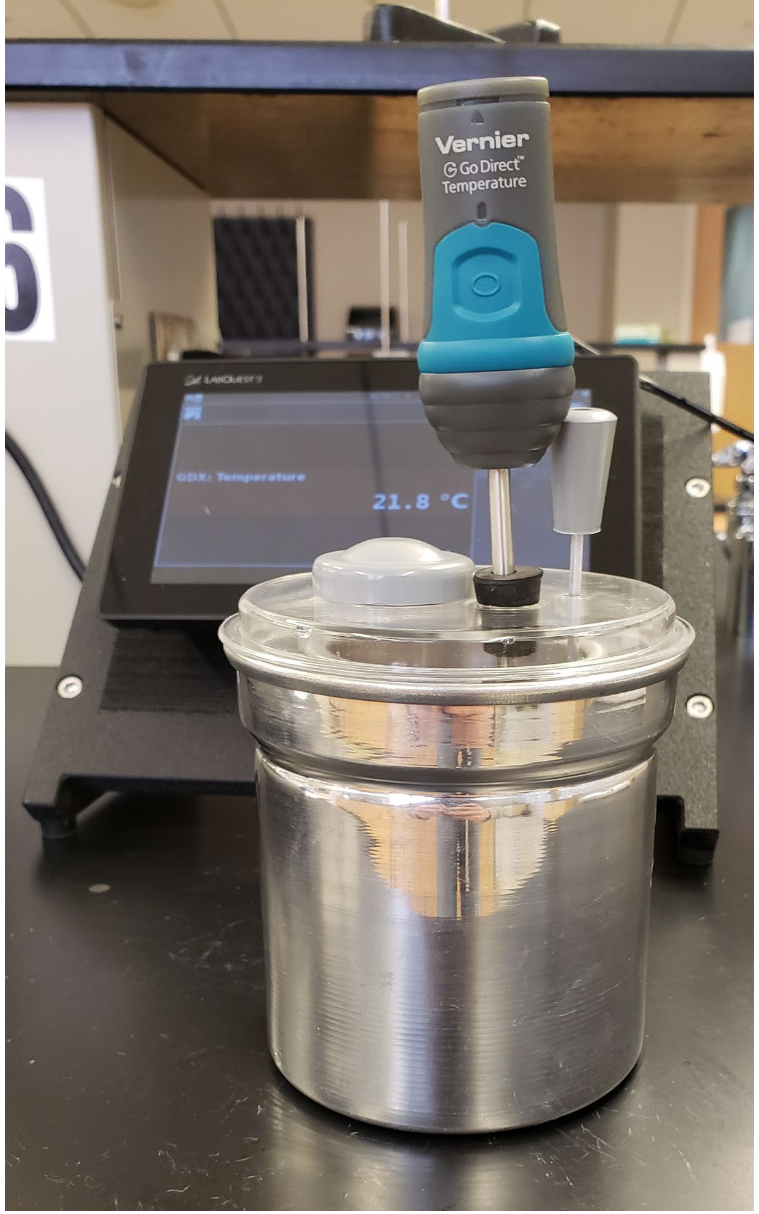
- When two substances at different temperatures are in contact with one another, energy is gained by one (H_2O) and energy is lost by the other (metal).

$$q_{H_2O} + q_M = 0 \qquad \textit{or} \qquad q_{H_2O} = -q_M$$

$$(m_{H_2O} \times C_{s,\,H_2O} \times \Delta T_{H_2O}) = -m_M \times C_{s,\,M} \times \Delta T_M$$

$$C_{s,\,M} = -\frac{(C_{s,\,H_2O} \times m_{H_2O} \times \Delta T_{H_2O})}{m_M \times \Delta T_M}$$



Calorimeter

- Will be adding metals or salts to this container.
- C_{cal}= 42.4 J/K

Note the units!

Part A: Specific Heat of an Unknown Metal

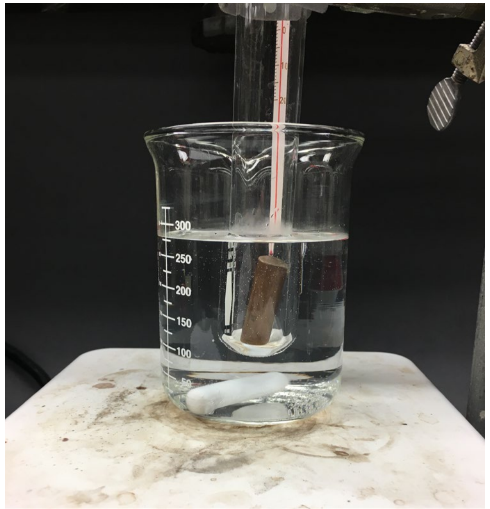
- Will be adding a hot piece of metal to room temperature water
- What's temperature of the metal?
- Room temperature?
- Identify metal based on specific heat
- It will be important to allow for all pieces to reach thermal equilibrium

$$q_{metal} + q_{water} + q_{calorimeter} = 0$$

Which portion will be absorbing heat?

$$(m_{metal} \cdot C_{s,metal} \cdot \Delta T) + (m_{water} \cdot C_{s,water} \cdot \Delta T) + (C_{cal} \cdot \Delta T) = 0$$

Could rearrange this equation



Part B: Enthalpy of Solutions

- Four trials for 4 different salts:

$$q_{solution} = q_{water} + q_{salt}$$

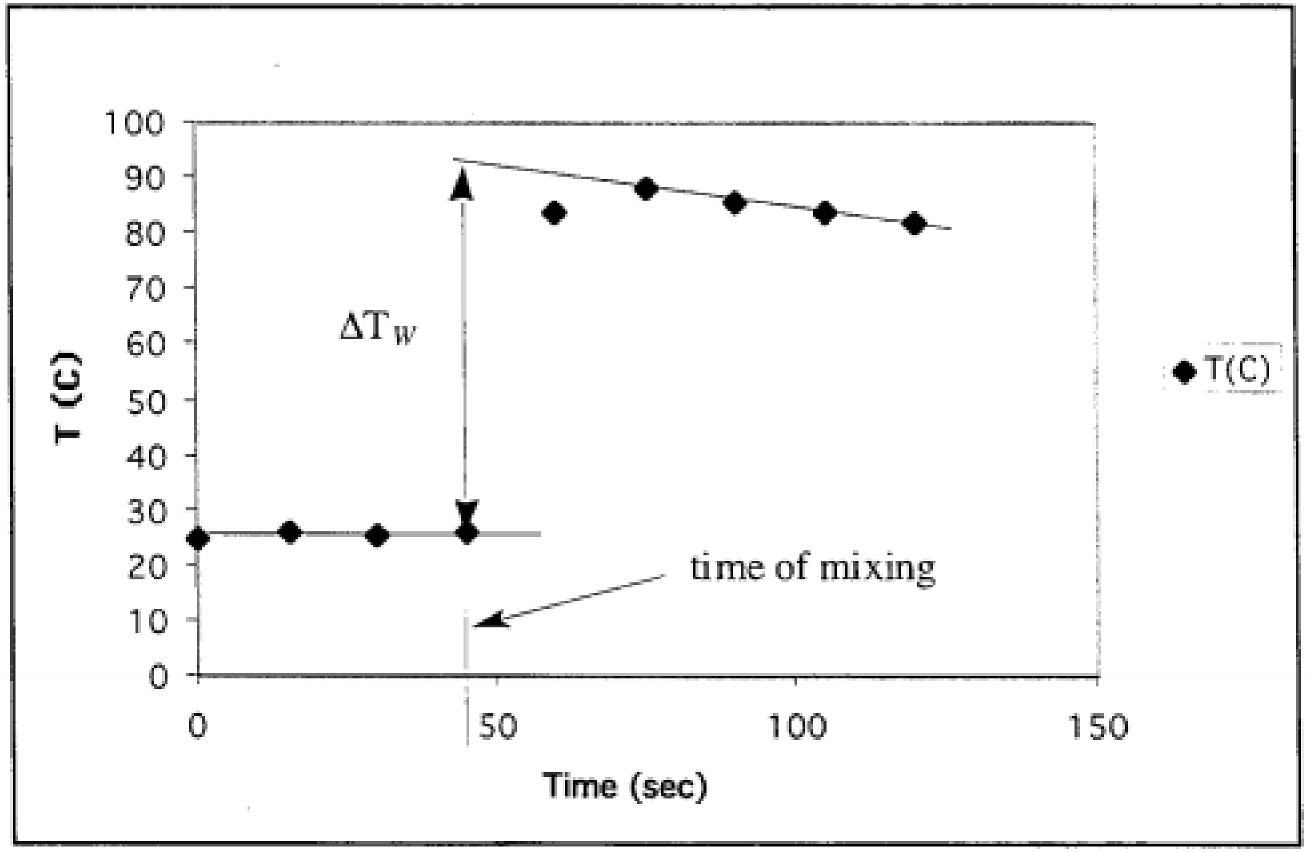
$$q_{solution} = (-m_{water} \cdot C_{s,water} \cdot \Delta T) + (-m_{salt} \cdot C_{s,salt} \cdot \Delta T)$$

$$\Delta T \; will \; be \; calculated \; from \; the \; graphs$$

$$\Delta H_{solution} = \Delta H_{lattice\ energy} + \Delta H_{hydration}$$

$$\Delta H = \frac{q_{solution}}{n}$$

Note on Data Analysis



Most accurate temperature change would be based on looking at this portion of your data.

Post Lab Analysis

- Enthalpy of solution is something you can look up.
- Would be nice to add a percent error with your work to see how you did.
- Since enthalpy of solution is related to lattice energy and hydration energy.
- Look up values for those values to help form conclusions.

Hazards and Waste

- All waste into aqueous waste container
- Return metal samples from Part A to containers

- Handling hot objects – use protection