Calorimetry

<u>CALORIMETRY</u> - is the technological process of measuring energy changes using an **isolated system** called a calorimeter.

In the calorimeter the system being studied is surrounded by a known quantity of water. Energy is then transferred between the chemical system and the water. The heat gained by the water can be determined and thus equals the heat lost by the system.

ASSUMPTIONS IN CALORIMETRY   Do Not Copy
1. no heat is transferred between the calorimeter and the outside environment.
2. any heat absorbed or released by the calorimeter materials is negligible.
3. a dilute aqueous solution has the same density and specific heat capacity as pure water.

Assumption #2 implies

$$\Delta H_{system} = - q_{calorimeter}$$

phase change
(dissolved ?)
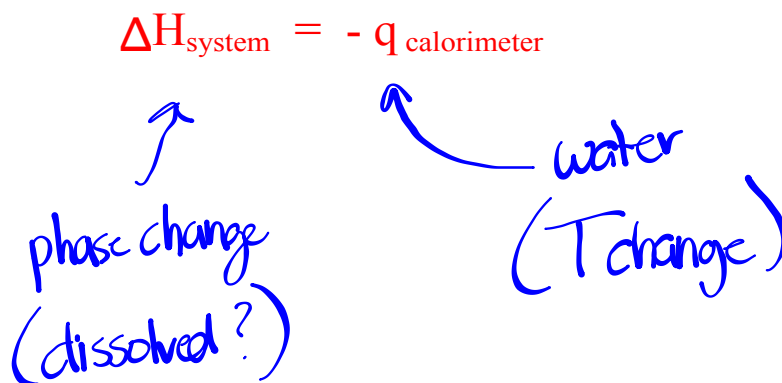
water
(T change)

$$q \quad - \quad T \text{ change}$$

$$\Delta H \quad - \text{ phase change}$$

$$\Delta E_T = q + \Delta H + \cdots$$

Example

4.24 g of lithium chloride is dissolved in 100. mL of water at an initial temperature of 16.3°C. The final temperature of the solution is 25.1°C. Calculate the molar enthalpy of solution, H_s, for lithium chloride.

$LiCl \qquad H_2O$

LiCl

$m = 4.24 g$

$H_s = ?$

$\Delta H_s = -q$

$n H_s = -vC\Delta T$

H_2O

$v = 100. mL$

$\Delta T = 8.8°C$

$\left(\dfrac{4.24g}{42.39 g/mol} \right) H_s = -(0.100L)\left(4.19 \dfrac{kJ}{L\cdot°C}\right)(8.8°C)$

$H_s = \dfrac{-(0.100L)\left(4.19 \dfrac{kJ}{L\cdot°C}\right)(8.8°C)}{0.100 \ mol}$

$\boxed{H_s = -36.9 \ kJ/mol}$

4.24g
LiCl

25.1°C

100.mL (16.3°C)
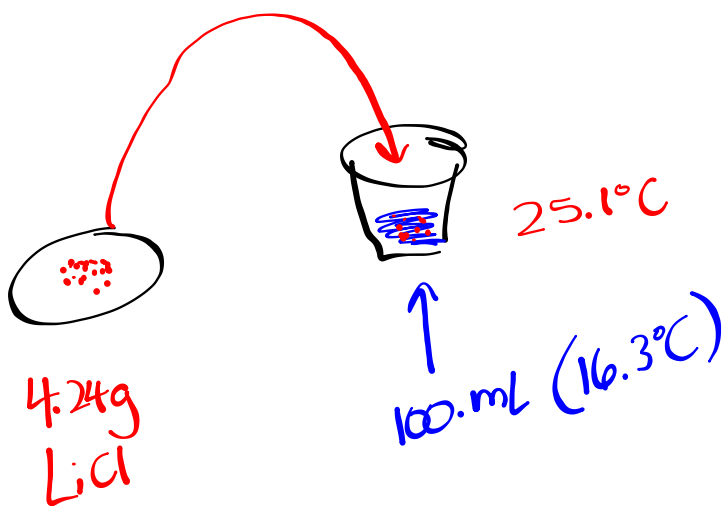
A block of aluminum at 95.0°C is placed into 500. g of water at 21.5°C. The final temperature of the water and aluminum is 28.0°C. Determine the mass of the aluminum.

Al
$m = ?$
$T_i = 95.0°C$

H_2O
$m = 500. g$
$T_i = 21.5°C$

$T_f = 28.0°C$

$$\overset{Al}{q_{Al}} = -\overset{H_2O}{q_{H_2O}}$$

$$mC\Delta T = -mC\Delta T$$

$$m\left(0.900 \frac{J}{g \cdot °C}\right)\left(-67.0°C\right) =$$

$$-\left(500. g\right)\left(4.19 \frac{J}{g \cdot °C}\right)\left(6.5°C\right)$$

$$m = \frac{-\left(500. g\right)\left(4.19 \frac{J}{g \cdot °C}\right)\left(6.5°C\right)}{\left(0.900 \frac{J}{g \cdot °C}\right)\left(-67.0°C\right)}$$

$$\boxed{m = 226 g}$$

Al

95.0°C

28.0°C

500.g 21.5°C

m = ?

Homework

Worksheet