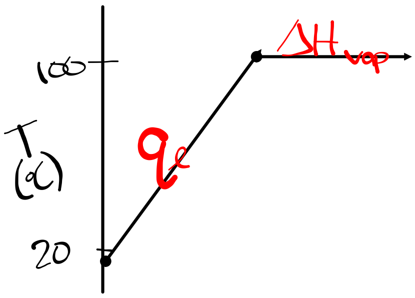
Water



Steel

20.0°C → 100.°C

500 kg

200 kg

20.0°C → 100.0°C

$$\Delta E_T = q_\ell + \Delta H_{vap} + q_{steel}$$

$$q_\ell = mC\Delta T$$

$$q_\ell = (200\,000\,g)(4.19\,\tfrac{J}{g\,°C})(80.0°C)$$

$$q_\ell = 67\,040\,000\,J$$

$$\Delta H_{vap} = nH_{vap}$$

$$\Delta H_{vap} = \left(\frac{200\,000\,g}{18.02\,g/mol}\right)\left(40.8\,\frac{kJ}{mol}\right)$$

$$\Delta H_{vap} = 452\,830.19\,kJ$$

$$q_{steel} = mC\Delta T$$

$$q_{steel} = (500\,000\,g)(0.528\,\tfrac{J}{g\,°C})(80.0°C)$$

$$q_{steel} = 21\,120\,000\,J$$

$$\Delta E_T = (67\,040\,kJ) + (452\,830\,kJ) + (21\,120\,kJ)$$

$$\boxed{\Delta E_T = 541\,000\,kJ}$$

Types of Systems

Classifying types of systems:

1. Open system - a system where both matter and energy can flow into or out of the system.
2. Closed system - a system where energy is allowed to be transferred into and out but matter cannot be transferred.
3. Isolated system - a system where neither matter nor energy is allowed to enter or leave the system.

Calorimetry

CALORIMETRY - 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.

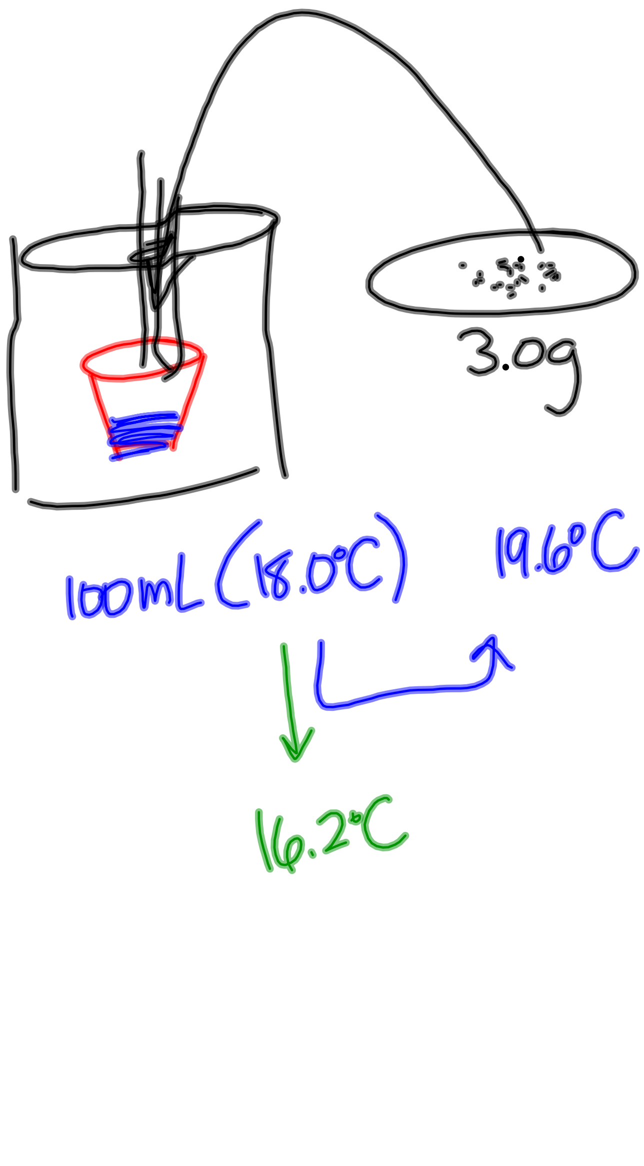
ASSUMPTIONS IN CALORIMETRY

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

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

$$nH_s = - vC\Delta T$$


3.0g
100mL (18.0°C)
19.6°C
16.2°C

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

$m = 4.24 g$

$H_s = ?$

H_2O

$v = 100. mL$

$T_i = 16.3°C$

$T_f = 25.1°C$

$\Delta H_s = -q$

$nH_s = -vC\Delta T$

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

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

$H_s = -36.9 \frac{kJ}{mol}$

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.

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

$$m_{Al}C\Delta T = -m_{H_2O}C\Delta T$$