Determination Of Latent Heat

Experimental determination of latent heat capacity of fusion of ice:

(1) A calorimeter is washed and dried and is weighed along with the stirrer.

(2) About 2/3rd of the calorimeter is filled with water and weighed again to get the mass of water taken. The initial temperature of water in the calorimeter is recorded.

(3) A piece of ice is completely dried off any water drop by soaking with a blotting paper and is gently dropped into the water in the calorimeter and by pushing with the stirrer it is taken to the bottom of the calorimeter.

(4) The temperature of water in the calorimeter falls and minimum temperature is recorded.

(5) The calorimeter weighed again to get the mass of ice taken in the calorimeter.

Calculation: Given

m_1 and s_1 = mass and specific heat capacity of the calorimeter along with the stirrer respectively.

m_2 and s_2 = mass and specific heat capacity of water in the calorimeter

Θ_1 = the initial temperature of water in the calorimeter

Θ = the final temperature of water in the calorimeter

m = mass of ice taken in the calorimeter

L = Latent heat capacity of fusion of ice.

Heat lost by the calorimeter = $m_1s_1(\Theta_1-\Theta)$ Joules

Heat lost by the water in the calorimeter = $m_2s_2(\Theta_1-\Theta)$ Joules

Total heat lost = $(m_1s_1+ m_2s_2)(\Theta_1-\Theta)$ Joules $\longrightarrow$ (1)

Heat absorbed by ice to change its state completely i.e. to melt into water without changing temperature at 0^0C = mL Joules

m mass of water (molten ice) then rises from 0^0C to Θ^0C and heat absorbed

$= ms_2(\Theta-0)$ Joules

Total heat absorbed = $(mL + ms_2\Theta)$ Joules $\longrightarrow$ (2)

From equation (1) and (2):

$$mL+ ms_2\Theta =(m_1s_1+ m_2s_2)(\Theta_1-\Theta)$$

$$L =[(m_1s_1+ m_2s_2)(\Theta_1-\Theta) - ms_2\Theta]1/m$$

Experimental determination of latent heat capacity of condensation of steam:

(1) A calorimeter is thoroughly cleaned washed and dried and weighed along with the stirrer.

(2) About $3/4^{th}$ of the calorimeter is filled with water and weighed again to get the mass of water taken in the calorimeter. The initial temperature of water in the calorimeter is recorded.

(3) Steam is produced in a boiler. A rubber tube from the boiler is connected to a steam trap. A steam trap is a short glass cylinder covered with non conducting wood, where water drops formed by condensation of steam in the rubber tube collected and the cylinder always remains filled with steam. A short rubber tube from the steam trap carries the steam to the calorimeter.

(4) The rubber tube from the steam trap is dipped into the calorimeter for few second till the temperature rises by about 10^0C. The final temperature of water in the calorimeter is recorded.

(5) Calorimeter is weighed again to get the mass of steam condensed into water.

Calculation: Given

m_1 & s_1 = mass and specific heat capacity of the calorimeter respectively along with the stirrer.

m_2 & s_2 = mass and specific heat capacity of water in the calorimeter respectively

Θ_1 = initial temperature of water in the calorimeter

Θ_2 = initial temperature of steam (close to 100^0C)

Θ = final temperature of water in the calorimeter

m = mass of steam condensed into water

L = Latent heat capacity of condensation of steam.

Heat absorbed by the calorimeter and water = $(m_1s_1+m_2s_2)(\Theta-\Theta_1)$ Joules (1)

Heat lost by steam during condensation = mL Joules

Heat lost by m kg of water (condensed steam) at $\Theta_2{}^0$C to cool down to Θ^0C

$= ms_2(\Theta_2-\Theta)$ Joules

Total heat lost = $mL+ ms_2(\Theta_2-\Theta)$ (2)

From equation (1) and (2): $mL+ ms_2(\Theta_2-\Theta) = (m_1s_1+m_2s_2)(\Theta-\Theta_1)$

$$L = [(m_1s_1+m_2s_2)(\Theta-\Theta_1) - ms_2(\Theta_2-\Theta)]1/m \text{ Joules/kg}$$