Calorimetry, Mechanical Equivalent

Specific heat capacity (S)

Heat required to rise the temperature of unit mass of body through *1° C* is called specific heat capacity. It's unit is *J/kg° C.*

Heat capacity or thermal capacity (C)

Heat required to rise the temperature of anybody through *1° C* is called heat capacity or thermal capacity.

$$\therefore \text{Heat capacity } (C) = mS$$

Heat gained or lost by a body

Heat gained or lost by a body depends on mass, specific heat capacity and change in temperature so

$$\text{Heat gained or lost } (Q) = mS\Delta\theta$$

Principle of Calorimetry

Heat lost by a body = Heat gained by another body

Water equivalent (W)

Mass of water that can give same rise in temperature for same amount of heat as body give. It's unit is *g* or *kg.*
$Q = ms\Delta\theta = WS_w\Delta\theta$
or, $C = WS_w$

- In *cgs* system $S_w = 1cal/g/^oC$ so $C = W$
  i.e. water equivalent of a body is numerically equal to heat capacity.
- n *SI* system $S_w = 4200J/kg/^oC$
  So, $C = W \times 4200$

Newton's Law of cooling

The rate of loss of heat of a body is directly proportional to the difference in temperature between body and surrounding. It is valid for small difference in temperature between body and surrounding

$$\therefore \frac{dQ}{dt} \propto (\theta - \theta_0)$$

$$\text{or, } \frac{dQ}{dt} = -\text{k}\,(\theta - \theta_0)$$

Where *−ve* sign indicates loss of heat decreases on increasing time, *K = proportionality constant.*

$$\text{or, } \frac{d\theta}{dt} = \frac{-k}{ms}(\theta - \theta_0)$$

Change in state

Heat required to change the state of matter without change in temperature is called latent heat. It is divided as

- **Latent heat of fusion**
  Heat required to change solid into liquid at it's melting point.
  Specific latent heat of fusion (L_f):
  Heat required to change unit mass of solid into liquid at it's melting point.
  $\therefore \text{Heat required } (Q) = mL_f$

- **Latent heat of vaporization**
  Heat required to change liquid into gas at it's boiling point.
  Specific latent heat of vaporization (L_v):
  Heat required to change unit mass of liquid into gas at it's boiling point.
  $\therefore \text{Heat required } (Q) = mL_v$

Mechanical equivalent

The heat energy developed equivalent to mechanical energy is called mechanical equivalent

$\therefore W = J.H$

W = Mechanical energy is measured in joule
H = Heat energy is measured in calorie
J = Joule's mechanical equivalent of heat

- Value of specific heat capacity depends on state of matter. Which is least for solid state, intermediate for liquid and maximum for gases.
- Specific heat capacity is maximum for hydrogen is *3.5 cal/g^o C* and minimum for radon andactinium ie *0.022 cal/g^o C*.
- Specific heat capacity during change in state is *infinite* and *0* for adiabatic process.