Specific Heat capacity:

Heat capacity (S):

The amount of heat required to raise the ~~t~~ unit temp of a substance is called heat capacity of the substance.

Suppose an amount of heat ΔQ supplied to a substance changes its temp from T to $(T+\Delta T)$.

Then, Heat capacity $(S) = \frac{\Delta Q}{\Delta T}$

Note: Heat capacity is dependent on mass (m) and Temperature.

i.e. a different amount of heat may be needed for a unit rise in temp at different temperatures.

Specific heat capacity (s):

To define a constant characteristic of the substance and independent of its amount, we ~~deti~~ devide S by the mass (m) of the substance in kg.

$$s = \frac{S}{m} = \left(\frac{1}{m}\right)\left(\frac{\Delta Q}{\Delta T}\right)$$

s is known as the specific heat capacity of the substance.

*. s depends on the nature of the substance and temperature.

*. The unit of s is J/kg/K.

Defn:- <u>specific heat capacity (s)</u>: The amount of heat required to raise the unit temperature of a unit mass substance is called specific heat capacity (s) of the substance.

<u>Molar specific heat capacity (c)</u>:

The amount of heat required to raise the unit temperature of a unit mole of substance is called ~~specific~~ molar specific heat capacity (c) of the substance.

$$c = \frac{S}{\mu} = \frac{1}{\mu} \cdot \frac{\Delta Q}{\Delta T}$$

Molar specific heat capacity is denoted by c, where μ is the number of moles of the substance.

*. c is independent on amount of substance.

*. c depends on the nature of the substance, its temperature and the conditions under which heat is supplied.

*. unit of c is J/mol/K.

Molar specific heat capacity of solids:

consider a solid of N_A-atoms, each vibrating about its mean position. (N_A = Avogradö's Number = 1 mole)

An oscillator in one dimension has ~~average~~ average energy of $2 \times \frac{1}{2} k_B T = k_B T$, since vibrational mode has both kinetic and potential energy modes.

In 3D, the average energy is $3 \times k_B T = 3k_B T$.

For a solid of 1 mole, i.e. N_A atoms, total energy is : $3k_B T \times N$

$$\therefore \quad U = 3Nk_B T = 3RT \quad \rightarrow (1)$$

where, $R = k_B \times N$

= universal Gas constant.

From 1st law of thermodynamics,

$$\Delta Q = \Delta U + P\Delta V \quad \longrightarrow (2)$$

Now, for a solid, change in volume is negligible, i.e. $\Delta V = 0$.

$$\therefore \quad \Delta Q = \Delta U + P \times 0 = \Delta U \quad \rightarrow (3)$$

Now,

$$C = \frac{1}{\mu} \cdot \frac{\Delta Q}{\Delta T} \quad \rightarrow (4)$$

since, $\mu = 1$ mole, $\Delta Q = \Delta U$

$$\therefore C = \frac{1}{1}\left(\frac{\Delta U}{\Delta T}\right) \qquad \left(\begin{array}{l} U = 3RT \\ \Rightarrow \Delta U = 3R\Delta T \end{array}\right)$$

$$= \frac{3R\Delta T}{\Delta T} = 3R$$

$$\Rightarrow C = 3R \rightarrow (5)$$

Break down at low temperature:

The experimentally measured values of molar specific heat capacity generally agrees with predicted value 3R at ordinary temperatures. (carbon is an exception).

~~This break down is known as~~

This agreement is known as break down at low tempr.