of matter

Thermal Properties of matter

Heat : Heat is a form of energy which produces in us the sensation of hotness or coldness

~~Temptur~~ Temperature : Temperature is a relative measure or indication of hotness or Coldness.

Thermometer : Thermometer is an instrument which is used to measure the temperature of the body.

Different scales of tempetature measurement

i) Celsius
ii) Fahrenheit
iii) Reaumer
iv) Kelvin

Date

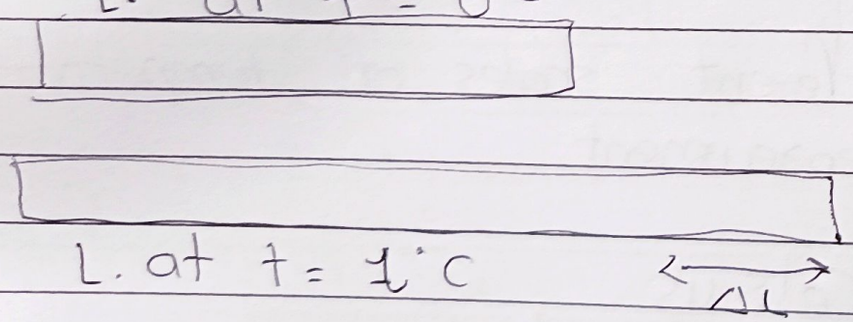
Conversion of temperature from on scale to another

$$\frac{C}{100} = \frac{F-32}{180} = \frac{R}{180} = \frac{K-273}{100}$$

Thermal Expansion

1. Linear expansion

When the length of a solid increases on heating the thermal expansion is called linear expansion.



$\therefore \Delta L = L - L_0$

Experimentally

i) $\Delta L \propto L_0$

ii) $\Delta L \propto \Delta T$

$\therefore \Delta L \propto L_0 \Delta T$

$\Delta L = \alpha L_0 \Delta T$

$$\alpha = \frac{\Delta L}{L_0 \Delta T} \quad \text{.....} (2)$$

The SI unit of α is $^\circ C^{-1}$ or K^{-1}

from eqn (1) and eqn (2)

$\Delta L = L - L_0$

$L - L_0 = \alpha L_0 \Delta T$

$L = L_0 + \alpha L_0 \Delta T$

$L = L_0 (1 + \alpha \Delta T)$ -----(3)

Where the constant of proportionality 'α' is called coefficient of linear expansion of the material of the rod.

Date

2) Area Expansion :-

When the area of a solid increases on heating the thermal expansion is called Area Expansion.

Experimentally :-

i) $\Delta S \propto S$.

(ii) $\Delta S \propto \Delta T$

$\therefore \Delta S \propto S.\Delta T$

$\Delta S = \beta S.\Delta T$ ..... ①

$$\boxed{\beta = \frac{\Delta S}{S.\Delta T}} \quad \text{---- ②}$$

Where, β is the constant of propor... know as coefficient of superficial expansion

The SI unit of β is $^\circ C^{-1}$ or K^{-1}

Now, $S - S_0 = \beta S_0 \Delta T$

$S = S_0 + \beta S_0 \Delta T$

$S = S_0 (1 + \beta \Delta T)$ .. ③

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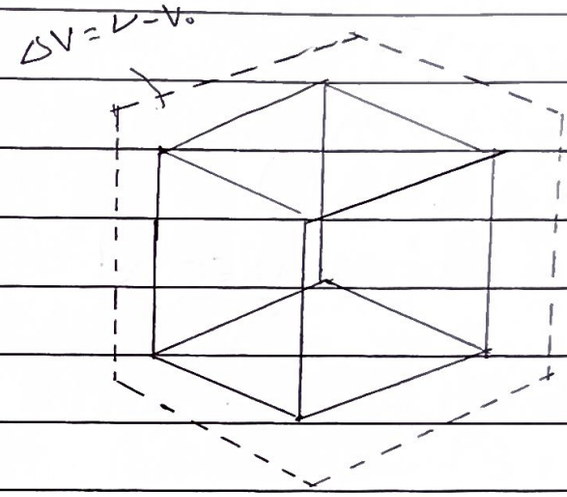
3) Volume / Cubical Expansion

When the volume of solid increases on heating the thermal expansion is called volume expansion.



Experimantally.

i) $\Delta V \propto V_0$

ii) $\Delta V \propto \Delta T$

$\therefore \Delta V = V_0 \Delta T$

$\Delta V = \gamma V_0 \Delta T$

$$\boxed{\gamma = \frac{\Delta V}{V_0 \Delta T}}$$

$[V = V_0 (1 + \gamma \Delta T)]$

γ is the Coefficient of cubical expansion.

SI unit of γ is $^\circ C^{-1}$ or K^{-1}

Date

Relationship beth the three coefficient of expansion

$L = L_0(1 + \alpha \Delta T)$

$L^2 = L_0^2 (1 + \alpha \Delta T)^2$

$S = S_0 (1 + \alpha^2 \Delta T^2 + 2\alpha \Delta T)$

Let $\alpha^2 \Delta T^2$ can be neglected

$\therefore$ α is small

$S = S_0 (1 + 2\alpha \Delta T)$

$S = S_0 (1 + \beta \Delta T)$

After comparing

$$\boxed{\beta = 2\alpha}$$

Date

Relationship beth α & γ :-

$L = L_0 (1 + 2\Delta T)$

$L^3 = L_0^3 (1 + \alpha \Delta T)^2$

$V = V_0 (1 + \alpha^3 \Delta T^3 + 3\alpha \Delta T + 3\alpha^2 \Delta T^2)$

$\because$ $\alpha^3 \Delta T^3$ and $\alpha^3 \Delta T^2$ can be neglect

$V = V_0 (1 + 3\alpha \Delta T)$

But $V = V_0 (1 + \gamma \Delta T)$

$$\boxed{\gamma = 3\alpha}$$

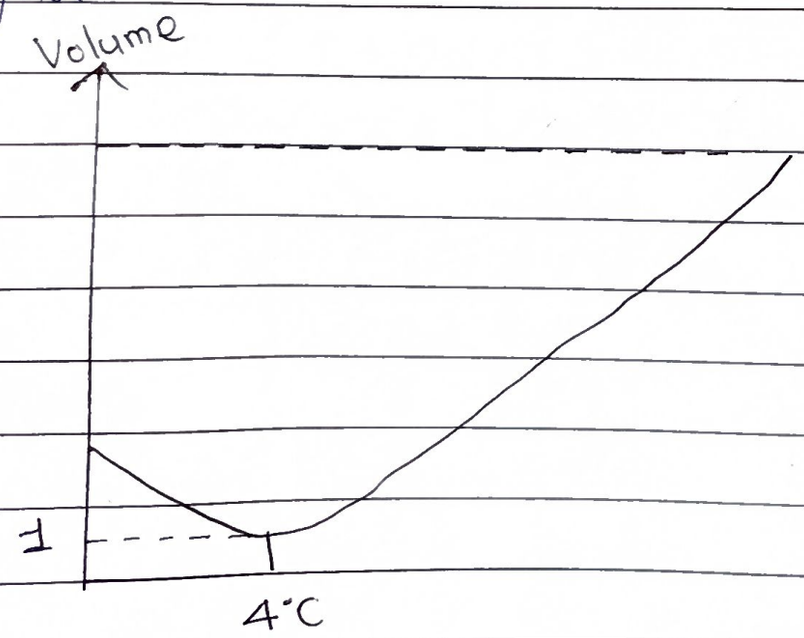
Finally $\alpha : \beta : \gamma = 1 : 2 : 3$

$$\frac{\alpha}{1} = \frac{\beta}{2} = \frac{\gamma}{3}$$

Date _____

Anomalous Expansion of water:

The common liquid water does not behave like other liquid. At above 0°C water expand as the temperature rises. Beth 0°C and 4°C water contract with increasing temperature The volume of given amount of water decreases as it is ~~closed~~ Cooled from room temp, until its tempt. reaches 4°C As shown in figure



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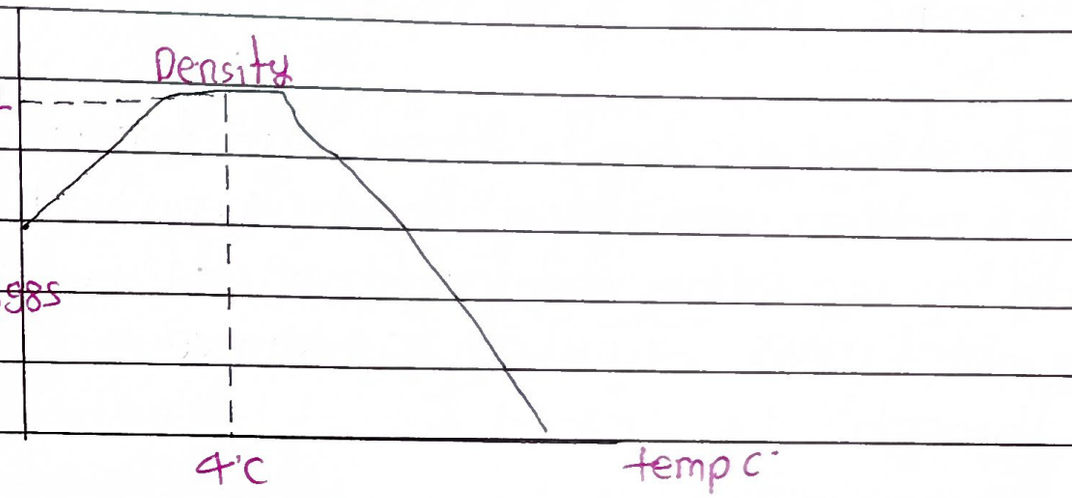

Below 4°C the volume increases but density decreases

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Specific Heat Capacity :-

The Specific heat of a substance is the amount of heat required to raise the temperature of a unit mass of the substance through 1 k or 1°C

Experimetally

$Q \propto m$

$Q \propto \Delta T$

$\therefore Q \propto \Delta T m$

$Q = SM\Delta T$

$S = \frac{Q}{m\Delta T}$ J/kg k

Date _____

Specific Heat of a Gas

The specific heat of a substance is the amount of heat required to increase the temp. of a unit mass of it through unit temp. change

Specific Heat at Constant Volume :-

The principle specific heat of a gas at constant volume is defined as the amount of heat required to raise the temp of 1g of the gas through 1°c or 1k at constant volume It is denoted by C_v

$$C_v = \left(\frac{dQ}{dT}\right)_v$$

Date

Specific Heat at Constant Pressure:

It is the amount of heat required to raise the temp. of 1g of the gas through 1°C or 1K at constant pressure

$$C_p = \left(\frac{dQ}{dT}\right)_p$$

Specific heat ratio

$$= \frac{C_p}{C_v} = \gamma$$

$[C_p - C_v = R]$ mayor relation

$C_p > C_v$ (always)

Date

Calorimetry :-

Principle of Calorimetry :-

Calorimetry means measurement of heat. According to principle of Calorimetry - "when a body at higher temp is brought in contact with another body at lower temp, the heat gained by the colder body, provided no heat is allowed to escape to the surrounding

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Date

Change in ~~water~~

A transition from one of the three states of matter to another is called change in state.

Date

Latent Heat

The amount of heat per unit mass transfered during a change of state of the substance is called latent heat

$$Q = mL \quad = \quad \boxed{L = \frac{Q}{m} \ J/kg}$$

Types of latent heat

1. Latent heat of fusion (L_f)
   - [solid, liquid. state]
2. latent heat of vapourization (L_v)
   - [liquid, gas state

Date

Heat Transfer

1) Conduction :

Conduction is the mechanism of transfer of heat beth two adjacent part of a body because of their temperature difference, without the actual movement of the particle from their equilibrium position

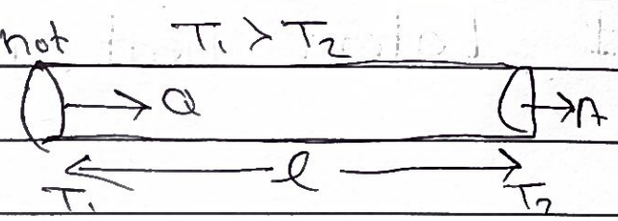
Experimentally,

i) $Q \propto A$

ii) $Q \propto t$

iii) $Q \propto (\Delta T)$

iv) $Q \propto \frac{1}{l}$



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After combining

$$Q \propto \frac{A(\Delta T)t}{l}$$

$$\boxed{Q = \frac{RA(T_2 - T_1)t}{l}}$$

R = Coefficient of thermal conductivity

Unit of 'k' = $Jm^{-1}K^{-1}sec^{-1}$ or $Wm^{-1}K^{-1}$

Date

Convection :

Convection is a process in which heat is transfered from one point to another by actual movement of material particle from a region of lighter temp. to region of lower temp.

Date

Radiation :

The energy emitted by a body in the from of radiation by virtue of its temp. is called thermal radiation. The most powerful source of radiation energy is sun

Black Body :

A perfectly black body is one which absorb completly the radiation of all wavelength falling on it