

[2]

Wax

Aim:- Determination the melting Point of wax

Theory:-

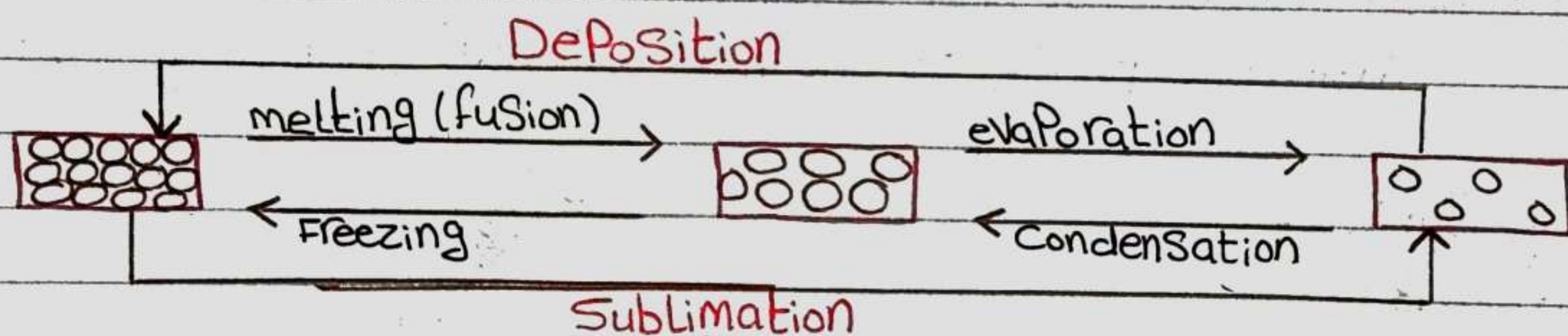
→ * Heat: Form of energy that transfer between Substances of different temperatures.

unit:- SI: Joule Cgs: erg - Calorie (cal.)

→ * Temperature: Measurement of the hotness or Coldness of the Substance.

unit:- Fahrenheit ($^{\circ}\text{F}$) - Celsius ($^{\circ}\text{C}$) - kelvin (K)

* A Substance in the Solid State can be converted to Liquid State by heating (thermal energy), by further heating it converts from Liquid to gas phase



State Phase	Solid	Liquid	gas
* attractive Force between molecules	greatest	less than Solid	approximately zero
* Intermolecular distance	Very Small	more than Solid	Very Large
* Shape	Constant	different	Variable
* Volume	Constant	Constant	Variable

⇒* Melting (Fusion):- The process which the substance converts from solid to liquid state.

⇒* Melting Point:- Temperature at which the substance converts from solid to liquid state.

⇒* Freezing:- The process which the substance converts from liquid to solid state.

⇒* Freezing Point:- Temperature at which the substance converts from liquid to solid state.

⇒* Specific heat:- Amount of heat required to raise the temp. of one gram of the substance one degree Celsius.

⇒* Latent heat:- Amount of heat required to transfer the substance from one phase to another without changing its Temp.

* Cooling Curve:-

• From A → B:-

* Temp. decrease

* The substance is in liquid state

• From B → C:-

* Transformation from liquid to solid.

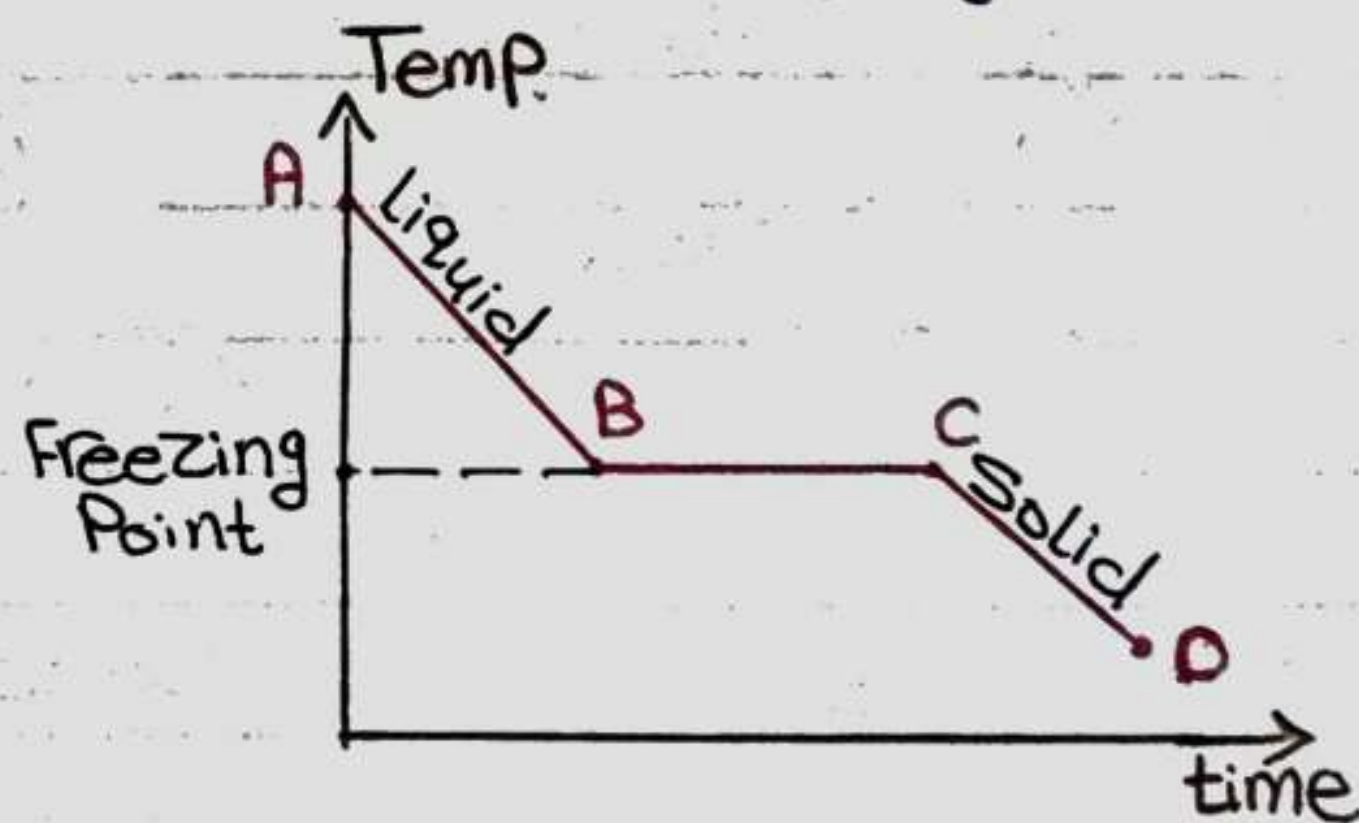
* The temp. remains constant.

* The thermal energy is used to overcome the repulsive forces between molecules.

• From C → D:-

* Temp. decrease

* The substance in solid phase



Tools:- ① Thermometer

② Heater

③ Tube filled with wax

④ Stop watch

⑤ water bath

Steps:-

① Heat wax tube by putting it in water bath until the wax reach 90°C

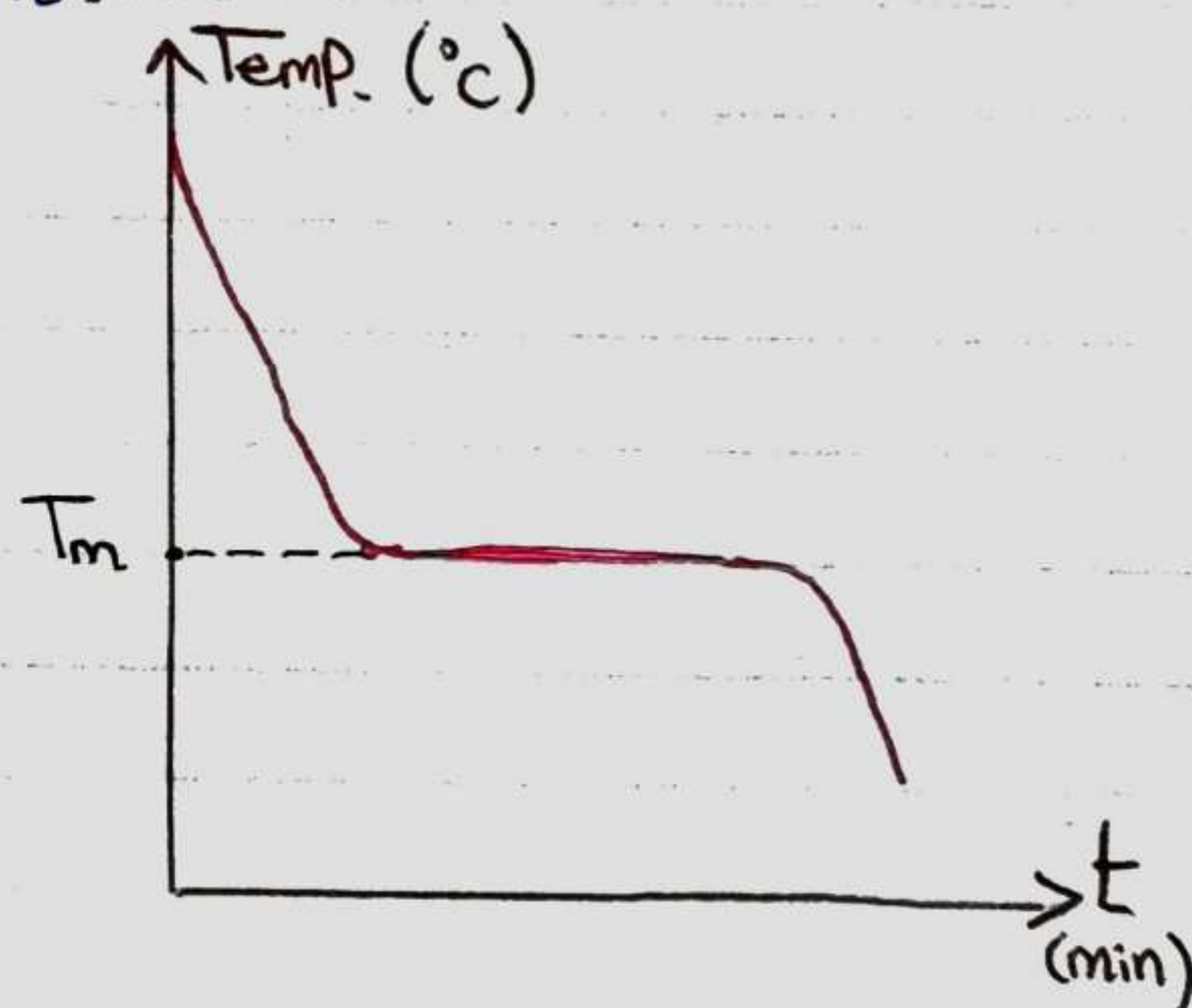
② Remove wax tube from water bath

③ Start the stop watch and read temp. each 0.5 minute until it reaches 45°C

④ Tabulate the results and draw Cooling Curve.

⑤ Determine (T_m) melting Point.

Temp. ($^{\circ}\text{C}$)	Time (min)
90°	0
	0.5
	1
	1.5
45°	



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Speed of Sound 1: [open - closed tube]

Aim: Determination the Speed of Sound in air

Theory:

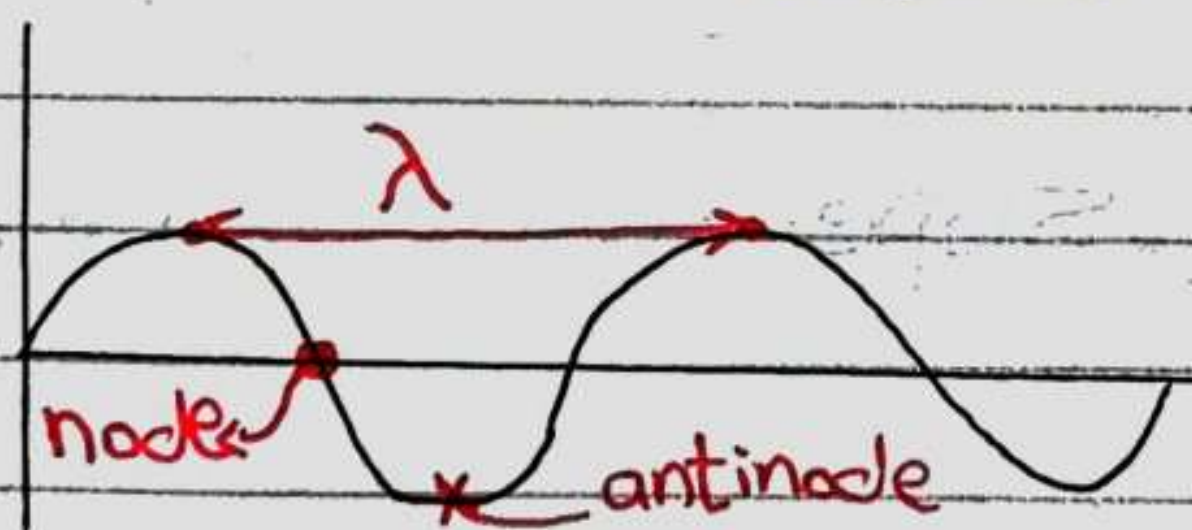
→ Sound: It is the kinetic energy of atom or molecules in motion in a periodic manner.

→ wave: disturbance ^{اضطراب} spread and carry energy with it

• Types of waves:

① Transverse wave: it is the wave that the vibration of medium molecules is normal to the direction of propagation

② Longitudinal wave: it is the wave that the vibration of medium molecules is in the same direction of propagation



« transverse wave »

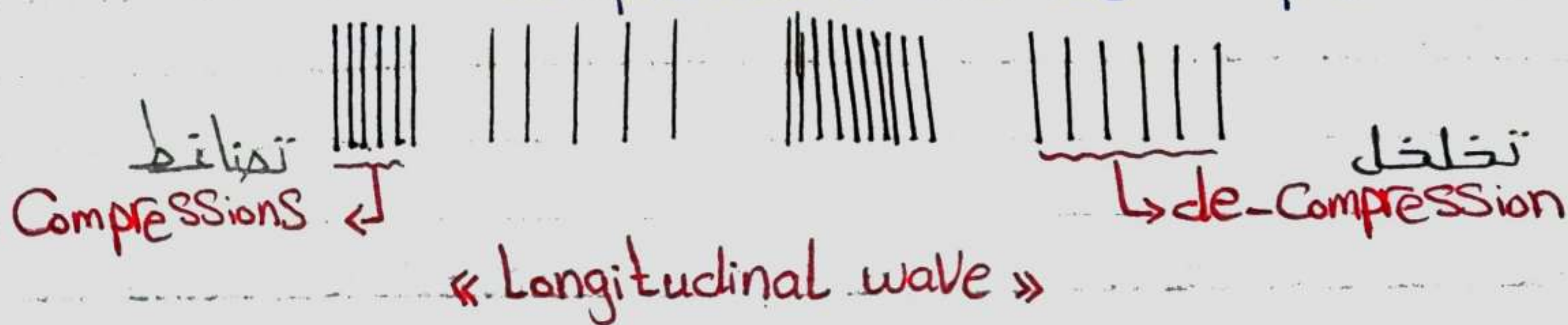
* classification of waves:

① Mechanical waves: Can propagate in medium, Can't in space
ex: Sound

② Electromagnetic waves: Can propagate in medium and space
ex: Light

③ Standing waves: It's a large amplitude waves that appear to be stationary with nodes and antinodes

⇒ Sound waves: Longitudinal mechanical waves Consists of Compressions and de-Compressions.



• Compressions:-

- ✓ Have pressure more than normal
- ✓ molecules of the medium are very close to each other

• De-Compressions:-

- ✓ Have pressure less than normal
- ✓ molecules of the medium are far from each other

~~~~~> Law:-

$$\therefore V = 4 \cdot L \cdot \nu$$

$$\therefore \text{Slope} = L \cdot \nu$$

$$\therefore V = 4 * \text{Slope} = \dots \text{cm/s}$$

Tools:-

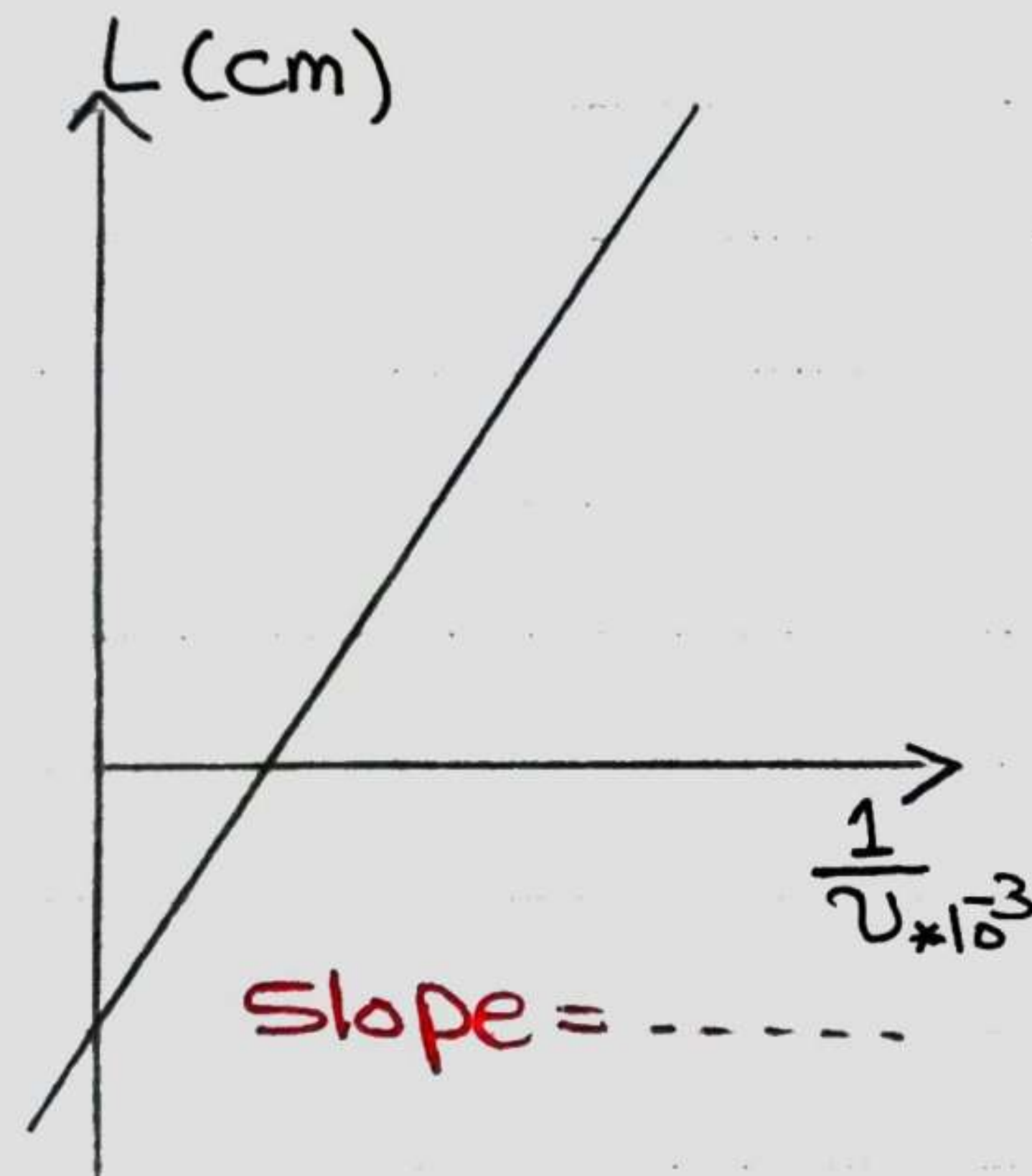
- ① Vacuum tube
- ② Set of tuning forks
- ③ ~~meter~~ ruler
- ④ tube filled with water

Steps:-

- ① put vacuum tube in the one that filled with water
- ② Hit the tuning fork and put it at upper end of the tube then move the tube up and down untill you hear the maximum intensity of sound, then measure the length.
- ③ Repeat the previous step with the other two forks.
- ④ Tabulate your results:-

| $\nu$ Hz | $L_1$ | $L_2$ | $L_3$ | $L_{av}$ | $\frac{1}{\nu} \times 10^{-3}$ |
|----------|-------|-------|-------|----------|--------------------------------|
|          |       |       |       |          |                                |
|          |       |       |       |          |                                |
|          |       |       |       |          |                                |
|          |       |       |       |          |                                |
|          |       |       |       |          |                                |

$$V = 4 * \text{Slope} = \dots \text{ cm/s}$$



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## Speed of Sound 2: [open-open tube]

Aim: Determination the Speed of Sound in air

Theory:

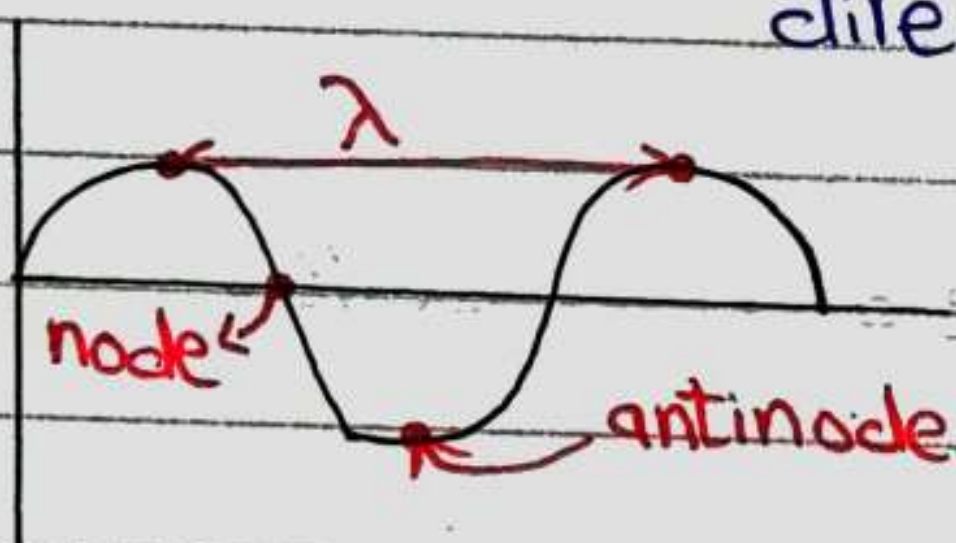
⇒ Sound: It is kinetic energy of atom or molecules in motion in a periodic manner.

⇒ wave: disturbance spread and carry energy with it

• Types of waves:

① Longitudinal wave: it is the wave that the vibration of medium molecules is in the same direction of propagation

② Transverse wave: it is the wave that the vibration of medium molecules is normal to the direction of propagation



« transverse wave »

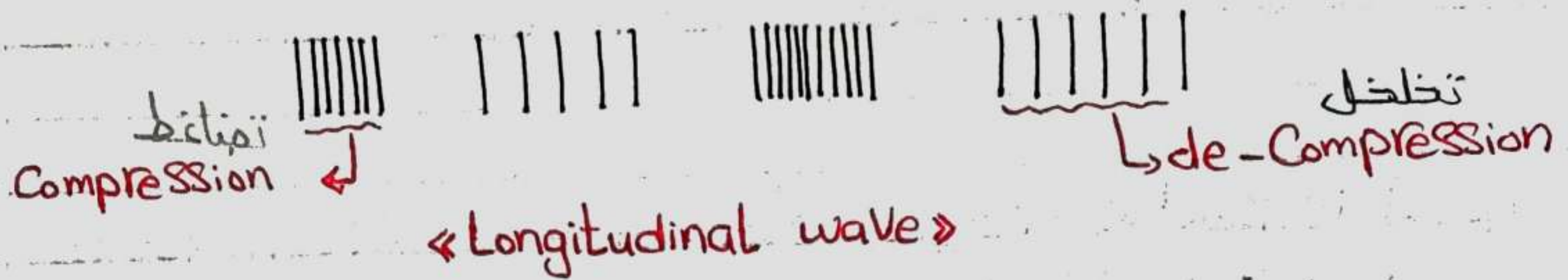
\* Classification of waves:

① Mechanical waves: Can propagate in medium, Can't in space  
ex: Sound

② Electromagnetic waves: Can propagate in medium and space  
ex: Light

③ Standing waves: It's a large amplitude waves that appear to be stationary with nodes and antinodes.

⇒ Sound waves: Longitudinal mechanical waves consists of Compressions and de-Compressions



### ● Compression:

- ✓ Have pressure more than normal
- ✓ molecules of the medium are very close to each other

### ● De-Compression:

- ✓ Have pressure less than normal
- ✓ molecules of the medium are far from each other

### → Law:

$$V = 2 \cdot L \cdot \nu$$

$$\text{Slope} = L \cdot \nu$$

$$\therefore V = 2 * \text{Slope} = \dots \text{cm/s}$$

### Tools:

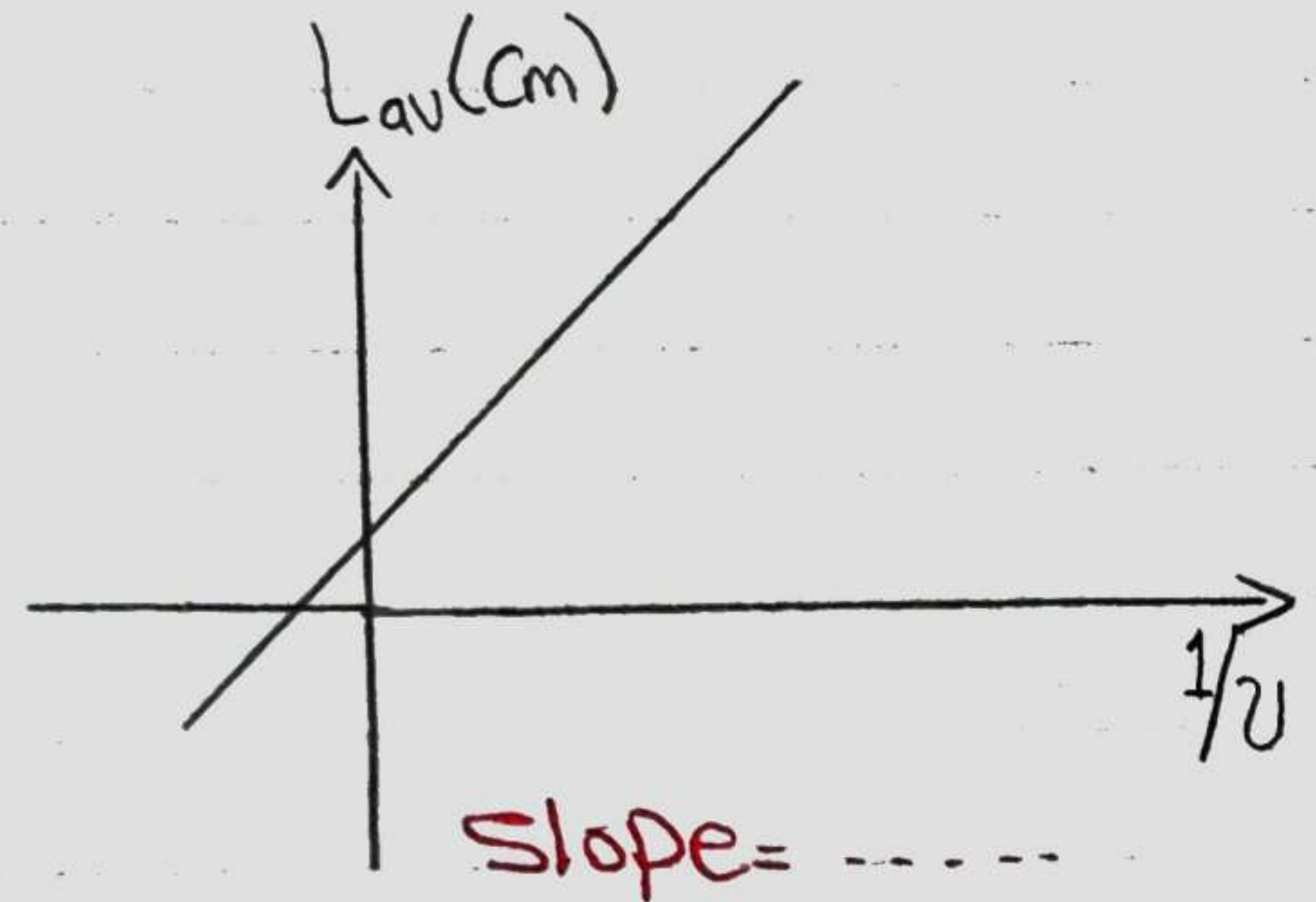
- ① Vacuum tube
- ② set of tuning forks
- ③ Ruler

### Steps:

- ① put one vacuum tube into the other
- ② Hit the tuning fork and put it at upper end of tube then move the tube up and down until you hear the maximum intensity of sound, then measure the length.
- ③ Repeat the previous step with the other two forks
- ④ Tabulate the results:-

| $v_{Hz}$ | $L_1$ | $L_2$ | $L_3$ | $L_{av}$ | $1/v \times 10^{-3}$ |
|----------|-------|-------|-------|----------|----------------------|
|          |       |       |       |          |                      |
|          |       |       |       |          |                      |
|          |       |       |       |          |                      |
|          |       |       |       |          |                      |
|          |       |       |       |          |                      |
|          |       |       |       |          |                      |
|          |       |       |       |          |                      |
|          |       |       |       |          |                      |
|          |       |       |       |          |                      |

$$v = 2 * \text{slope} = \dots \text{ cm/s}$$



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# Latent heat of fusion of ice

Aim: Determination of the latent heat of fusion of ice ( $L_f$ )

Theory:

⇒ \* Heat: Form of energy that transfer between substances of different temperatures.

unit: →

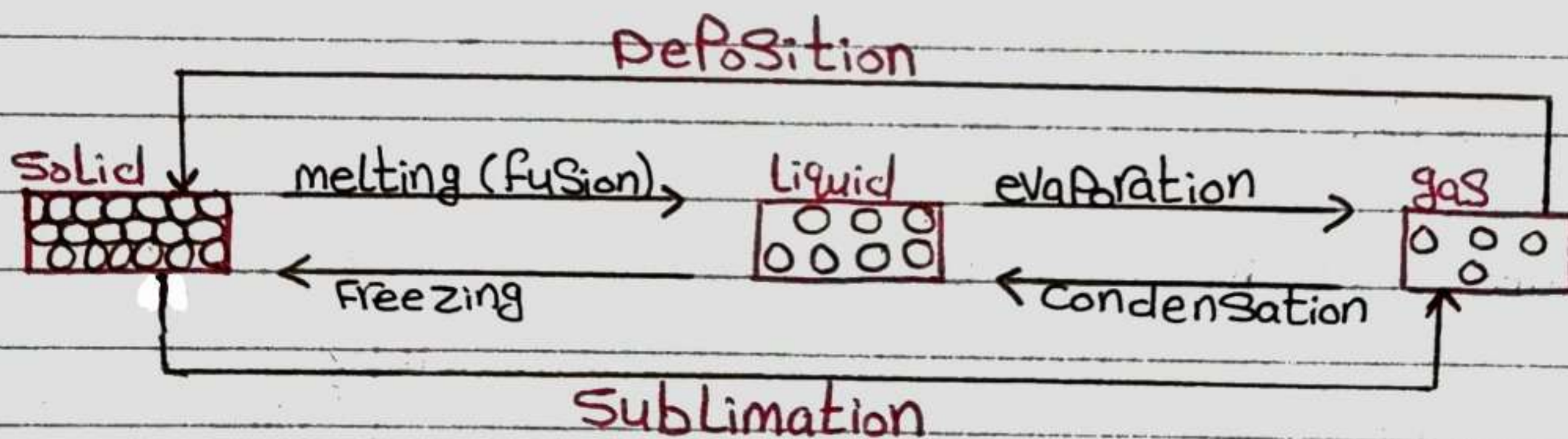
SI: Joule , CGS: erg - Calorie (cal.)

⇒ \* Temperature: Measurement of the hotness or coldness of the substance.

unit:

Fahrenheit ( $^{\circ}F$ ) - Celsius ( $^{\circ}C$ ) - Kelvin (K)

\* A substance in the solid state can be converted to liquid state by heating (thermal energy), by further heating it converts from liquid to gas phase.



| State Phase                          | Solid      | Liquid          | Gas                |
|--------------------------------------|------------|-----------------|--------------------|
| * attractive force between molecules | greatest   | less than Solid | approximately zero |
| * Intermolecular distance            | Very small | more than Solid | Very large         |
| * Shape                              | constant   | different       | Variable           |
| * Volume                             | Constant   | Constant        | Variable           |

⇒ \* Melting (fusion):- The process which the substance converts from solid to liquid state.

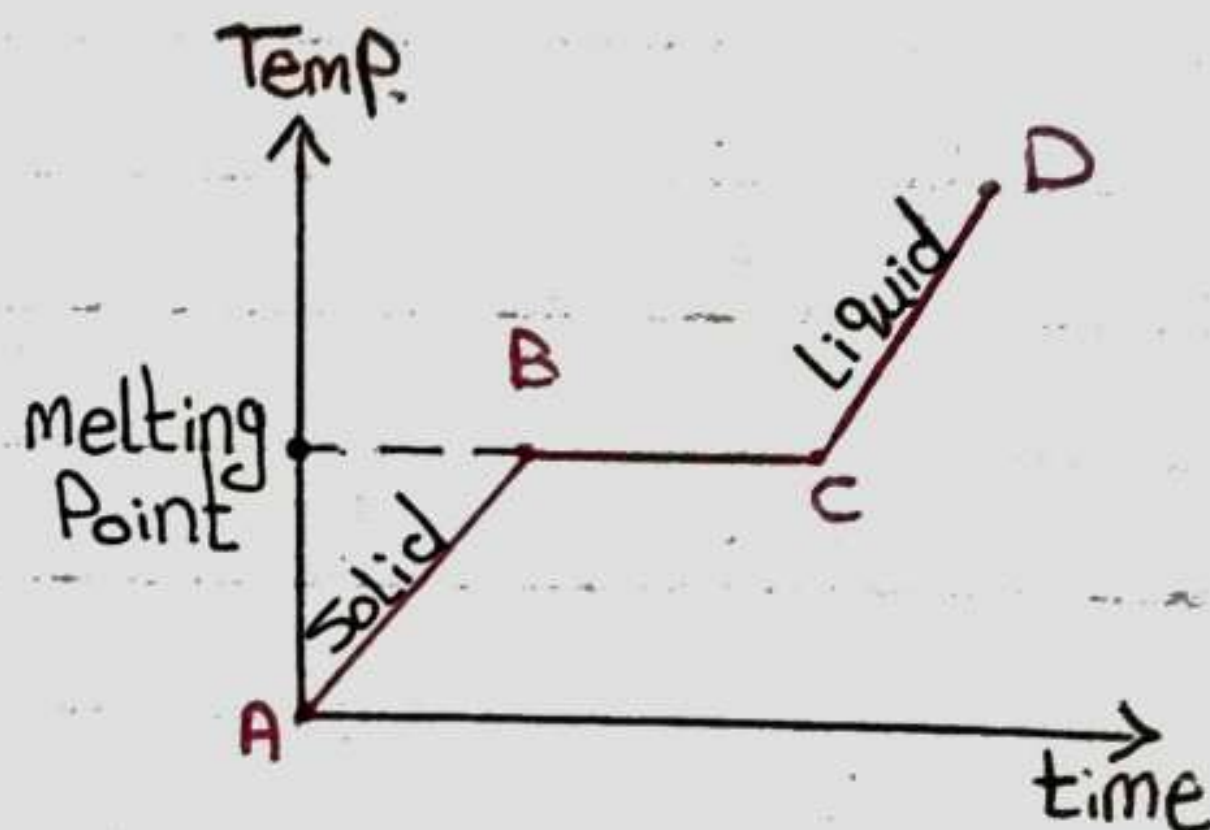
⇒ \* Melting temperature (point):- Temperature at which the substance converts from solid to liquid state.

### \* Heating Curve:-

• From A → B:-

\* Temp. increase.

\* The substance is in solid state.



• From B → C:-

\* transformation from solid to liquid.

\* The temp. remains constant.

\* The thermal energy (heat) is used to overcome the attraction forces between molecules.

• From C → D:-

\* Temp. increase.

\* The substance in liquid phase.

### \* Cooling Curve:-

• From A → B

\* Temp. decrease

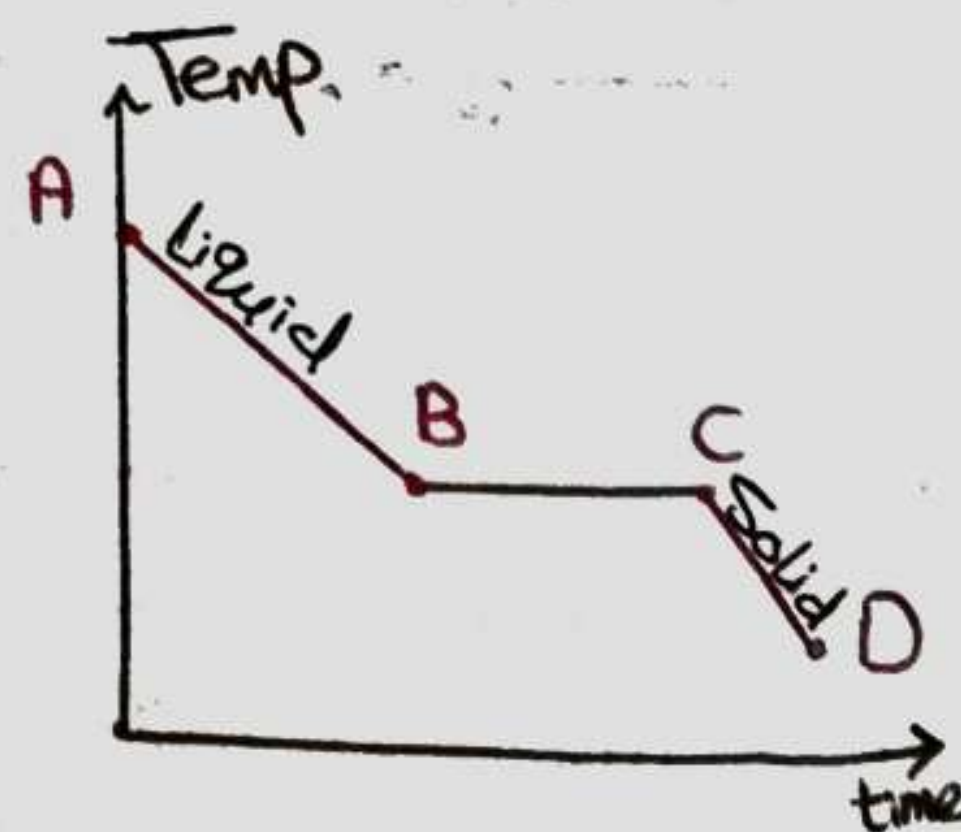
\* The substance is in liquid state.

• From B → C:-

\* Transformation from liquid to solid

\* The temp. remains constant

\* The thermal energy (heat) is used to overcome the repulsive forces between molecules.



• From C → D:-

\* Temp. decrease.

\* The substance in solid phase

\* in the transformation region (B-c), although we continue providing the substance with heat. However, the temp. not changes. This is mostly like that the heat is hidden within the system. That is what we call **Latent heat**.

⇒\* **Latent heat**: Amount of heat required to transfer the substance from one phase to another without changing its temp.

⇒\* **Latent heat of fusion**: Amount of heat required to transfer the substance from ~~one~~ solid to liquid phase without changing its temp.  $Q = mL_F$

$$* L_F = \frac{[(T_w - T_F)(M_w C_w + M_c C_c)] - M_i C_i T_F}{M_i} = \dots \text{Cal/g}$$

where:  $T_w \rightarrow$  Temp. of water

$T_F \rightarrow$  Temp. of Fusion (mixture)

$M_w \rightarrow$  mass of water

$M_i \rightarrow$  mass of ice

$M_c \rightarrow$  mass of calorimeter

$C_c \rightarrow$  Specific heat of calorimeter =  $0.25 \text{ Cal/g} \cdot ^\circ\text{C}$

$C_w \rightarrow$  Specific heat of water =  $1 \text{ Cal/g} \cdot ^\circ\text{C}$

$C_i \rightarrow$  Specific heat of ice =  $1 \text{ Cal/g} \cdot ^\circ\text{C}$

⇒\* **Specific heat**: Amount of heat required to raise the temp. of one gram of the substance one degree Celsius.

$$S = \frac{Q}{m \cdot \Delta T}, \quad \Delta T = (T_f - T_i)$$

\* when two substance are in thermal contact with each other, they are therefore must having different temp.

$\begin{matrix} T_1 & T_2 \\ \boxed{A} & \boxed{B} \end{matrix} \Rightarrow$  Thermal Contact  $T_1 \neq T_2$

$\begin{matrix} T_1 & T_2 \\ \boxed{A} & \boxed{B} \end{matrix} \Rightarrow$  Thermal equilibrium  $T_1 = T_2$

⇒\* Thermal equilibrium: Occurs when two substances are in thermal contact and reaches the same temp.

In this case, there is no heat exchange

⇒ The heat Lost = The heat gained.

Tools: ① Calorimeter

② balance

③ water

④ ice

⑤ Thermometer

Steps:

① Determine mass of Calorimeter ( $m_c$ ) by using balance.

② Add warm water to Calorimeter about half of it.

③ measure Temp. of water ( $T_w$ )

④ Determine mass of water and Calorimeter ( $m_1$ ) Then calculate ( $M_w$ ) where  $M_w = m_1 - m_c = \dots \text{ gm}$ .

⑤ Add ice to water and mix it well until it melts.

⑥ measure Temp. of mixture ( $T_f$ )

⑦ Determine mass of mixture ( $m_2$ ) Then calculate ( $m_i$ ) where  $m_i = m_2 - m_1 = \dots \text{ gm}$ .

⑧ Determine the latent heat of fusion of ice ( $L_f$ ) where:

$$L_f = \frac{[(T_w - T_f)(M_w C_w + M_c C_c)] - m_i C_i T_f}{m_i} = \dots \text{ Cal/g}$$

## Newton's Law of Cooling

**Aim:** Study Newton's Law of Cooling by plotting a graph between Cooling time and temperature.

### Theory:

⇒ **Heat**: Form of energy that transfer from one object to another as a result of difference in their temp.

**units**: SI: Joule      Cgs: erg - Calorie (cal)

⇒ **Temperature**: Measurement of the hotness or coldness of the substance

**units**: Fahrenheit ( $^{\circ}\text{F}$ ) - Kelvin ( $^{\circ}\text{K}$ ) - Celsius ( $^{\circ}\text{C}$ )

⇒ **Thermometer**: It's a device calibrated to measure the temp. of an object

**Types**:

- ① Liquid thermometer
- ② Gas thermometer
- ③ Resistance thermometer
- ④ Thermo Couple thermometer

### \* Cooling Curve:-

• From A → B:-

\* Temp. decrease

\* The substance is in liquid state

• From B → C

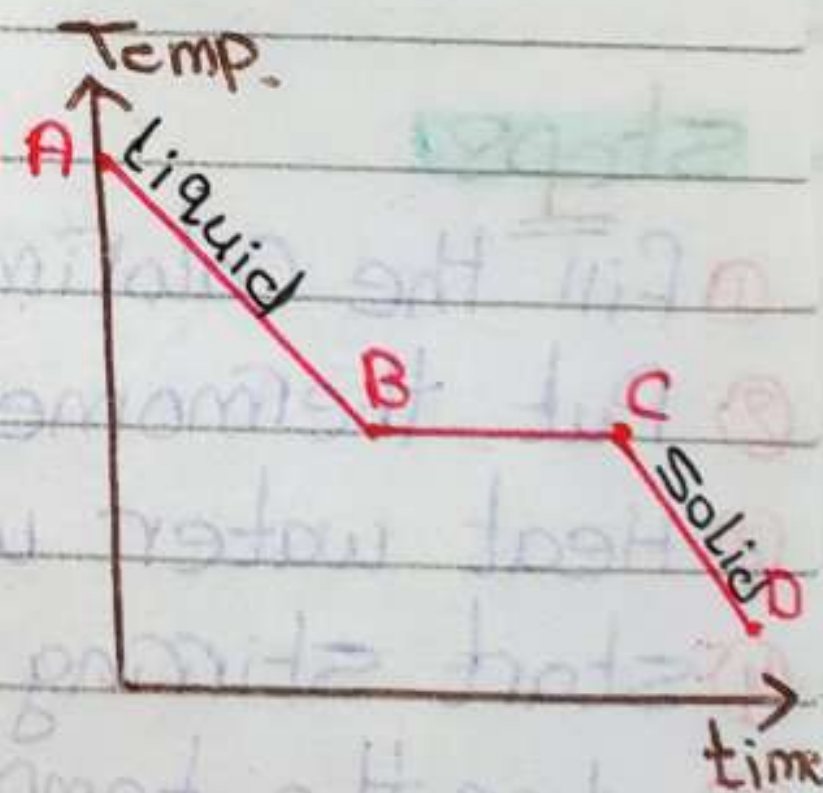
\* transformation from liquid to solid

\* The temp. remains Const.

• From C → D

\* Temp. decrease

\* The substance in solid phase



⇒ **Newton's Law of Cooling states that:-**

The rate of loss of heat of a body is directly proportional to the difference of temp. between the body and the surroundings.

⇒ Only apply on small difference of temp.

⇒ **The rate of loss of heat depends on:-**

- ① The area of the exposed surface.
- ② The nature of surface
- ③ Surface temp.
- ④ Surrounding temp.

$$* \frac{dT}{dt} = K (T_f - T_i) \quad \text{الحرارة قبل التسخين (حرارة الغرفة)}$$

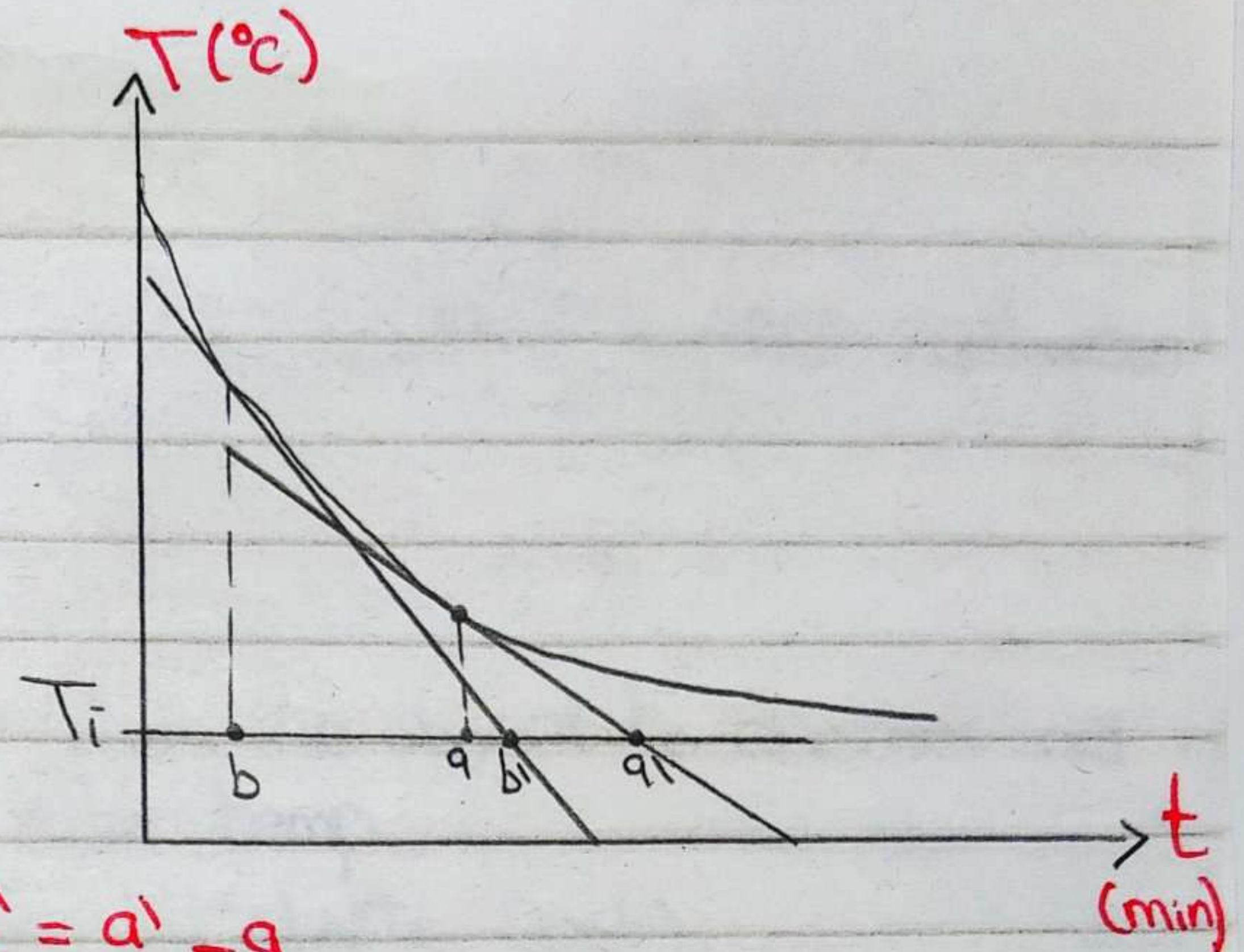
**Tools:-**

- ① Calorimeter with stirrer
- ② Thermometer
- ③ Stopwatch
- ④ heating device (heater)
- ⑤ water

**Steps:-**

- ① Fill the Calorimeter about 2/3 with water
- ② Put thermometer in water
- ③ Heat water until the temp. is 80°C
- ④ start stirring water to make it Cool down regularly
- ⑤ when the temp. is about 70°C start stop watch
- ⑥ Continue stirring and note temp. every 1 minute.
- ⑦ Note results at the table then plot the graph between time and temp.
- ⑧ If AA' = BB' then newton's Law of Cooling is verified

| Temp. ( $^{\circ}\text{C}$ ) | Time (min) |
|------------------------------|------------|
| $T_0$                        | 0          |
|                              | 1          |
|                              | 2          |



$$aa' = a' - a$$

$$bb' = b' - b$$