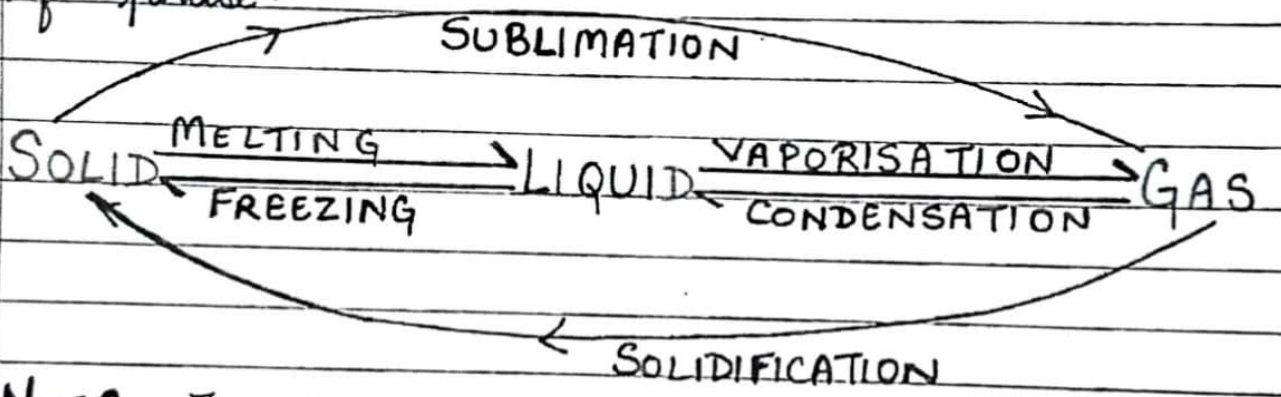
Tender heart high school
sec33b,chd

CHANGE OF PHASE (STATE) OF MATTER

As you all know that, there are three states (or phases) of matter namely - solid, liquid and gas.
The same matter can exist in all the three phases under different conditions of temperature.
The process of change from one state to another at a constant temperature (i.e. - change in temperature, $\Delta T = 0$) is called the change of phase.



NOTE – The process of condensation is also known as LIQUEFACTION.

LATENT HEAT AND SPECIFIC LATENT HEAT

When an ice melts into water at 0°C, it converts into water and at that instant the temperature of water is also 0°C. Hence, there is change in phase of ice but there is no change in temperature during melting (i.e. $\Delta T = 0$)
Thus, according to $Q = m\,c\,\Delta T$, $Q = 0$ J
But it does not mean that ice has not absorbed heat
The heat energy absorbed (or liberated) in change of phase is not externally manifested

by any rise or fall in temperature, it is called the latent heat (The word latent means hidden)
Latent heat, when expressed mathematically is given by, $L = Q/m$ or $Q = mL$
(when there is no change in temperature)
Specific latent heat of a phase is the quantity of heat energy absorbed (or liberated) by the unit mass of the substance for the change in its phase at a constant temperature.
S.I unit of L : J/kg
Other units : cal/g and kcal/kg.
Let us define -

- Specific Latent Heat of fusion of ice.
The specific latent heat of fusion of ice is the heat energy required to melt unit mass of ice at 0°C to water at 0°C without any change in temperature.

- Specific Latent Heat of freezing of ice
It is the heat energy released when a unit mass of water at 0°C freezes to ice at 0°C without any change in temperature.

Note: For a pure substance, the specific latent heat of freezing is same as the specific latent heat of fusion.

The specific latent heat of fusion of ice is 336000 J/kg (336 J/g or 80 cal/g). It means that $L = \frac{Q}{m} = \frac{336000\ J}{kg}$ i.e. 1kg of ice at 0°C absorbs 336000 J of heat energy to convert into water at 0°C.

It can also be said that 1 kg of water at 0°C will liberate 336000 J of heat energy to convert into ice at 0°C.

Natural Consequences of High Specific Latent Heat of fusion of ice.

1. **Snow on mountains does not melt all at once:** Since specific latent heat of fusion of ice is high (336000 J/kg), thus ice changes into water slowly as it gets heat energy from the sun. (If L of ice would have been less, then all the ice would have melted in a short time on getting heat from the sun).

2. **In cold countries water in lakes and ponds does not freeze all at once-** The water in lakes and ponds will have to liberate a large quantity of heat to the surroundings before freezing (i.e. 336 J/g). The layer of ice formed over the water surface acts as a poor conductor and further prevents the loss of heat from the water of the lake, hence the water does not freeze all at once.

3. **When ice in a frozen lake starts melting, its surrounding becomes very cold:** A large amount of heat energy is required for melting the frozen lake which is absorbed from the surrounding atmosphere. As a result, the temperature of the surrounding falls and it becomes very cold.

For similar reason, it is generally more cold after a hail-storm (when ice melts) than during or before the hail-storm.

HEATING CURVE

Heating Curve is a graph between Temperature and time.
Now if we want to draw a graph showing conversion of ice at $-10^\circ C$ to steam at $110^\circ C$.

Students before drawing the graph let us understand how the heat energy is gained at every step.
Students,

Step -1 : Heat is absorbed by ice such that the temperature rises from $-10^\circ C$ to $0^\circ C$ (Here, $Q = mc\Delta T$, $\Delta T = 0 - (-10^\circ) = 10^\circ C$)

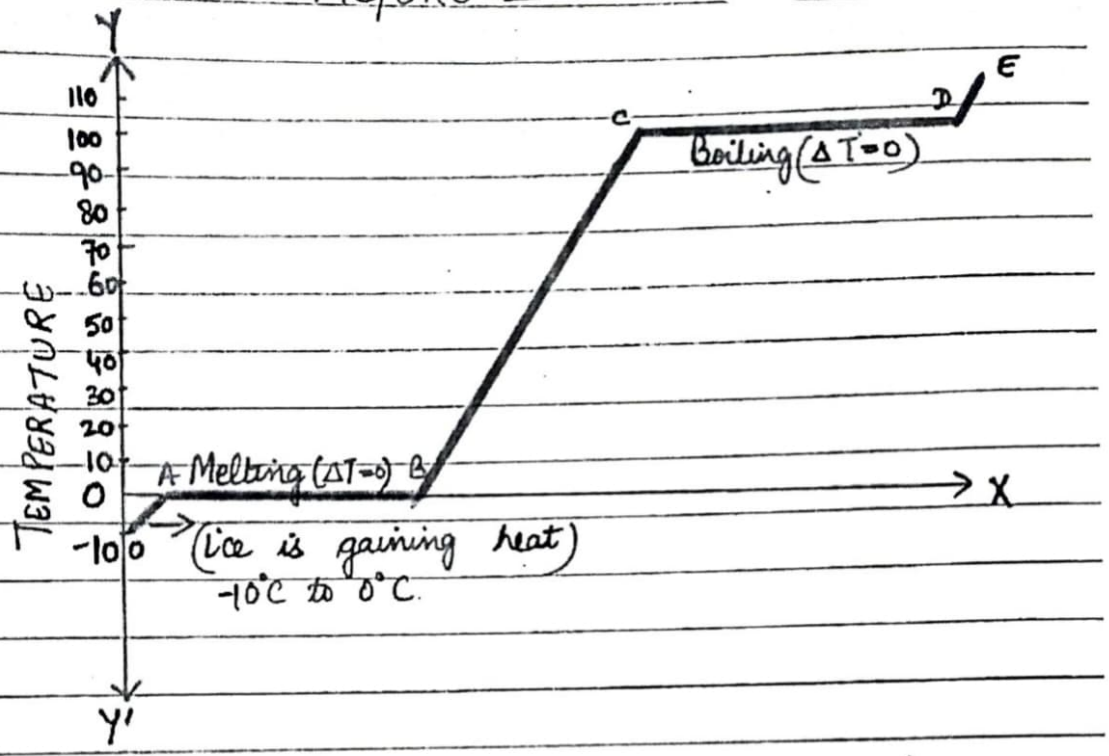
Step -2 : Ice is melted into water at $0^\circ C$ and $\Delta T = 0^\circ C$ (Heat is calculated using $Q = mL$)

Step -3 : Heat is absorbed by water at $0^\circ C$ to reach temperature $100^\circ C$.

Step -4 : Heat is gained to change in phase i.e. from water at $100^\circ C$ to steam at $100^\circ C$.

Step -5 : Heat gained to raise the temperature of steam at $100^\circ C$ to steam at $110^\circ C$.

FIGURE-2



AB → ice at 0°C melts into water at 0°C
CD → water at 100°C boils into steam at 100°C
so, for both these parts (i.e. AB and CD shown in figure -2) there is change in phase but no rise in temperature, and here heat is gained due to specific latent heat

With this I come to an end of this interactive session. Students, Kindly re-read the given notes and also solve the tick marked questions in your Physics notebook.

(LAST PAGE)