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"What one man calls God, another calls the laws of physics."

-Nikola Tesla

TOPIC 10: THERMAL PROPERTIES

THE ABOUT

CHAPTER ANALYSIS

TIME

- 3 **key** concepts
- Straightforward chapter

EXAM

- Tested infrequently

WEIGHTAGE

- Light overall weightage
- Constitute to around **2.5%** of marks for past 5 year papers

KEY CONCEPT

INTERNAL ENERGY
CHANGE IN STATE
BOILING VS EVAPORATION

The hot coffee has a **higher temperature**, but **not more internal energy**.

Although the iceberg has less internal energy per mass due to its lower temperature and being in solid state, its enormously **greater mass** gives it a greater total energy than that in the small cup of coffee.

INTERNAL ENERGY OF A SYSTEM

The **internal energy** of a system is the **sum of its internal kinetic energy & internal potential energy.**

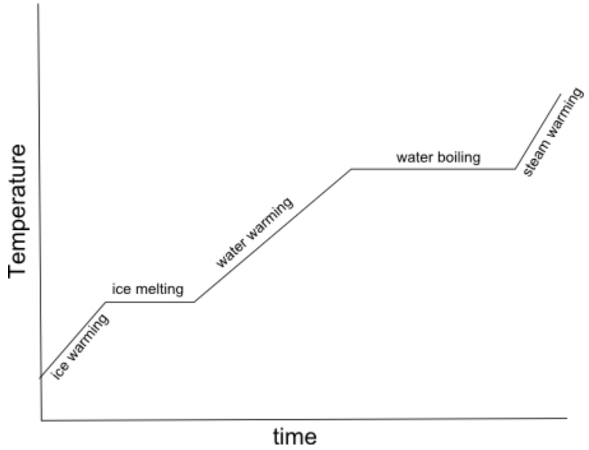
Internal kinetic energy is due to the **motion** of all its particles and depends on **temperature**.

Internal potential energy is due to **intermolecular forces** and depends on their **separation**.

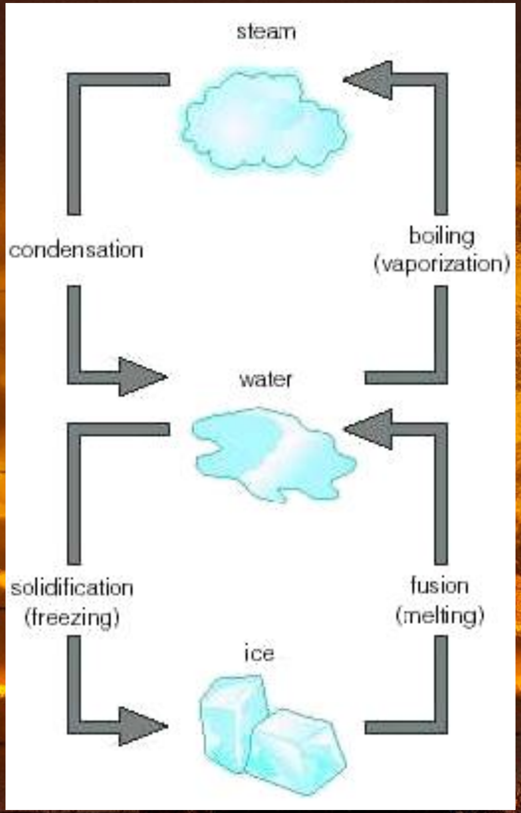
When a body is heated, it either increases its internal kinetic energy (rise in temperature) or increases its internal potential energy (increase separation, change in state).

Heating Graph

Ice warming: internal kinetic energy increases (rise in temperature)
Ice melting: internal potential energy increases (increased separation/change state)
Water warming: internal kinetic energy increases (rise in temperature)
Water boiling: internal potential energy increases (increased separation/change state)
Steam warming: internal kinetic energy increases (rise in temperature)



CHANGE IN STATE



MELTING

Energy is absorbed to **overcome the attractive forces** holding the particles together.

Thermal energy absorbed is used to overcome attractive forces instead of rising the temperature. Hence, temperature remains constant when melting.

FREEZING

Energy is released as **molecules lose their molecular potential energy** and are pulled closer.

Thermal energy is released to offset the cooling down of temperature. Hence, temperature remains constant when freezing.

BOILING

Energy is absorbed to **overcome the attractive forces** & separate the molecules to be far apart.

Thermal energy absorbed is used to overcome attractive forces instead of rising the temperature. Hence, temperature remains constant when boiling.

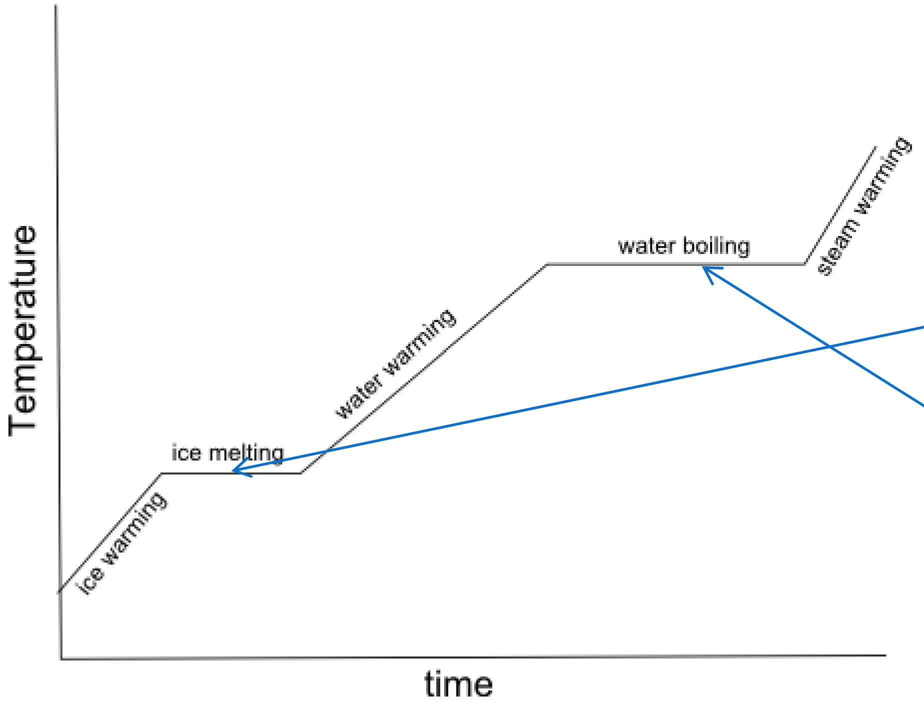
CONDENSATION

Energy is released as **molecules lose their molecular potential energy** and are pulled closer.

Thermal energy is released to offset the cooling down of temperature. Hence, temperature remains constant when condensing.

FOR EXAMPLE

HEATING CURVE



MELTING

Energy is absorbed to **overcome the attractive forces** holding the particles together.

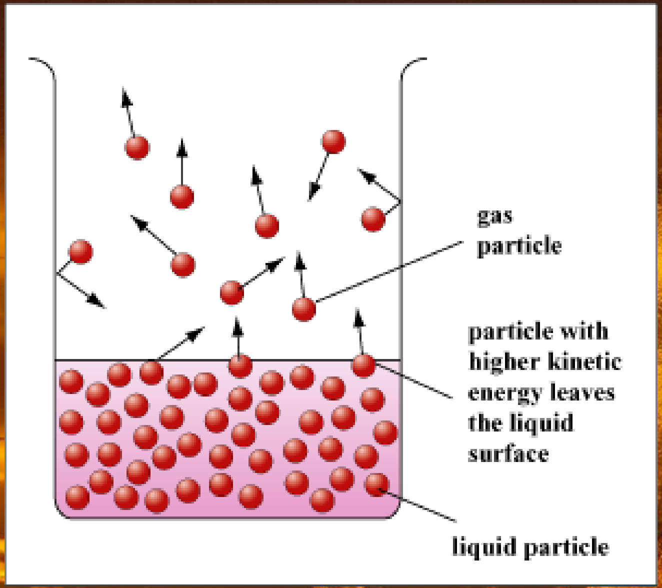
Thermal energy absorbed is used to overcome attractive forces instead of rising the temperature. Hence, **temperature remains constant** when melting.

BOILING

Energy is absorbed to **overcome the attractive forces** & separate the molecules to be far apart.

Thermal energy absorbed is used to overcome attractive forces instead of rising the temperature. Hence, **temperature remains constant** when boiling.

EVAPORATION



Why does evaporation occur?

- liquid molecules are in constant random motion and collide with each other continuously

- when the molecules with higher kinetic energy collide with others when it is near the surface of the liquid, it may gain enough energy to overcome the intermolecular forces of the liquid and leave the liquid body

EVAPORATION

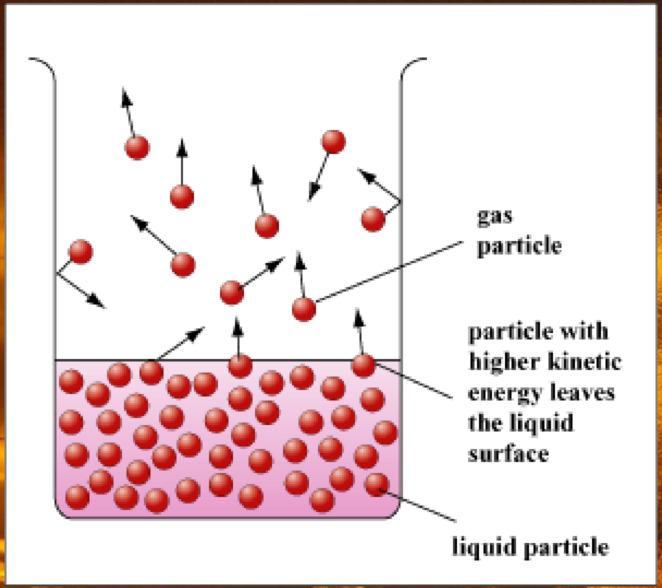
Evaporation is the process by which the **more energetic molecules** at the **surface** of the liquid **overcome the downward attractive intermolecular forces** from other water molecules and **escape** into the surroundings as **gas molecules**.

As the more energetic molecules escape, the **average kinetic energy of the molecules decreases** and the temperature decreases.

Hence, evaporation has a **cooling effect**.

Boiling	Evaporation
Occurs at boiling point	Occurs at any temperature
Occurs throughout the liquid	Occurs at the surface
Bubbles can be seen	No bubbles can be seen
Process is fast	Process is slow
Source of heat required	No direct source of energy needed

EVAPORATION



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FACTORS AFFECTING RATE OF EVAPORATION

Increases when:

- **temperature increases** - higher average kinetic energy of the molecules
- **surface area increases** - liquid molecules are more likely to leave the surface of the liquid
- **humidity decreases** – air is drier, lower likelihood of liquid molecules colliding and rebounding back into liquid
- **wind speed increases** - carries away liquid vapour formed by evaporation and lowers humidity
- **atmospheric pressure decreases** - less air molecules bombard liquid molecules, easier to escape
- **boiling point is low** – liquid is more volatile, easily changes from liquid to gas state

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Darrell Er
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8777 0921
(Whatsapp)

@DarrellEr
(telegram username)