

# 1 | States of Matter

## ----- States of Matter -----

- There are three states of matter: SOLIDS, LIQUIDS, GASES

**Remember this:** *Three states refer to three conditions of a substance. A substance exists in three conditions depending on the physical factor of the environment. Just like  $H_2O$  existing →*

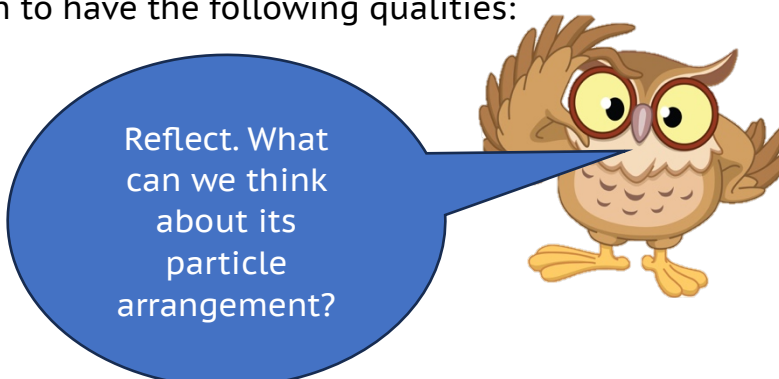


- They exist in different conditions because their particles are arranged differently due to varying physical factors.
- Therefore, the three different states of matter have three different arrangements of particles, correspondingly.
- Particles having different arrangements can explain two points:
  - General reaction of the state.
  - Shape of the substance
- We call this the '**Kinetic Theory of Matter**'.

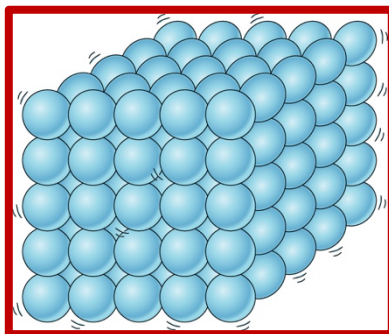
### I) Solids

KS2 → Solids are known to have the following qualities:

- Fixed Shape
- Fixed Volume
- Cannot flow



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- This is the particle arrangement of a solid.
- The particles of a solid are arranged regularly and closely packed as they have strong forces of arrangement.
- The particles of a solid vibrate around in fixed positions.
- The particles of a solid have the lowest level of kinetic energy.



## Critical Thinking



Why can't you move through a solid brick wall?

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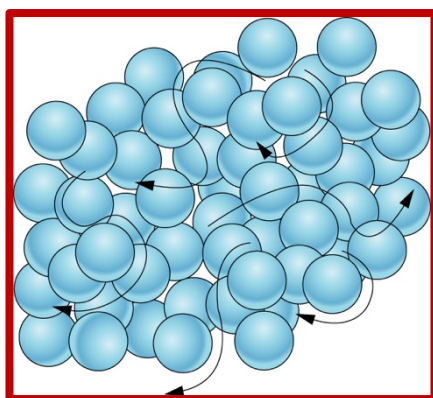
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## II) Liquids

KS2 → Liquids are known to have the following qualities:

- Unfixed Shape
- Fixed Volume
- Flows

Reflect. What can we think about its particle arrangement?



- This is the particle arrangement of a liquid.
- The particles of a liquid are mostly touching but some gaps can be found.
- The particles of a liquid are randomly arranged as the forces of attraction are less effective.
- The particles of a liquid possess a moderate level of kinetic energy.

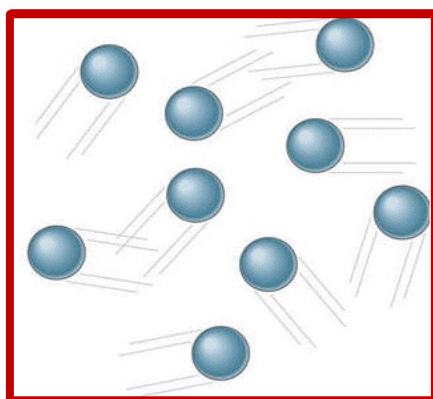
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## III) Gases

KS2 → Gases are known to have the following qualities:

- Unfixed Shape
- Unfixed Volume
- Flows

Reflect. What can we think about its particle arrangement?



- This is the particle arrangement of a gas.
- The particles of a gas are further apart from each other as they have no forces of attraction.
- The particles of a gas randomly move at high speeds in all directions.
- The particles of a liquid possess a highest level of kinetic energy.

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## ----- Interconversions -----

- An interconversion is defined as the conversion between two states to another of a substance.
- Substances can be interconverted on grounds of:
  - a) Melting
  - b) Boiling/Evaporating
  - c) Condensation
  - d) Freezing
  - e) Sublimation
  - f) Deposition

### I) Melting

Think of it like this:

- A substance is heated, as a result energy is provided to make the particles of a solid faster.
- If this continues, the forces of attraction between them will become weaker to hold the particles together.
- This weak composition loosens the structure to form a structure like liquids.



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## II) Freezing

Think of it like this:

- A liquid cool down, the particles of a liquid would move around slowly and eventually, the forces of attraction will get stronger.
- When the forces of attraction becomes stronger, they will form a fixed shape.



## III) Boiling/Evaporating

- Boiling occurs when a liquid is heated strongly that particles would vibrate faster for it to overcome the forces of attraction between particles.
- Evaporation would occur over a range of temperatures and at the surface of the liquids, in which high energy particles can escape from the liquids.
- Both are NOT the same because
  - a) Boiling happens during the boiling point of a liquid while evaporation occurs over a range of temperature between the melting point and the boiling point.
  - b) Boiling happens throughout the liquid while evaporation happens on the surface of the liquid.

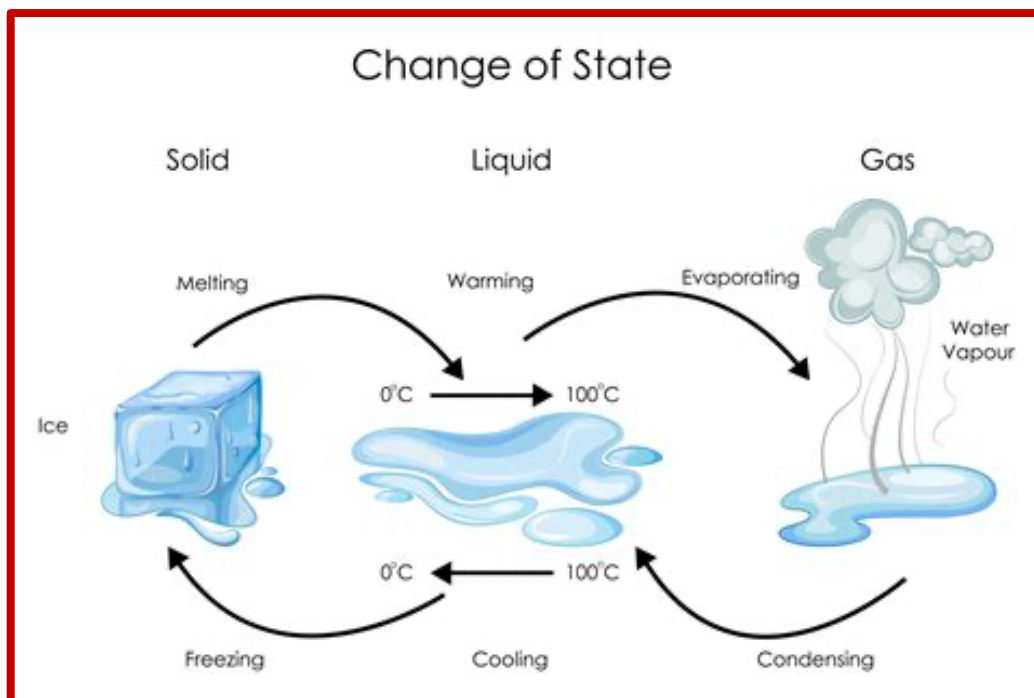
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- Yet, they are same on one ground: they convert liquid to gas.



## IV) Condensation

- If the gas is cooled down, the particles move slowly.
- They will be held by the forces of attraction, and they will lack the sufficient energy to move.



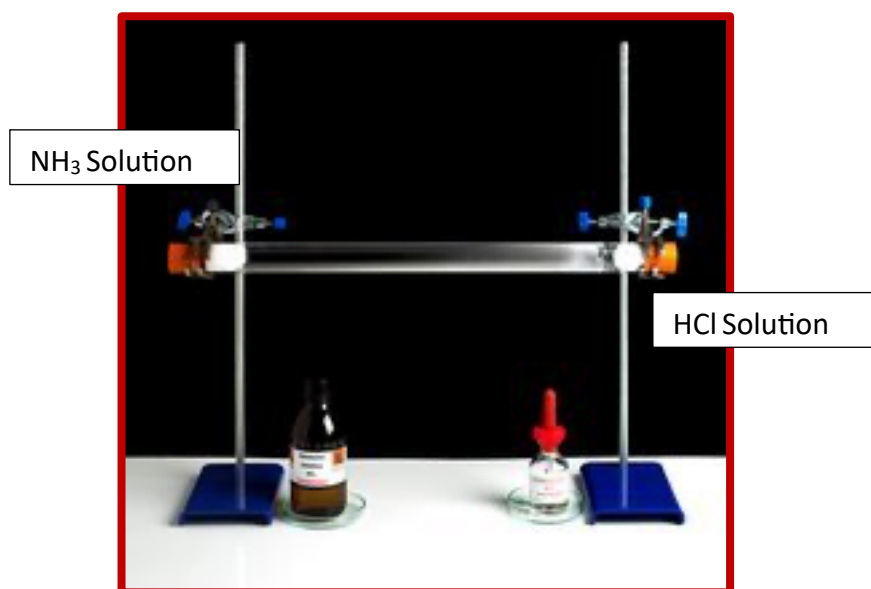
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## ----- Melting Point / Boiling Point -----

- Melting point refers to the temperature the solid melts at.
- Boiling point refers to the temperature the liquid boils at.
- A substance can be a solid if the temperature is below melting point.
- A substance can be a liquid if the temperature is between the melting point and boiling point.
- Finally, a substance can be a gas if the temperature is above melting point.

## ----- Diffusion -----

- Diffusion is the spreading out of particles from an area of high concentration to a region of low concentration.
- We can look at the process of diffusion by looking over the action of forming ammonium chloride.



- We set up the apparatus just like the picture above.
- We place balls of cotton wool on each end of the glass tube.



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- Rubber bungs are placed on each end to ensure that poisonous gases will not escape.
- The process is highlighted below:

Particles of  $\text{NH}_3$  (ammonia) and  $\text{HCl}$  (hydrochloric acid) would diffuse along the tube and when they meet each other, they react to form a solid white ammonium chloride ( $\text{NH}_4\text{Cl}$ ).

A white  $\text{NH}_4\text{Cl}$  appears close to the  $\text{HCl}$  end since ammonia particles travel faster since they are lighter than hydrochloric acidic particles.

- The general theory is that: Lighter particles travel faster than heavy particles and its product will form closer to the heavy-sized solution.
- This product is formed through the movement of particles from the area of low concentration to an area of high concentration, or diffusion.
- Diffusion over liquids will be quite difficult as its particles are much closer to the particles of a gas, therefore less space for particles to collide together.

## Note