Chemical Properties of Matter and Reactions

Matter: Physical and Chemical Properties

Matter in our Surroundings

Def^n: Anything that has **mass** and **volume** (occupies space) is **matter.**

Examples of matter: Cup, pen, table, dog, cat, humans.

Non-living things. living things

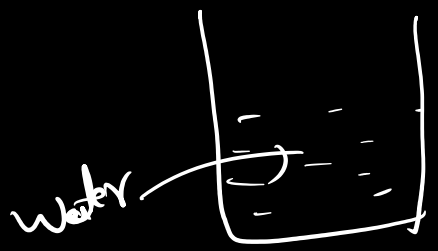
Earliest know classification of matter was done by Aristotle.

into **Metals** and **Non-metals**

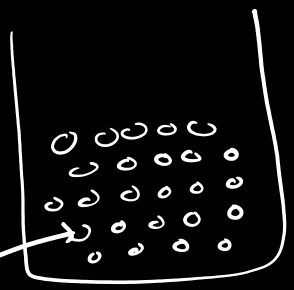
In modern days Scientists have evolved two types of classification of matter based on their physical and chemical nature/properties.

Physical nature of matter :

(I) Matter is made up of particles



→ If we magnify water by millions of times

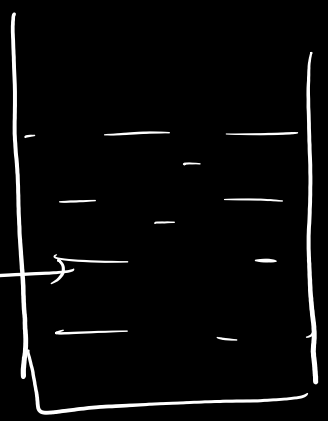


(i) These particles are very-very small.

(ii) These tiny particles are also known as molecules

(iv) Molecule can be defined as the smallest particle of ~~matter~~ which can exist independently and retain all the properties of matter.

1 drop of ink.



eg: Water

- Transparent liquid
- Tasteless
- No smell.
- Boiling point ⇒ 100°C (Boiling temperature)
- Freezing point ⇒ 0°C

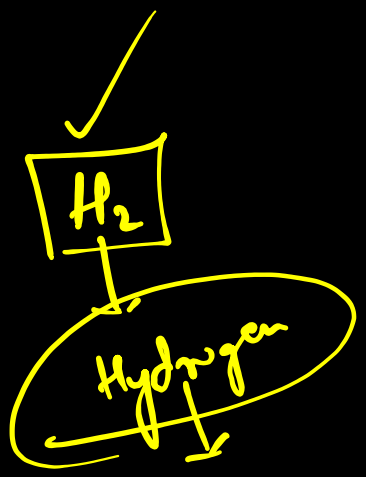
Distilled water ⇒ Purest form of water.

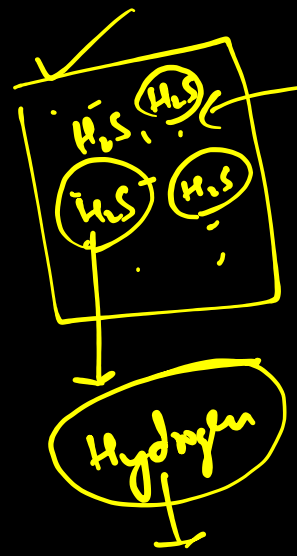
Water → take smallest particle of water (molecule of water)

Transparent liquid, BP 100°C, FP 0°C ← H_2O ⇒ one molecule of water

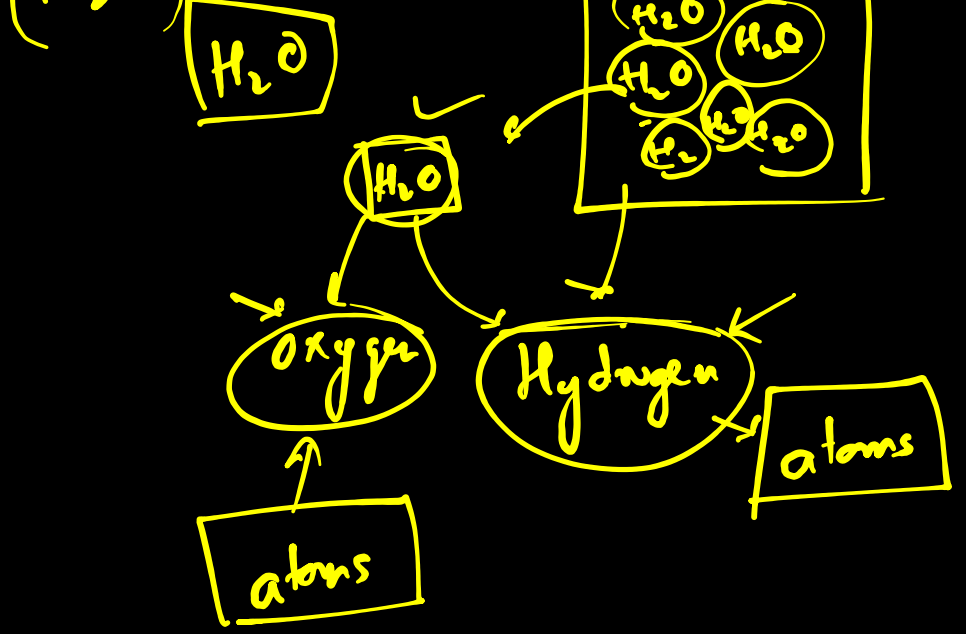
If we break H_2O further, then the properties of water will be lost.

∴ H_2O is the smallest particle with which water (matter) is made up of.





Hydrogen Sulphide
(H_2S) → Rotten egg like smells



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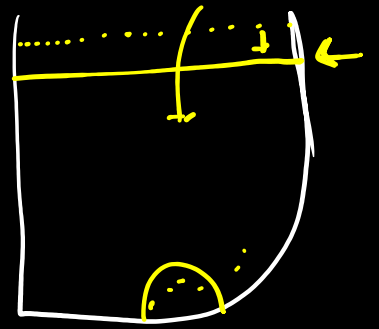
Characteristics of Particles of matter.

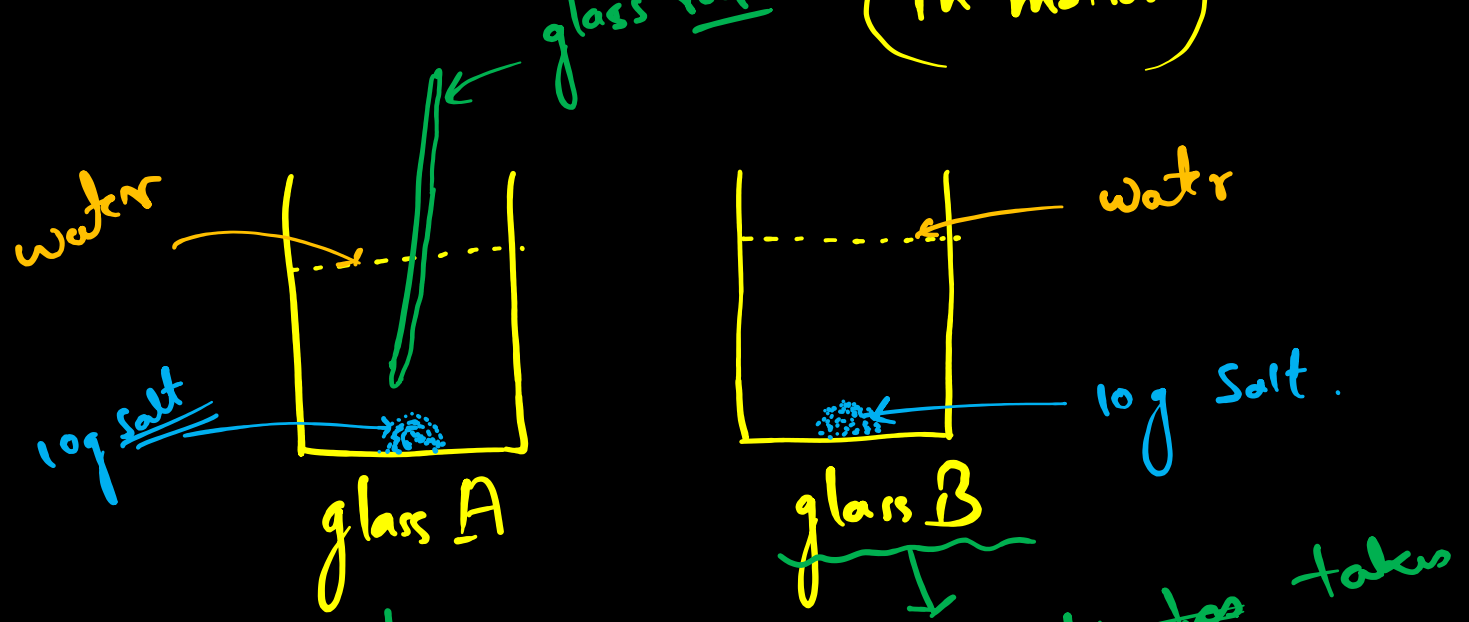
① Particles of matter have space between them.

Q. Why level of water rises when we put a spoon in the glass but does not changes when a spoon of salt dissolved in it?



(11) Particles of matter are continuously moving.

(in motion)



↓

Salt dissolves within minutes when we stir the content of glass A

Salt ~~dissolves~~ takes longer time to dissolve.

(iii) Particles of matter attracts each other.

→ Magnitude of force of attract is different for different matter / substance.

States of Matter

- Solid
- Liquid
- Gas

Not so important:

- 6th → Fermionic Condensate
- 7th → Quark-Gluon Plasma

4th state → **Plasma** → found at very high temperature.

5th state of matter → **BEC** → Bose-Einstein Condensate

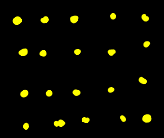
↳ at very low temp (−200°C and below)

Solid

Particles are closely packed

⇒ Fixed Shape & Fixed volume

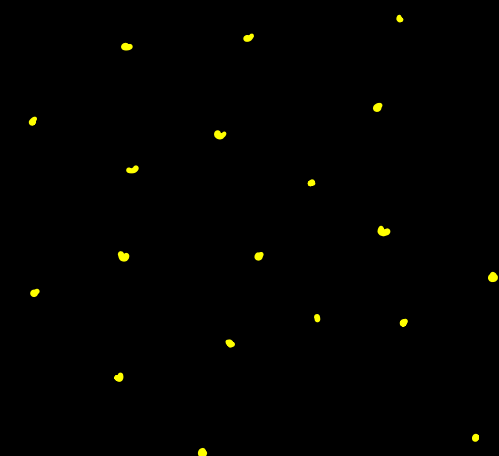
Liquid



Loosely packed

⇒ Do not have fixed shape, but have fixed volume.

Gas

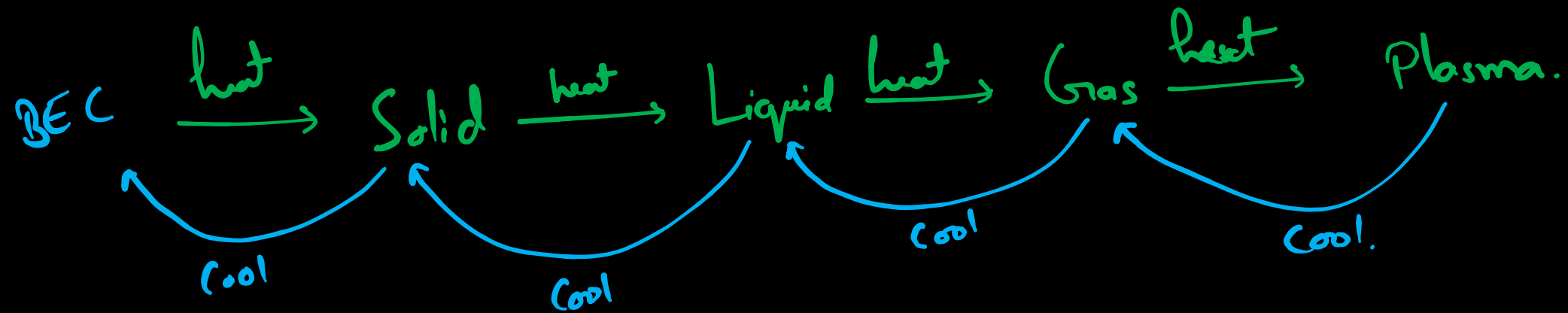


water

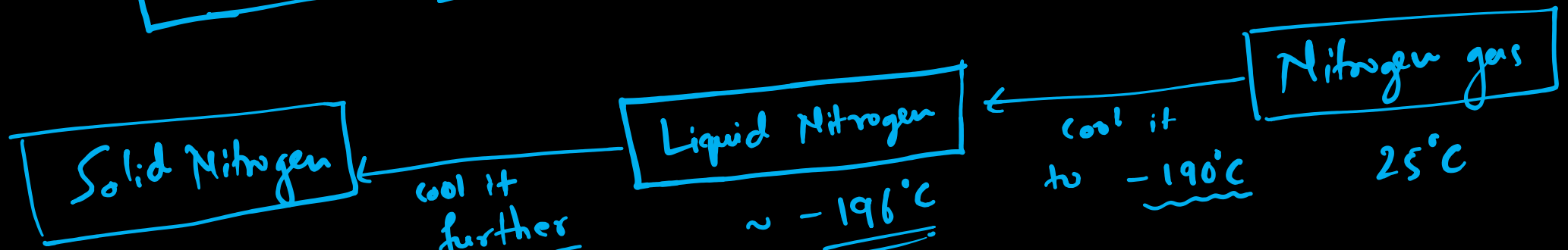
Very loosely packed.

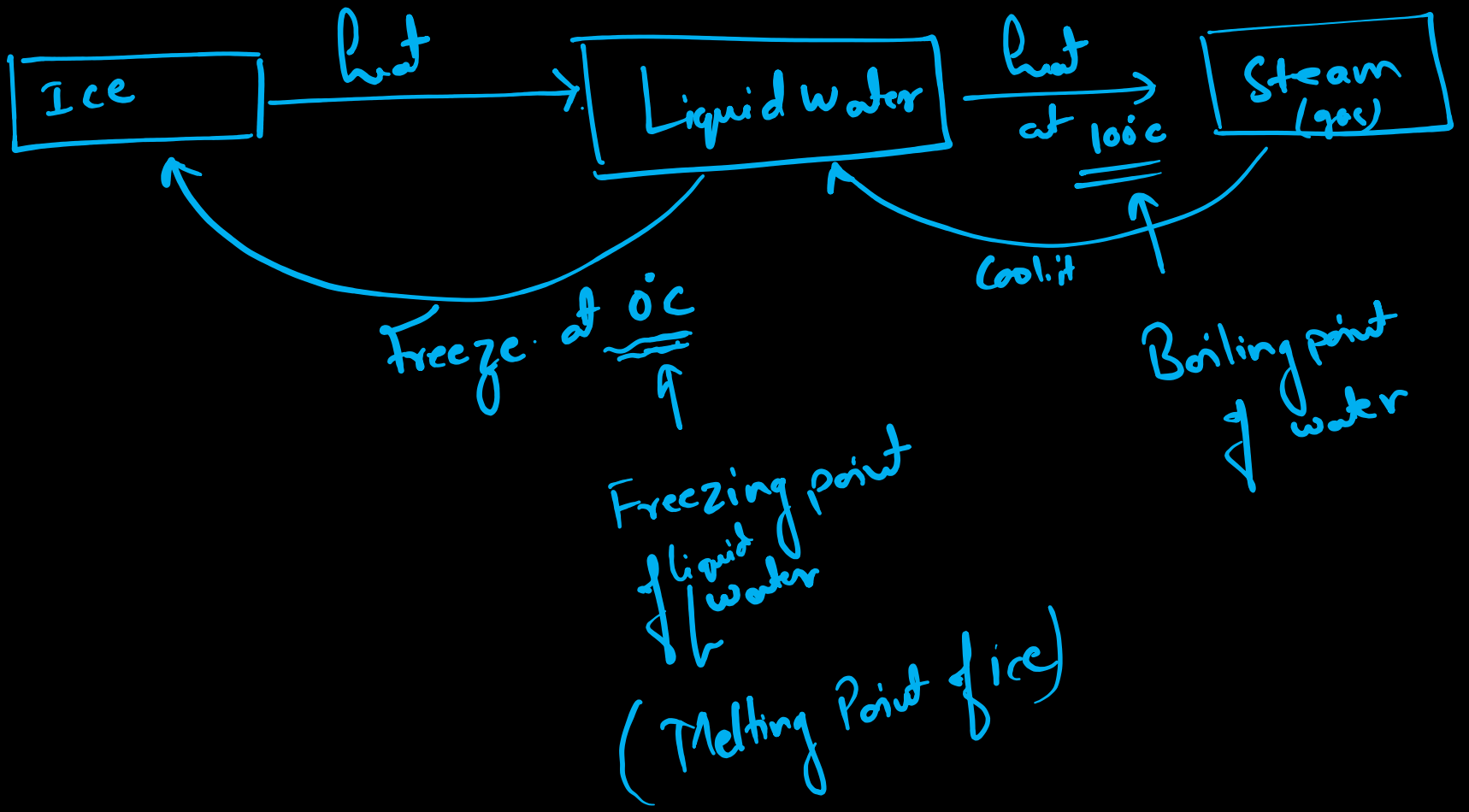
→ Do not have fixed shape.
Also, do not have fixed volume.

States of matter are inter convertible

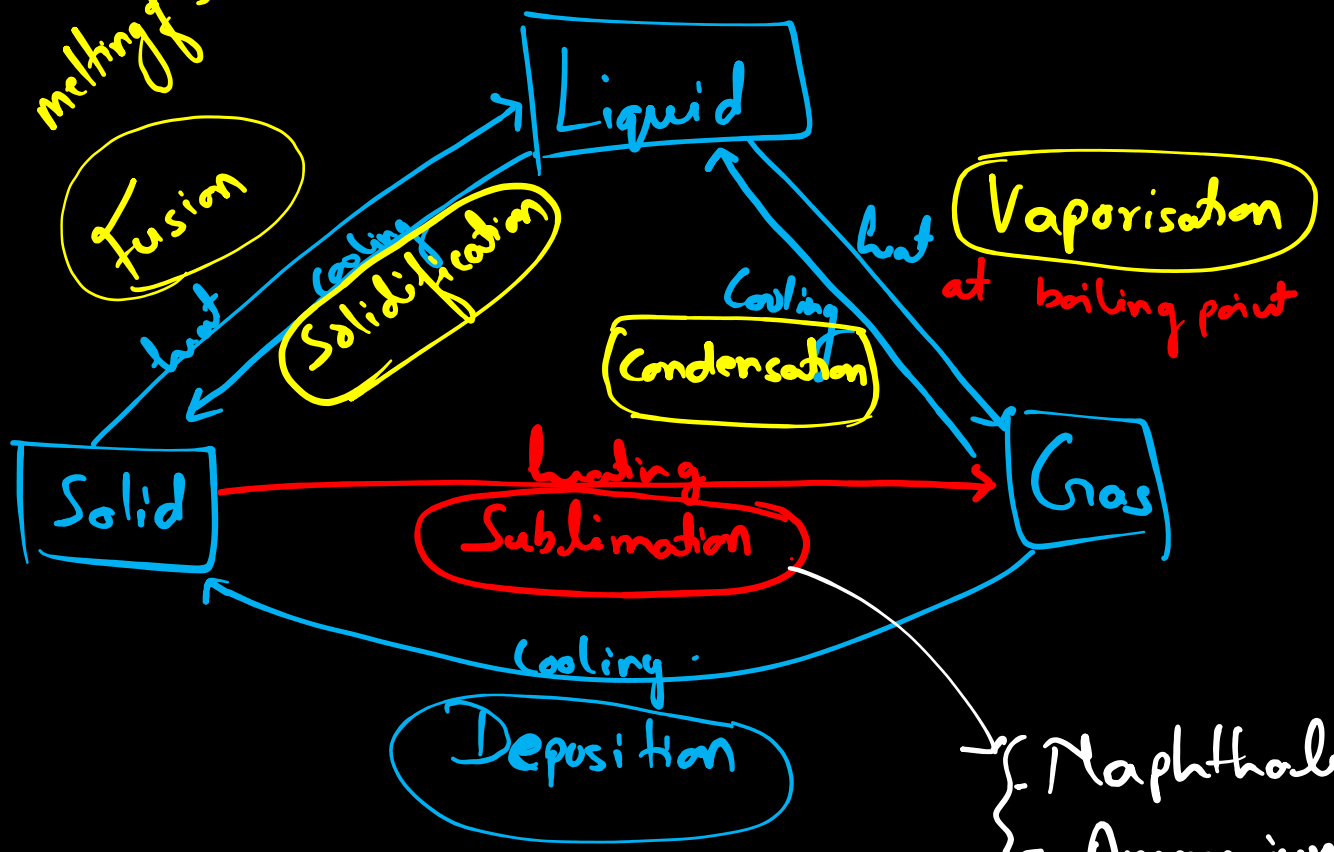


$-273^{\circ}C$ 0 Kelvin





melting of solid to liquid



- Camphor (Kapoor)

- Naphthalin
- Ammonium Chloride
- Dry ice [Solid CO_2]

Properties of matter

Chemical Properties

(These properties are determined by changing the identity of matter/substance)

- Acidity / Acidic behaviour
- Basicity / Basic behaviour.
  - → Reaction with water
  - → Reaction with air (oxygen)
  - → Reaction with other chemicals.

Physical Properties

(Matter do not change its identity)

Intensive Properties

→ Not dependent on amount of matter

eg: density | Boiling Pt.
colour. | Melting

Extensive Properties

→ Depends on amount of matter.

eg: - mass
- volume
- length.
- shape.

Intensive Properties of matter

→ Intensive properties are those that are unaffected by the amount of matter present in the sample.

eg: Temperature, Colour, density, B.P., T.P., Pressure,

→ 3L water boils at 100°C
→ 5L water also boils at 100°C

Extensive Properties

→ Extensive Properties are those that are affected by the amount of substance present in the sample.

eg: mass, volume, weight, shape, length.

3L milk

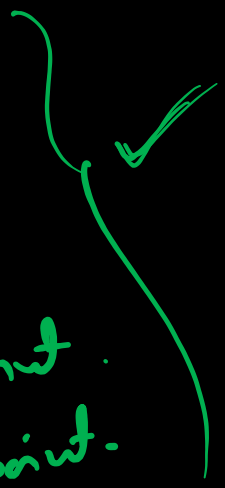
→ 5L milk has more mass than 3L milk.

Physical Properties of matter

⇒ Those properties that can be measured without changing the chemical composition (identity) of the substance under study.

The six main physical properties are:

- → Colour
- → density
- → volume
- → mass.
- → Boiling point
- → Melting point.



Some other physical properties are:

- → Shape
- → Size
- → Texture
- → Freezing point
- → Length
- → Conductivity

Chemical Properties

Chemical properties are those properties that can only be measured or observed by changing the chemical identity of the substance.

Ex. Reactivity, Flammability, Toxicity, Acidity.

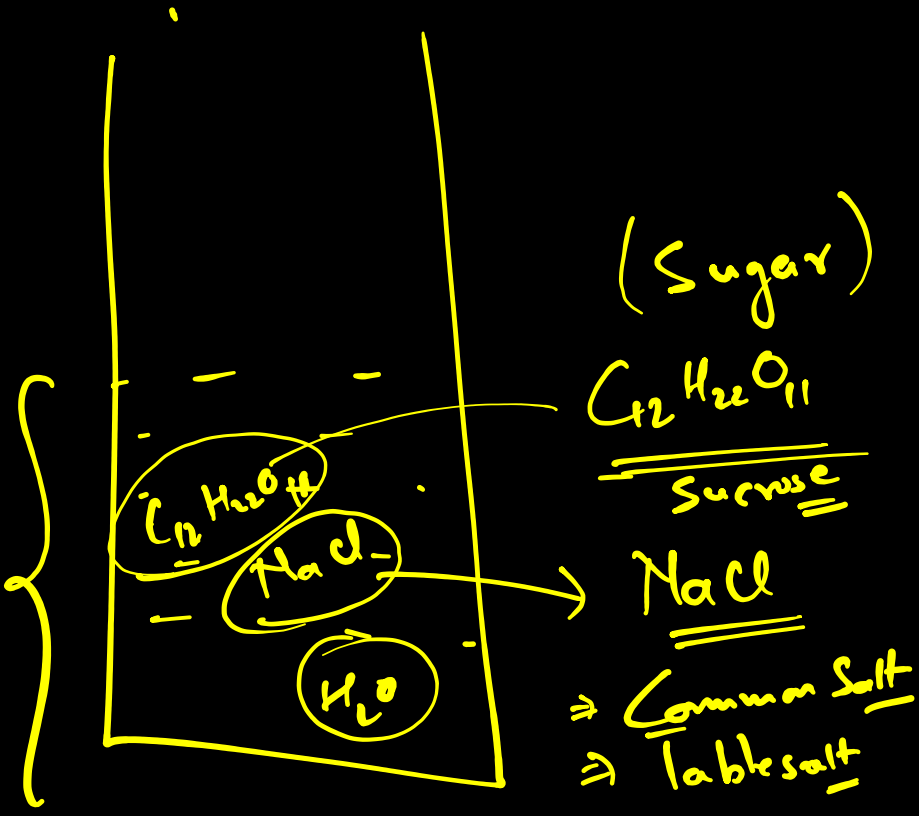
Physical and Chemical Change

Physical Change

- Change of state } physical change
- Separation of mixture }

⇒ Change in which physical appearance of a matter is altered, but composition remains same.

⇒ It does not involves breaking and making of new bonds.



Same types of compound or elements that were there in the beginning of the change are there at the end of the change.

Examples of physical change

	Before Change	After Change
(i) Melting of wax	Solid wax	Liquid wax
(ii) Lemonade	Water + Sugar + Salt + Lemonjuice.	Mixture of water sugar salt lemon juice.
(iii) Melting of ice	water	Water.

* Physical change is generally reversible. But not always!!

Chemical Change :

⇒ Chemical change occurs when bonds are broken and/or formed between molecules or atoms

* Atoms rearrange themselves by breaking old bonds and forming new bonds.

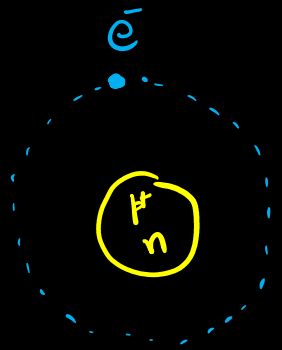
* One substance with a certain set of properties (melting points, colour, taste, etc) is turned into a different substance with different properties.

Examples of chemical change

	Before Change		After Change
(i) Burning of wax	Wax	Burns in air →	Carbon dioxide, H_2O
(ii) Burning of paper	Paper	→	$CO_2 + H_2O$
(iii) Formation of curd from milk.	Milk (Lactose)	→	Curd (Lactic Acid)
(iv) Respiration	glucose	→	$CO_2 + H_2O$ + energy
(v) Rusting of iron	Iron	(Oxygen) (water) →	Rust (Oxide of iron)
(vi) Digestion of food	Food particle	→	Glucose, amino acids, etc., fatty acids..

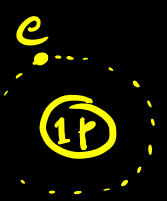
Atom

- Nucleus (central part)
  - Neutrons (Neutral)
  - Protons (positive charge)
  - (Nucleons)
- Electrons (negatively charged)

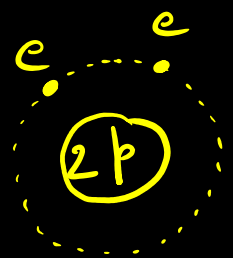


In any atom, number of electrons are same as no. of protons in the nucleus.

If nucleus has only one protons



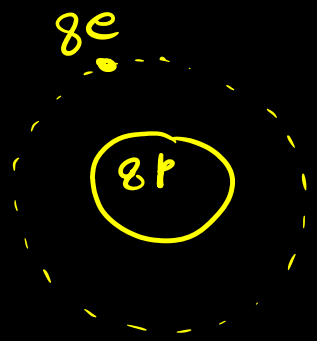
Hydrogen atom



Helium atom

Lithium

Atom of oxygen 8 proton



Element	Atomic Symbol	# Protons	Atomic No.	Metal / Non-metal / Metalloid
Hydrogen	H	1	1	Non-metal
Helium	He	2	2	
Lithium	Li	3	3	
Carbon	C	6	6	
Nitrogen	N	7	7	
Oxygen	O	8	8	
Sodium	Na	11	11	
Magnesium	Mg	12	12	
Chlorine	Cl	17	17	
Calcium	Ca	20	20	Metal

Chlorine atom and Sodium atom

Cl Na

Non-metals : gains electrons

Metals : loose ~~the~~ electrons

Na
$11p^+, 11e^-$

one loosing 1 electron $\Longrightarrow$ Na
$11p^+, 10e^-$ $\Rightarrow$ Na^+

Atom

Upon loosing electrons, forms

+ve ions are aka Cations

Ions
(Charged species)
(Charged atom)

Chlorine atom

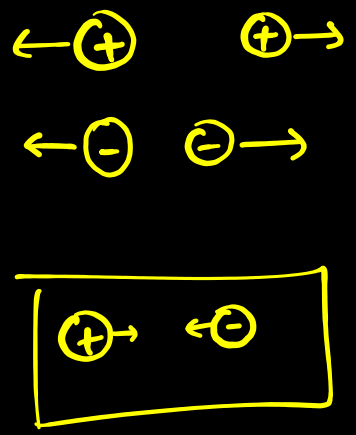
Cl
$17p^+, 17e^-$
Atom

on gaining 1 electron $\Longrightarrow$ Cl
$17p^+, 18e^-$ $\Rightarrow$ Cl^-
Ion

upon gaining electrons, form $\longrightarrow$ Ions

-ve ions are aka anions

* Opposite charges attract each other
* Same charges repel each other.



$Na^+ \rightarrow \leftarrow Cl^-$ This attractive force between Na^+ and Cl^-, which holds them together is called bond.

NaCl

Sodium chloride (Common salt / Table salt)

or, chemical bond.

Types of chemical reactions

→ In any chemical reaction old bonds are broken and new bonds are formed.

① Combination Reaction (Synthesis Reaction)

Two or more reactants combines to form a single new substance product.

$A + B \longrightarrow AB$

$H_2 + O_2 \longrightarrow H_2O$

$C + O_2 \longrightarrow CO_2$

$Mg + O_2 \rightarrow MgO$

② Decomposition Reaction :

Opposite of combination reaction

⇒ In this reaction single substance (reactant) breaks down to to form two or more products

$$AB \longrightarrow A + B$$

eg: ① $H_2O \xrightarrow{\text{electricity}} H_2 + O_2$]

⇒ $AgBr \xrightarrow{\text{sunlight}} Ag + Br_2$] Black and white photography

Silver bromide

3. Displacement Reaction

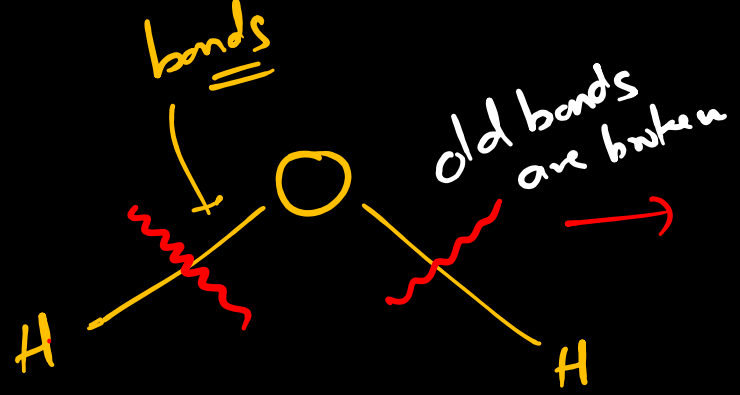
4. Double displacement Reaction

5. Oxidation and Reduction Reaction

Redox reaction

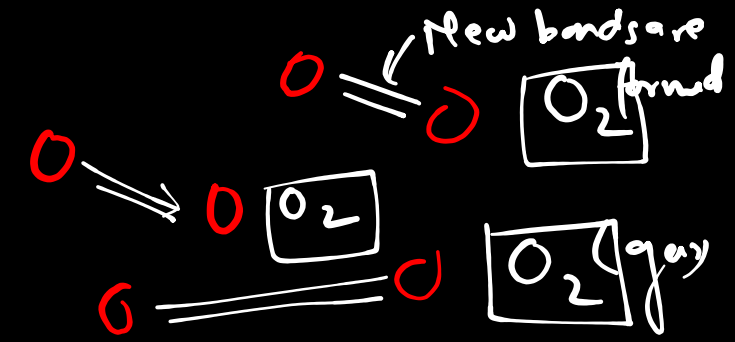
H_2O

molecule

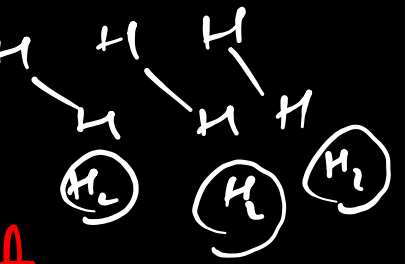


O

2H



$O=O$



To break these bonds, we need to supply energy

* when bonds broken, energy is absorbed
* when bonds are formed, energy is released.

- in the form of heat
- in the form of electricity
- in the form of sunlight

In chemical reactions,

if energy required to break old bond(s) is more than the energy released during in the formation of new bond(s). , then,

such reactions are called endothermic reaction.

100 cal. absorbed

80 cal. released

Net Energy = 20 cal absorbed

End of the chapter