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DRDO – CEPTAM

Senior Technical Assistant B / Technician A

Defence Research & Development Organisation (DRDO)

Volume - 1

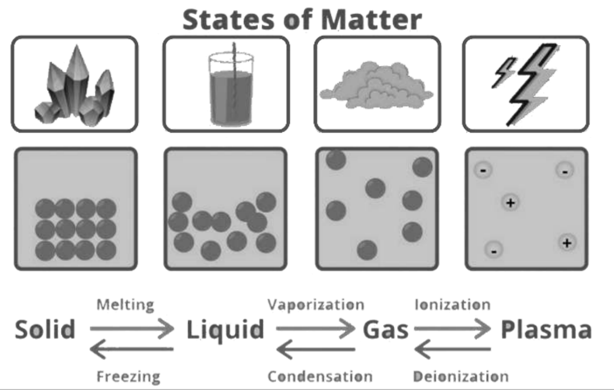
General Science

SIERRA INNOVATIONS

INDEX

1 CHAPTER Chemistry

States of Matter



Solids

- Matters which have **fixed volume** and **shape**.
- **Eg** - stone, wood, brick, ice, sugar, salt, coal, etc.
- **All metals** are solid **except mercury** and **gallium**.

Properties of solids

- Fixed volume.
- Fixed shape.
- High density.
- Heavy.
- Do not flow.

Liquids

- Matters which have **fixed volume** but **indefinite shape**.
- **Eg** - milk, water, petrol, kerosene, alcohol, oil, etc.
- Since **liquid** can **flow**, it is also called **fluid**.

Properties of liquids

- Definite volume.
- No definite shape.
- Get the shape of container in which they are kept.
- Cannot be compressed much.
- Have less density compare to solid.
- Lighter than solid.
- Liquids flow and hence are called fluids.

Gas

- Matters which have **indefinite shape** and **volume**.
- **Eg** - air, oxygen, hydrogen, nitrogen, carbon-dioxide, etc.

Properties of gases

- Indefinite shape
- No fixed volume.
- Get the shape and volume of container.
- Fill the container completely.
- Have very low density.
  - So, gases are light.
- Can flow easily and hence are called fluids.

Properties	Solids	Liquids	Gases
Shape	Definite shape	Do not have a definite shape, will take the shape of the container	No definite shape
Volume	Definite volume. As intermolecular forces between the constituent particles are strong	Definite volume. As intermolecular forces between the constituent particles are strong	No definite volume. As intermolecular forces between the constituent particles are weak
Compressibility	Negligible	Negligible	High
Diffusion	Can diffuse into liquids	Diffusion in higher than solids	Highly diffusible as particles move randomly at high speed
Fluidity or rigidity	Very rigid and cannot flow from one place to another	Less rigid and are capable of flowing from higher to lower levels	No rigidity and can flow most easily among the three states of matter. They usually flow from high pressure to low pressure areas.

Cause of different physical states of matters

The physical states of matter depend upon three main factors:

- The **force of attraction** between particles.
- The **space** between the **particles**.
- The **kinetic energy** of particles.

Solids

- The **force of attraction** between the particles of solids is **very strong**.
- There are **minimum spaces** between the particles of solids.
- The particles of solids have **minimum kinetic energy**.
- Because of great force of attraction **particles** of solids are **closely packed** together.
    - This makes the **space** between particles of solids **almost negligible.**
- The **lowest kinetic energy** of particles is **not able to move the particles** of solids.
- Hence, the great force of attraction and least space between particles of solids and lowest kinetic energy of particles **keep the particles** at **fixed places**.
- Because of the combination of these characters **matter** exists in **solid state**.

Liquids

- The **force of attraction** between particles is strong but **less strong than solids.**
- The **space** between particles is **more than** that of **solids** but not less than liquids.
- The **kinetic energy** of particles is **greater** than **solid**.
- **Strong force of attraction** keeps the particles of **liquids packed** together.
    - But the **force** of attraction between particles of liquids is **less strong** than that of solid.
    - Because of this particles of **liquids** are **loosely packed** compared to solid.
- The **kinetic energy** of **particles** of **liquids** is **greater** than that of **solids**.
- Because of more space between **particles** and more **kinetic energy than solids** the particles of liquids slide over one another.
- These characters make a matter to exist in liquid state.
- **Liquid** can **flow** because its particles can slide over one another.

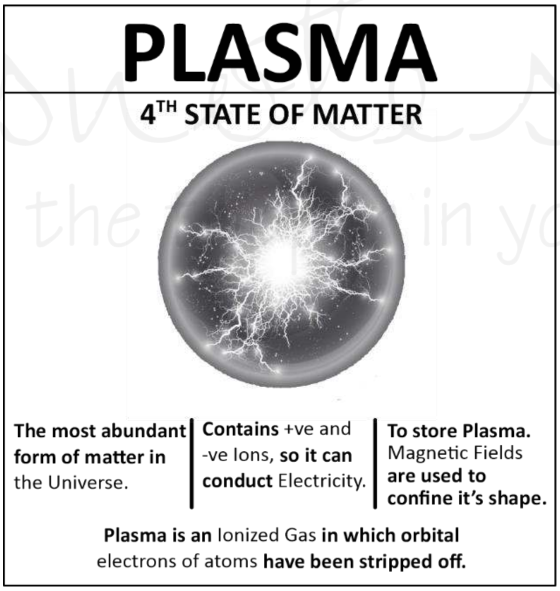
Gases

- The **force of attraction** between particles of gas is almost **negligible**.
- The **space** between particles of solid is **greatest**.
- The particles of gases have the **greatest kinetic energy**.
    - Because of negligible force of attraction the **particles of gases** are **loosely packed** consequently there are lots of spaces between their particles.
    - Because of the **greatest kinetic energy** the particles of **gas move** with **high speed.**
- Because of **negligible** force of **attraction** between **particles** and greatest kinetic energy the particles of gas have a tendency to escape out.
    - Because of these characteristics a matter exists in gaseous state.

- A **matter** exists in **solid** state because of the **greatest** force of **attraction** between its **particles** which makes the **particles closely packed**.
- A matter exists in **liquid** state because of **less force of attraction** between its particles than a solid, which makes the **particles** closely packed but allow them to **slide** over one another.
- A matter exists in **gaseous** state because of an almost **negligible force of attraction** between its particles, which is unable to keep the particles bonded together.

Other states of matter

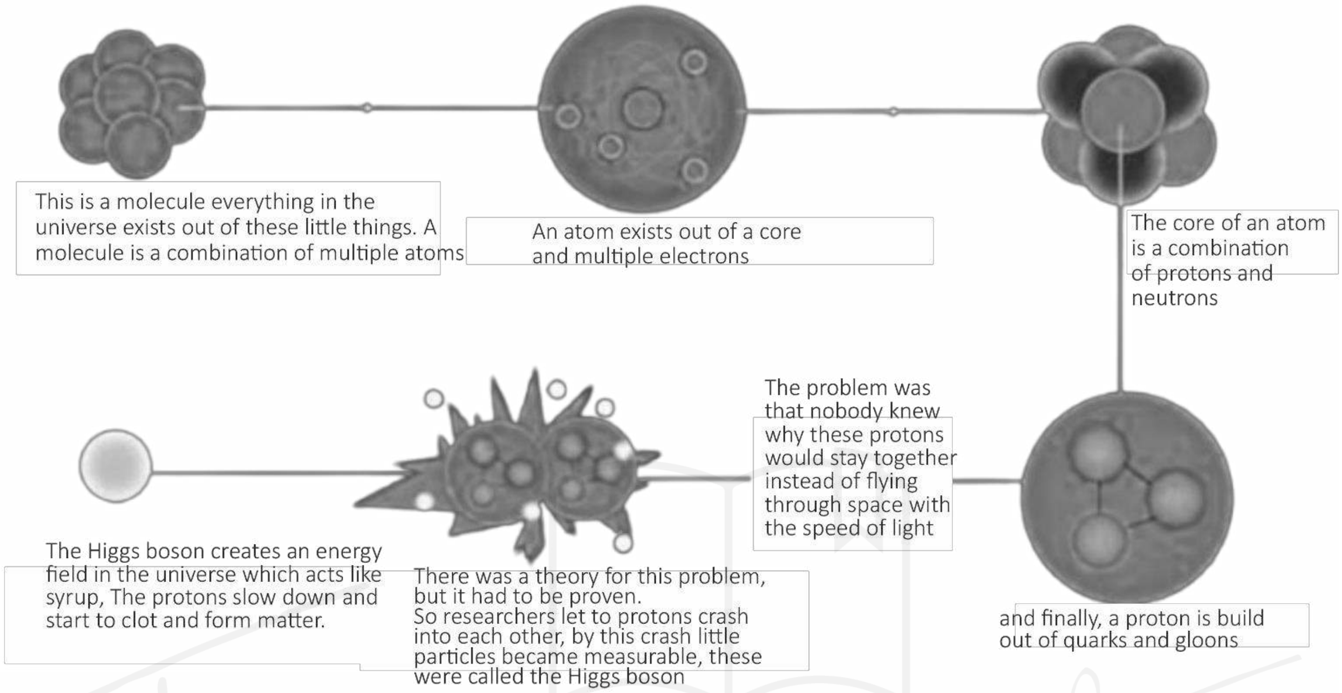
Plasma



- **Fourth state** of matter.
- **Similar** to **gas**.
- Particles of plasma are made of **free electrons** and **ions**.
- Do **not** have a **definite shape** or a **definite volume** unless enclosed in a container.
- Defined as **electrically neutral** medium of **positive** and **negative particles**.

- Plasma is one of the **most commonly occurring states** of matter in universe.
- Plasma **occurs naturally** in the **stars**.
- All **stars** are made of **plasma**.
    - Because of the **presence of plasma stars glow**.
- Plasma is formed because of **nuclear fusion** in **stars**.
    - Our **sun glows** because of presence of plasma.
    - **Plasma TV** got its name because of presence of plasma in it.
    - Plasma is also found in **fluorescent light** or **neon sign**.
    - Plasma is formed when **electricity** is **passed** in a **fluorescent** tube or **neon sign**, which makes them glow.

Bose-Einstein Condensate (BEC)

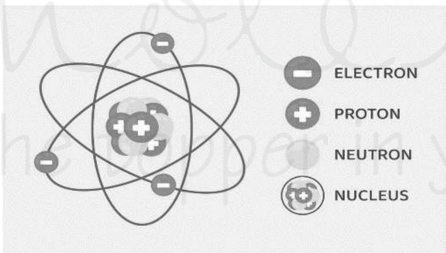


- **Fifth state** of matter.
- **Satyendra Nath Bose** and **Albert Einstein** were predicted about this state of matters, that's why it got its name as **Bose-Einstein Condensate (BEC).**
- Plasma and BEC are has **opposite** characters.
    - Plasma is a **super hot** and **super excited atom**
    - Condensate has **super cool** and **super unexcited atoms**.
- BEC was obtained by **cooling the vapour of rubidium-87** at super **low temperature** by Eric Cornell and Carl Wieman on June 5 1995.
- After sometimes Wolfgang Ketterle also obtained BEC from **sodium-23** at MIT, USA.
- Cornell, Wieman and Ketterle got **Nobel Prize** in Physics for this achievement in 2001.

Atomic Structure

Fundamental Constituents of an Atom

- An atom contains **three basic particles** namely protons, neutrons and electrons.
- The **nucleus** of the atom contains **protons** and **neutrons**.
    - **Protons** are **positively charged**.
    - **Neutrons** are **neutral**.
- The **electrons** are located at the **outermost regions** called the **electron shell**.



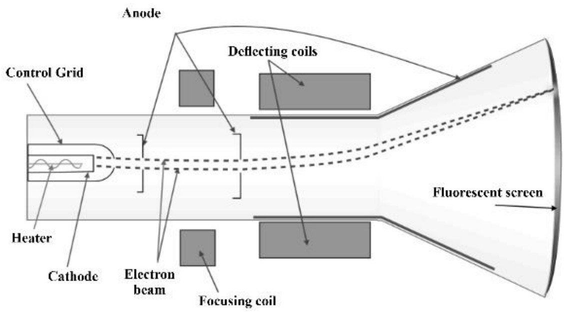
Electron

- **J. J. Thomson**, in **1897**, discovered **negatively charged particles** emitted by the **cathode** towards the anode in a cathode ray experiment.
- These **negatively** charged particles are **Electrons**.

Cathode ray experiment

- **J. J. Thomson** discovered the **existence** of **electrons**.
- He did this using a cathode ray tube, which is a **vacuum-sealed tube** with a **cathode** and **anode** on one end that created a **beam** of electrons travelling towards the other end of the tube.
- The air inside the **chamber** is subjected to **high voltage** and **electricity** flows through the air from the **negative electrode** to the **positive electrode**.

- The **characteristics** of cathode rays (electrons) **do not depend** upon the **material** of **electrodes** and the **nature** of the **gas** present in the cathode ray tube.



- The experiment showed that the **atom** was **not** a **simple**, **indivisible** particle and contained **at least one subatomic particle** – the electron.

Protons

- **Ernest Goldstein**, in 1886, discovered that with a different condition in the same chamber, **anode** emitted **positively charged particles** known as **Canal rays** or later named as **Protons**.

Neutrons

- **J. Chadwick** discovered a subatomic particle with **no charge** and a **mass** equivalent to **protons** in the nucleus of all atoms.
- These **neutrally charged** particles are Neutrons.

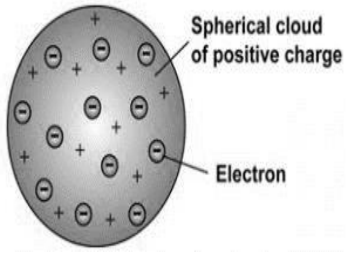
Properties of electrons, protons, and neutrons

Property	Electrons	Protons	Neutrons
Charge	Negatively Charged	Positively Charged	No Charge
Affinity	Attracts to positively charged	Attracts to negatively charged	Get attracted neither to positive nor negative
Weight	Mass is negligible	1 a.m.u	1 a.m.u
Location	Outside the nucleus	Within the nucleus	Inside the nucleus

Different Models on Structure of an Atom

Thomson's Model of an Atom

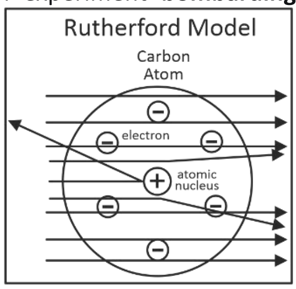
- **J. J. Thomson** proposed that the structure of an atom is similar to that of a **Christmas pudding** where electrons are embedded like currants in the sphere.
- He **proposed** that:
  - The **structure** of an **atom** is a **positively charged sphere** that embeds electrons in it
  - An atom is **electrically neutral** as the **protons** and **electrons** are **equal** in magnitude



- **Drawbacks** of Thomson's Model:
  - Thomson's structure of an atom **failed** to **explain** the **arrangement** of **protons** and **electrons** in its structure.

Rutherford's Model of an Atom

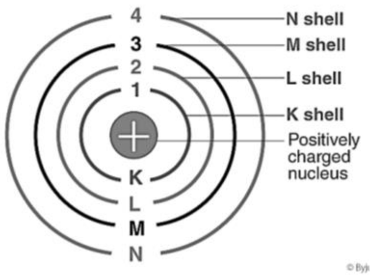
- **Rutherford** conducted an experiment **bombarding** the **alpha (α)-particles** on a **gold foil**.



- He observed the **trajectory** of the **alpha (α)-particles** after passing through an atom and **drafted** some **postulates** of the experiment, which are:
  - **Most** of the **space** in an **atom** is **empty** as the **particles passed** through the **gold foil** without any **hindrance**
  - The **positively charged centre** is called the **Nucleus**, and all the **mass** of an atom **resides** in the **centre**.
    - **The** particles **deflected 180°** after **bombarding** the **nucleus**
  - The **electrons orbit** the centre in a **defined path**
  - The **size** of the **nucleus** is **small** compared to the total size of the atom
- **Drawbacks** of the Model:
  - Although **Rutherford** presented an **entirely new model** regarding the structure of the atom, there were a lot of drawbacks which he failed to explain, are-
    - The **electrons revolve** in an **unstable path**, and they undergo **acceleration radiating energy**.
    - When the **electrons revolve**, they **lose energy**.
    - Soon electrons would **collapse** into the **nucleus**.
    - This tendency would make an **atom highly unstable** while the **atom** is **highly stable**
    - Rutherford's structure of an atom **failed** to **explain** the **atomic number** concept as it explained only the presence of protons in the nucleus

Bohr's Model of an Atom

- Bohr devised a model in order to **overcome** the **objections** that **Rutherford's model** raised.
- So, he stated the following **postulates**:
  - An atom **permits** only a **discrete** amount of **orbitals** for the **electrons** to **orbit** and make the outer structure of an atom



  - While revolving, the **negatively charged particles** do **not lose energy** in these **orbitals** or **energy levels**
  - When the **electron jumps** from **one energy shell** to **another**, a change in magnitude takes place
- Bohr's model gives an **elaborative explanation** on the structure of an atom and **overcomes** the **objections** faced by all the other models on the structure of an atom**.**

Distribution of Electrons in Distinct Shells

- Bohr-Bury Scheme **suggested** the **arrangement** of **particles** in **different orbits**.
- The following are the rules to write the number of particles in different orbitals:
  - The formula **2n^2** gives the accommodation of the **maximum number of electrons** in each shell, n=1, 2, 3, 4 for K=2, L=8, M=18, N=32.
  - The **outermost orbit** can hold a **maximum** of **8 electrons.**
  - The electrons fill the inner levels first as they **follow** the **stepwise filling of orbitals**
- **Number of electrons in K-shell:** n = 1
  - 2n^2 = 2 × 1^2 = 2
  - Maximum number of electrons in K-shell, first shell = 2
- **Number of electrons in L-shell, n** = 2,
  - 2n^2 = 2 × 2^2 = 8
  - Maximum number of electrons in L-shell, Second shell = 8
- Using the **formula 2n^2** number of **electrons** in any shell can be **calculated**.

Valency

- **Valence Electrons** - The negatively charged particles present in the outermost shell.
  - These valence electrons are **responsible** for the **valency** of an atom.
- **Valency** - tendency of an atom to react with the other atoms of the same or various elements.
  - The atoms that fill the **outermost paths** show **chemical activity** towards other valence electrons.
  - This reactivity is **responsible** for the **formation** of **molecules** between two or more atoms.
- The valency **becomes zero** for an **atom** when the **outer bounds** have **eight electrons** or **no electrons** to lose.
- The particle with **eight electrons** in the **outermost shell** is an octet, and these molecules are **mostly inert** in nature.
- **Eg**:
  - **Magnesium** (Mg) has a configuration (2, 8, and 2), so the valency is two.
  - **Oxygen** (O) (2, 8, and 6) has the valency two as the number electrons it can gain is two to achieve a packed outer energy level.
  - **Helium** (He) has 2 electrons in its outer shell, Neon (Ne) (2, 8, and 8) has eight electrons in its outer shell.
    - Hence, they do not show any chemical activity.

Atomic Number (Z)

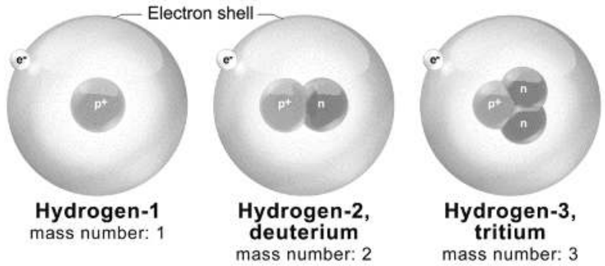
- Atomic number = **number of protons** present in one atom of an element.
- As the atom is **electrically neutral**, the number of **protons** and **electrons** are the same.
- The notation **Z** denotes an **Atomic number**.
- The atomic number of Hydrogen is one as it has **only one proton.**
  - **Number of Protons** present in an atom = Atomic number (Z)
  - **Number of Electrons** present in an atom= Atomic number (Z)
  - **Number of Neutrons** = Mass number (A)-Atomic number (Z)

Mass Number (A)

- Measure of the **total** number of **protons** and **neutrons** in the nucleus of an atom.
- The notation **A** indicates the Mass number.
- N = total number of **neutrons**.
- Mass Number = **Atomic Number + Number of Neutrons** in the Nucleus
  - A = Z + n°
- aka **Nucleon** number.

Isotopes

- The atoms of the **same elements** with the **same atomic number** and **different mass numbers**.
- **Hydrogen** has **three isotopes**: Protium, Deuterium, Tritium.



Isobars

- The atoms of **different molecules** with the **same mass number**.
- **Eg**, in **Calcium**, atomic number 20, and **argon**, atomic number 18, the mass number of both these elements is 40.
    - This shows that the total number of **nucleons** is the **same** in the atoms.

Metals, Non- metals and Metalloids

Metalloids

- Elements which have the properties of both metals and non-metals are known as metalloids.
    - For example, Boron, Arsenic, etc.

METALS AND NON-METALS

METALS

Physical Properties

- Solid.
- Lustrous.
- Malleable and ductile.
- Hard and have high density.
- Good conductors of heat and electricity.
- High melting and boiling points.

Chemical Properties

- React with dilute acids to liberate hydrogen gas
- React with oxygen to form basic oxides.
- Do not combine with hydrogen.
- React with water to form metal oxides or metal hydroxides.
- Electropositive i.e. form positive ions by losing electrons.
- Reducing agents.

NON-METALS

Physical Properties

- Solids, liquids and gases.
- Non-lustrous.
- Non-malleable and non-ductile.
- Varying hardness and have low density.
- Poor conductors of heat and electricity.
- Low melting and boiling points.

Chemical Properties

- Do not displace hydrogen on reaction with dilute acids.
- React with oxygen to form acidic or neutral oxides
- Combine with hydrogen to form stable hydrides.
- Do not react with water.
- Electronegative i.e. form negative ions by gaining electrons.
- Oxidising agents.

Corrosion

The eating up of metals by the action of air and moisture or a chemical on their surface.

Alloys

It is a homogeneous mixture of two or more metals (or a metal and a non-metal). For e.g. Brass is an alloy of 2 metals-copper and zinc.

Rusting

The corrosion of iron is known as rusting. Rust is hydrated iron (III) oxide,
$Fe_2O_3 . xH_2O$.
Presence of air and water are the two conditions necessary for rust. It can be prevented by painting, applying grease, by galvanization and by alloying.

Ionic Compounds

1. Usually crystalline solids.
2. Have high melting point and boiling point.
3. Conduct electricity when dissolved in water or melted.
4. Usually soluble in water and insoluble in organic solvent.

Covalent Compounds

1. Usually liquids / gases, few are solids.
2. Have low melting and boiling point.
3. Do not conduct electricity.
4. Usually insoluble in water and soluble in organic solvents.

Table 5.6 Modern Periodic Table

Metals | Metalloids | Non-metals

The zigzag line separates the metals from the non-metals.

GROUP NUMBER

PERIODS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H Hydrogen 1.0																	2 He Helium 4.0
2	3 Li Lithium 6.9	4 Be Beryllium 9.0											5 B Boron 10.8	6 C Carbon 12.0	7 N Nitrogen 14.0	8 O Oxygen 16.0	9 F Fluorine 19.0	10 Ne Neon 20.2
3	11 Na Sodium 23.0	12 Mg Magnesium 24.3											13 Al Aluminium 27.0	14 Si Silicon 28.1	15 P Phosphorus 31.0	16 S Sulphur 32.1	17 Cl Chlorine 35.5	18 Ar Argon 39.9
4	19 K Potassium 39.1	20 Ca Calcium 40.1	21 Sc Scandium 45.0	22 Ti Titanium 47.8	23 V Vanadium 50.9	24 Cr Chromium 52.0	25 Mn Manganese 54.9	26 Fe Iron 55.9	27 Co Cobalt 58.9	28 Ni Nickel 58.7	29 Cu Copper 63.5	30 Zn Zinc 65.4	31 Ga Gallium 69.7	32 Ge Germanium 72.6	33 As Arsenic 74.9	34 Se Selenium 79.0	35 Br Bromine 79.9	36 Kr Krypton 83.8
5	37 Rb Rubidium 85.5	38 Sr Strontium 87.6	39 Y Yttrium 88.9	40 Zr Zirconium 91.2	41 Nb Niobium 92.9	42 Mo Molybdenum 95.9	43 Tc Technetium (99)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.3	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
6	55 Cs Caesium 132.9	56 Ba Barium 137.3	57 La* Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 181.0	74 W Tungsten 183.9	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (210)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium (226)	89 Ac** Actinium (227)	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Uub	–	114 Uuq	–	Uuh	–	–

* Lanthanoides	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.5
** Actinoides	90 Th Thorium 232.0	91 Pa Protactinium (231)	92 U Uranium 238.1	93 Np Neptunium (237)	94 Pu Plutonium (242)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (245)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (253)	101 Md Mendelevium (256)	102 No Nobelium (254)	103 Lr Lawrencium (257)

Properties of Metalloids

- They have a metallic luster but behave like non-metals.
- They are brittle, shiny substances
- They are solid at ambient temperatures and have relatively high melting points.

Melting Temperatures of Metalloids

Element	**Melting Temperature (°C)**
Boron	2079
Silicon	1410
Germanium	938.3
Arsenic	817
Tellurium	449.5
Antimony	631

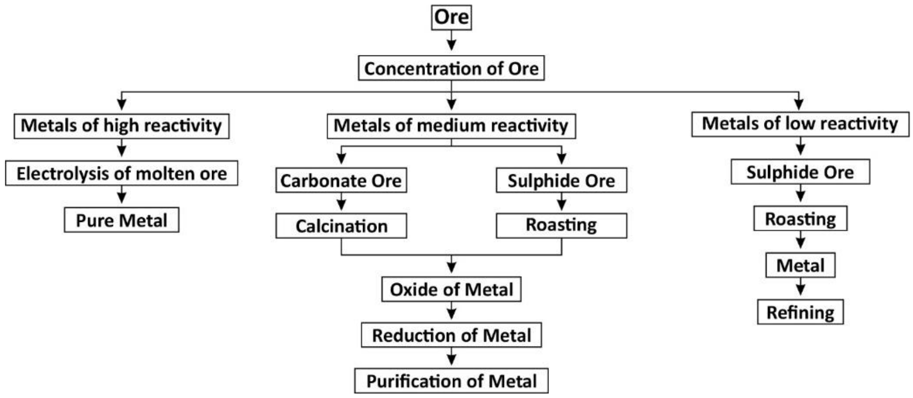
- They are good electric conductors but poorer than metals.
- They have intermediate energies of ionisation and values of electronegativity
- Like non-metals, they form anions, have multiple oxidation states, and form covalent bonds
- They form metallic alloys.

Metalloids and their applications

Element	Description	Application
Boron	An allotropic semimetal that is extremely hard and heat resistant. Has an atomic number of 5.	Used with silicon to make thermal shock-resistant glass.
Silicon	A grey and shiny semiconductive metal. It has high melting (1,410 °C) and boiling points (3,265 °C). Has an atomic number of 14.	Commonly used for semiconductors.
Germanium	Is hard and brittle in its elemental form. Has an atomic number of 32.	Less commonly used for semiconductors.

Arsenic	A steel-grey semimetal known for being poisonous. It has an atomic number of 33.	Often used as an insecticide.
Tellurium	Brittle in its elemental form. It is a chalcogen, along with selenium and sulfur. It has an atomic number of 52.	Used as a steel additive to improve machinability.
Antimony	A hard and brittle semimetal with an atomic number of 51.	Used to colour paints; often alloyed with lead.

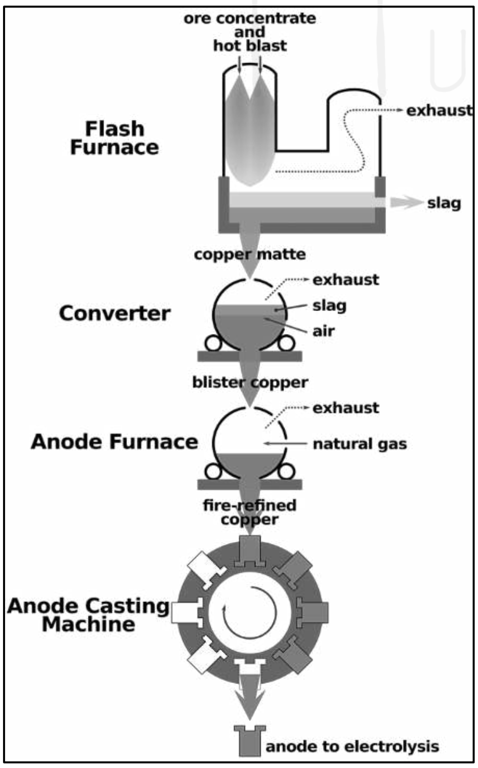
Metallurgical Principles and methods



- **Metallurgy** - a process that is used for the extraction of metals in their pure form.
- **Minerals** - The compounds of metals mixed with soil, limestone, sand, and rocks.
- Metals are **commercially extracted** from **minerals** at **low cost** and minimum effort.
  - These minerals are known as **ores**.
- A **substance** which is added to the **charge** in the **furnace** to remove the **gangue** (impurities) is known as **flux**.
- Metallurgy **deals** with the **process** of **purification** of **metals** and the **formation** of **alloys**.

Steps in Metallurgical Process

- The following are the various **steps** in the metal extraction or metallurgical process:



  - **Crushing** and **grinding** the ore.
  - The **concentration of ore**, is also known as ore enrichment.
  - **Metal extraction** from concentrated ore.
  - Impure metals are **refined** or **purified**.

Principles of Metallurgy

- The metallurgical process can be **classified** as the following:
  - Crushing and grinding
    - The **first process** in **metallurgy**.
    - Crushing of ores into a **fine powder** in a **crusher** or **ball mill**.
- This process is known as **pulverization**.
  - Concentration of ores
    - aka **ore dressing.**
    - It is the process of **removing impurities** from ore.
    - In metallurgy, we concentrate the ores mainly by the following **methods**.
  - Hydrolytic method
    - The **ore** is **poured** over a sloping, **vibrating** corrugated **table** with grooves.
    - A **jet** of **water** is allowed to **flow** over the **surface**.
    - The denser ore particles **settle** in the **grooves**, and the **impurities** are **washed away** by water.
  - Magnetic separation
    - The **crushed ore** is placed on a **conveyor belt**.
    - This belt **rotates** around **two wheels** in which one of the **wheels** is **magnetic**, and therefore the **magnetic particles** get **attracted** to the **magnetic wheel** and fall apart from the **non-magnetic particles**.

- Froth floatation
  - The **crushed ore** is taken in a **large tank** which contains **oil** and **water**.
  - A **current** of **compressed** air is **passed** through it.
  - The ore gets **wet** by **oil** and is **separated** from the **impurities** in the form of **froth**.
  - **Ore** is **lighter**, and so it **comes** on the **surface** and impurities are left behind.
- Roasting and calcination
  - **Roasting** - The process of heating a concentrated ore in the **presence** of **oxygen**.

- This process is applied in the case of **sulfide ores**.
  - **Calcination** - For ores containing **carbonate** or **hydrated oxides**, heating is done in the **absence** of **air** to melt the ores.

Important ores and alloys

Ores

- A mineral from which a metal can be extracted economically is called an ore.
- In it, a metal is present in appreciable quantities and from which the metal can be extracted economically.
- The main active substances present in nature, expecially in the atmosphere are oxygen and carbon dioxide.
- In the earth's crust, sulphur and silicon are found in large quantities.
- Sea-water contains large quantities of chloride ions (obtained from dissolved sodium chloride).
- Most active metals are highly electropositive and therefore exist as ions.
- It is for this reason that most of the important ores of these metals occur as
  - Oxides
  - Sulphides
  - carbonates
  - halides
  - silicates
- Some sulphide ores undergo oxidation by air to form sulphates.
  - This explains the occurrence of sulphate ores.
- Ores are invariably found in nature in contact with rocky materials.
  - These rocky or earthy impurities accompanying the ores are termed as gangue or matrix.

Important metals and their ores

Important metals and their ores		
Metal	**Ores**	**Chemical Formula**
Sodium (Na)	Chile saltpeter	$NaNO_3$
	Trona	$Na_2CO_3, 2NaHCO_3 \cdot 3H_2O$
	Borax	$Na_2 B_4O_7 \cdot 10H_2O$
	Common salt	$NaCl$
Aluminium (AI)	Bauxite	$Al_2O_3 \cdot 2H_2O$
	Corundum	Al_2O_3
	Felspar	$KAlSiO_8$
	Cryolite	Na_3AlF_6
	Alunite	$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 4Al(OH)_3$
	Kaolin	$3Al_2O_3 \cdot 6SiO_2 \cdot 2H_2O$
Potassium (K)	Nitre (salt peter)	KNO_3
	Carnalite	$KCl \cdot MgCl_2 \cdot 6H_2O$
Magnesium (Mg)	Magnesite	$MgCO_3$
	Dolomite	$MgCO_3 \cdot CaCO_3$
	Epsom salt	$MgSO_4 \cdot 7H_2O$
	Kieserite	$MgSO_4 \cdot H_2O$
	Carnalite	$KCl \cdot MgCl_2 \cdot 6H_2O$
Calcium (Ca)	Dolomite	$CaCO_3 \cdot MgCO_3$
	Calcite	$CaCO_3$
	Gypsum	$CaSO_4 \cdot 2H_2O$
	Fluorspar	CaF_2
	Asbestus	$CaSiO_3 \cdot MgSiO_3$
Strontium (Sr)	Strontianite	$SrCO_3$
	Silestine	$SrSO_4$
Copper (Cu)	Cuprite	Cu_2O
	Copper glance	$Cu_2 S$
	Copper pyrites	$CuFeS_2$
Silver (Ag)	Ruby Silver	$3Ag_2 S \cdot Sb_2 S_3$
	Horn Silver	$AgCl$
Gold (Au)	Calaverite	$AuTe_2$
	Silvenites	$[(Ag, Au)Te_2]$
Barium (Ba)	Barytes	$BaSO_4$
Zinc (Zn)	Zinc blende	ZnS
	Zincite	ZnO
	Calamine	$ZnCO_3$
Mercury (Hg)	Cinnabar	HgS
Tin (Sn)	Casseterite	SnO_2
Lead (Pb)	Galena	PbS
Antimony (Sb)	Stibenite	$Sb_2 S_3$

Cadmium (Cd)	Greenocite	CdS
Bismuth (Bi)	Bismuthite	$Bi_2 S_3$
Iron (Fe)	Haemetite	Fe_2O_3
	Lemonite	$2Fe_2O_3 \cdot 3H_2O$
	Magnetite	Fe_3O_4
	Siderite	$FeCO_3$
	Iren Pyrite	FeS_2
	Copper Pyrites	$CuFeS_2$
Cobalt (Co)	Smelite	$CoAsS_2$
Nickel (Ni)	Milarite	NiS
Magnese (Mn)	Pyrolusite	MnO_2
	Magnite	$Mn_2 \cdot 2H_2O$
Uranium (U)	Carnetite	$K_{(UO)_2} \cdot VO_4 \cdot 3H_2O$
	Pitch blende	U_3O_8

Alloys

- Alloys are mixtures of two or more metals and are formed by mixing molten metals thoroughly.
  - In a few cases, non-metals are mixed with metals to produce alloys.
- Alloying produces a metallic substance with more useful properties than the original pure metals from which it is made.
  - For example, the alloy brass is made from copper and zinc.

Properties of alloys

Alloys are prepared to impart some desirable properties which the individual metals do not possess. These are,

- **Change in the chemical reactivity:** Sodium acts vigorously with water, but *Na–Hg* amalgam reacts slowly to suit the requirement of some chemical reactions.
- **Hardness:** Silver, gold, and soft metals become hard when alloyed with copper.
- **Melting Points:** Melting points of an alloy may be higher or lower than any of its components. Wood-metal, which is an alloy of *Bi, Pb, Sn* and Cd, fuses at 60°C, while none of these metals fuses at this low temperature.
- **Change of colour:** Aluminium bronze is an alloy of aluminium and copper. It is of golden, yellow colour and is used in making decoration articles, jewellery and coins while the colour of aluminium is white and that of copper is red.
- **Corrosion resistance:** Iron gets corroded soon, whereas stainless Steel, an alloy of iron and chromium, resists corrosion.
- **Casting:** An alloy of lead and antimony is known as type metal and is used for casting type required in printing works.

Advantages of alloys

- Alloys do not get corroded or get corroded to a very less extent.
- They are harder and stronger than pure metals (For example, gold is mixed with copper, and it is harder than pure gold)
- They have less conductance than pure metals (For example, copper is a good conductor of heat and electricity, whereas brass and bronze are not good conductors)
- Some alloys have lower melting points than pure metals (For example, solder is an alloy of lead and tin, which has a lower melting point than each of the metals)
- When metal is alloyed with mercury, it is called amalgam.

Important Alloys

Alloys of Silver

Alloy	Percentage composition	Uses
Coin silver	Ag = 90, Cu = 10	For making silver coins.
Silver solder	Ag = 63, Cu = 30, Zn = 7	For soldering and joining metals
Dental alloy	Ag = 33, Hg = 52, Sn = 12.5, Cu = 2.0, Zn = 0.5	For filling teeth
Silver palladium	Ag = 40, Pd = 60	Potentiometers, and winding of some special instruments.

Alloys of Iron

Name	Percentage	Uses
Stainless steel	Fe = 73%, Cr = 18%, Ni = 8% and carbon	For making utensils, cutlery and ornamental pieces.
Manganese steel	Fe = 86%, Mn = 13% and carbon	For Making rock drills, safes etc.
Tungsten steel	Fe = 94%, W = 5% and carbon	For making high speed cutting tools.
Invar	Fe = 64%, Ni = 36%	For making watches, meter scales, pendulum rods etc.

Nickel steel	Fe = 98?96%, Ni = 2?4%	For making wire cables, gears, drive shafts etc.
Permalloy	Fe = 21%, Ni = 78% and carbon	For making electromagnets, ocean cables etc.
Chrome steel	Fe = 98?96%, Cr = 2?4%	For making axles, ball bearings and cutting tools such as files.
Alnico	Fe = 60%, Al =12%, Ni = 20%, Co = 8%	For making permanent magnets.

Alloys of Copper

Alloy	**Percentage Composition**	**Uses**
Brass	Cu = 80, Zn = 20	For making utensils, condenser tubes, wires parts of machinery etc.
Bronze or Copper bronze	Cu = 80, Zn = 10, Sn = 10	For making cooking utensils, statues, coins etc.
Aluminium bronze	Al = 95, Cu = 5	Coins, picture frames, cheap jewellery
Gun metal	Cu = 90, Sn = 10	For making gun barrels.
Bell metal	Cu = 90, Sn = 20	For making bells, gongs etc.
Constantan	Cu = 60, Ni = 40	For electrical apparatus
German silver	Cu = 60, Zn = 20, Ni = 20	For making silver wire, resistance wires etc.
Monel metal	Cu = 30, Ni = 67, Fe and Mn = 3	For making acid pumps and acid containers.
Phosphor bronze	Cu = 95, Sn = 4.8, P = 0.2	For making springs, electrical equipment
Gold-copper alloy	Au = 90, Cu = 10	For making gold coins, jewellery, watch cases, spectacle rims etc.

Alloys of Lead and Tin

Alloy	**Percentage Composition**	**Uses**
Solder	Pb = 50, Sn = 50	For soldering.
Pewter	Pb = 20, Sn = 80	In making cups, mugs and other utensils.
Type metal	Pb = 70, Sb = 20 and Sn = 10	For making printing type.
Rose metal	Pb = 22, Sn = 28, Bi = 50	For making electric fuses.
Britannia metals	Sn = 90, Sb = 8, Cu = 2	For making table wares.

Alloys of Aluminium

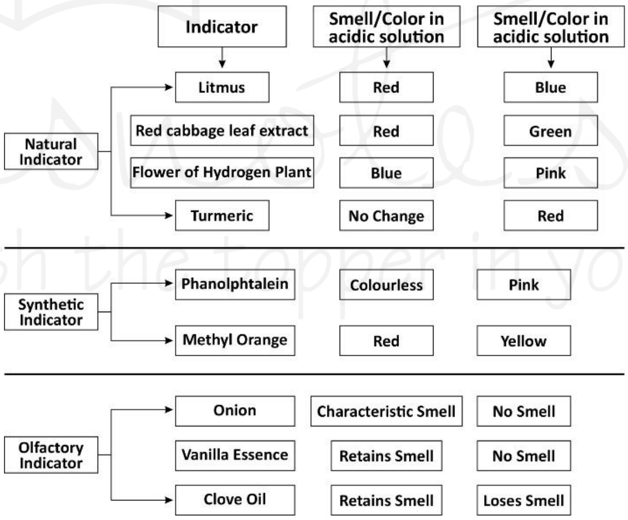
Alloy	**Percentage**		**Uses**
Aluminium bronze	Al Cu	95% 5%	Coins, utensils, jewellery picture frames etc.
Magnalium	Al Mg	95% 5%	Light instruments, balance beam, pressure cookers etc.
Duralumin	Al Cu Mg Mn	95% 4% 0.5% 0.5%	Making airplanes, automobile parts pressure cookers etc.

Acids, Bases and Salts

Indicators

Substances which **indicate** the **acidic** or **basic nature** of the **solution** by the **colour change.**

Types of Indicator



Natural Indicators

- Indicators obtained from **natural sources**.
- **Eg**:
  - **Litmus**
    - Obtained from **lichens**.
    - The **solution** of **litmus** is **purple** in colour.
    - Litmus paper comes in **two colours**- blue and red.
    - An **acid** turns blue **litmus** paper **red**.
    - A **base** turns red **litmus** paper **blue**.

- Turmeric:
  - **Yellow** in colour.
  - **Turns reddish brown** with **base**.
  - Des **not change colour** with **acid**.
- **Red Cabbage:**
  - Juice of **red cabbage** is originally **purple** in **colour**. J
  - Turns **reddish** with **acid** and turns **greenish** with **base**.

Olfactory Indicator

- Substances which **change** their **smell** when mixed with **acid** or **base**.
- **Eg:**
  - **Onion**
    - Paste or **juice** of **onion loses** its **smell** when added with **base**.
    - It does **not change** its **smell** with **acid**.
  - **Vanilla**
    - The **smell** of vanilla **vanishes** with **base**, but its smell does not vanish with an acid.

Synthetic Indicator

- Indicators that are **synthesized** in the **laboratory**.
- **Eg**.
- **Phenolphthalein**
  - A **colourless liquid**.
  - **Remains colourless** with **acid** but turns into **pink** with a **base**.
- **Methyl orange**
  - Originally **orange** in colour.
  - Turns into the **red** with **acid** and turns into **yellow** with **base**.

Indicator	Original Colour	Acid	Base
Red litmus	Red	No Change	Blue
Blue litmus	Blue	Red	No change
Turmeric	Yellow	No Change	Reddish brown
Red cabbage juice	Purple	Reddish	Greenish yellow
Phenolphthalein	Colourless	Colourless	Pink
Methyl Orange	Orange	Red	Yellow
Onion	n/a	No change	Smell vanishes
Vanilla	n/a	No change	Smell vanishes

Acids

- **Sour** in taste.
- Turn blue **litmus red**.
- **Dissolve** in **water** to release H^+ ions.
- Acid solution **conducts electricity**.
- **Example**: Sulphuric acid (H_2SO_4), Acetic Acid (CH_3COOH), Nitric Acid (HNO_3) etc.

Types of Acids

Natural Acids

- Acids which are obtained from **natural sources.**
- aka **Organic Acids**.
- **Examples:**
  - Methanoic acid ($HCOOH$)
  - Acetic acid (CH_3COOH)
  - Oxalic acid ($C_2H_2O_4$) etc.

Organic Acids and their Sources	
Acids	**Sources**
Acetic acid	Vinegar
Ascorbic acid	Guava, amla
Citric acid	Lemon, orange and other citrus fruits
Lactic acid	Sour milk, curd
Methanoic acid	Ant sting, nettle sting
Oxalic acid	Tomato
Tartaric acid	Tamarind

Mineral Acids

- Acids that are **prepared** from **minerals**.
- aka **Inorganic acids, man-made acids** or **synthetic acid**.
- **Eg**.
  - Hydrochloric acid (HCl)
  - Sulphuric acid (H_2SO_4)
  - Nitric acid (HNO_3)
  - Carbonic acid (H_2CO_3)
  - Phosphoric acid (H_3PO_4) etc.

Strong Acids

- An acid which is **completely ionised** in **water** and **produces** a large amount of **(H+)ions .**
- **Eg** - Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3)

Weak Acids

- An acid which is **partially ionised** in water and thus produces a **small amount** of hydrogen ions **(H+) ions.**
- **Eg** - Acetic acid (CH_3COOH), Carbonic acid (H_2CO_3)

Bases

- **Bitter** in taste, have **soapy** touch, **turn** red **litmus blue** and give **hydroxide ions (OH–)** in aqueous solution.
- **Eg**:
    - Sodium hydroxide (caustic soda) – NaOH
    - Calcium hydroxide – $Ca(OH)_2$
    - Potassium hydroxide (caustic potash) – (KOH)

Properties of Bases

- Have a **bitter taste**.
- **Soapy** to touch.
- **Turns** red **litmus blue**.
- **Conducts electricity** in solution.
- Release **OH– ions** in **Aqueous** Solution

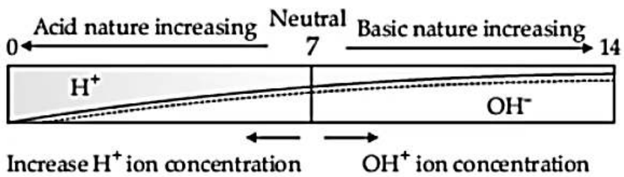
Types of bases

Water soluble bases

- The **hydroxide** of **alkali** and **alkaline earth metals** are soluble in water.
    - aka alkali.
- **Eg**. sodium hydroxide, magnesium hydroxide, calcium hydroxide, etc.
- Alkali is considered a **strong base**.

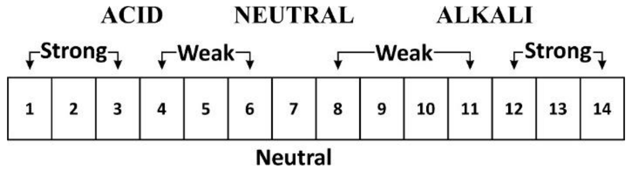
Strength of Acid and Bases

- **Strong Acids** - Acids in which complete dissociation of hydrogen ion takes place.
- **Strong bases** - Similarly, bases in which complete dissociation of hydroxide ion takes place.
- For **water** or **neutral solutions** : pH = 7
- For **acidic solutions** : pH < 7
- For **basic solution** : pH > 7



Universal Indicator

- Shows **different colour** over the range of pH value from **1 to 14** for a given solution.
- **Available** both in the form of **strips** and **solution**.
- **Combination** of **many indicators**, such as water, propanol, phenolphthalein, sodium salt, sodium hydroxide, methyl red, bromothymol blue monosodium salt, and thymol blue monosodium salt.
- The **colour matching chart** is supplied with a universal indicator which shows the different colours for **different** values of **pH**.



Salts

- Ionic compounds which are produced after the **neutralization** reaction between **acid** and **base**.
- **Electrically neutral**.
- Most **common salt** - sodium chloride.

Characteristics of salt

- Most of the salts are **crystalline soild**.
- Salts may be **transparent** or **opaque**.
- Most of the salts are **soluble** in **water**.
- Solution of the salts **conducts electricity** in their **molten state** also.
- The salt may be **salty**, **sour**, **sweet**, **bitter** and **umami** (savoury).
- Neutral salts are **odourless**.
- Salts can be **colourless** or **coloured**.

Some Important Compounds and their Uses

Common Name	Chemical name	Chemical formula	Uses
Washing soda	Sodium carbonate decahydrate	$Na_2CO_3 \cdot 10H_2O$	Manufacture of borax, caustic soda, softening of hard water.
Baking soda	Sodium hydrogen carbonate	$NaHCO_3$	Used as antacid, ingredient of baking powder.
Bleaching powder	Calcium oxychloride	$CaOCl_2$	Bleaching clothes, used as oxidizing agent, disinfecting water, manufacture of chloroform.
Plaster of Paris	Calcium sulphate hemihydrate	$CaSO_4 . 1/2 H_2O$	Plastering fractured bones, making toys, decorative materials, statues.

Equations of Acids, Bases and Salts:

- **Acid + Metal → Salt + Hydrogen gas**
    - $H_2SO_4 + Zn \rightarrow ZnSO_4 + H_2$
- **Base + Metal → Salt + Hydrogen gas**
    - $2NaOH + Zn \rightarrow Na_2ZnO_2$ (Sodium zincate) + H_2

- **Base + Acid → Salt + Water**
  - $NaOH (aq) + HCl (aq) \rightarrow NaCl (aq) + H_2O (l)$
- **Acids give hydronium ions in water**
  - $HCl + H_2O \rightarrow H_3O^+ + Cl^-$
- **Bases generate OH- ions in water**
  - $NaOH (aq) + H_2O \rightarrow Na^+ (aq) + O^- (aq)$

Concept of pH and Buffers

- pH scale is used for denoting the concentration of hydrogen ions.
- pH notation was devised by the Danish biochemist Soren Sorensen in 1909.
- The term pH means "power of hydrogen".
- The pH is the logarithm of the reciprocal of the hydrogen ion concentration. It is written as

$$pH = \log \frac{1}{[H^+]}$$

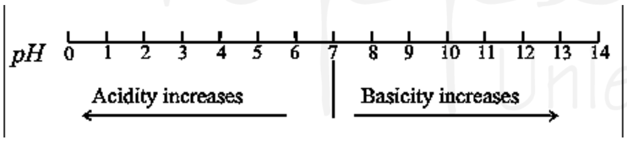
- Alternately, the pH is the negative logarithm of the hydrogen ion concentration i.e pH = –log [H+].

$$pH = -\log [H^+].$$

- Because of the negative sign in the expression, if [H+] increases, pH would decrease and if it decreases, pH would increase.

pH Scale

- The pH scale ranges from 0 to 14 on this scale.
- pH 7 is considered neutral, below 7 acidic and above 7 basics.
- Farther from 7, the more acidic or basic the solution is.



- The sum of pH and pOH of any aqueous solution remains constant.
- Therefore, when one increases the other decreases.

$$pH + pOH = 14$$

pH of some common substances

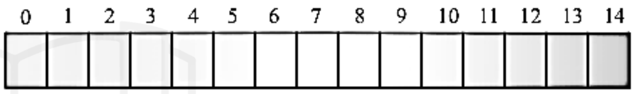
Common Acids	pH	Common Bases	pH
HCl (4%)	0	Blood Plasma	7.4
Stomach Acid	1	Egg White	8
Lemon Juice	2	Sea Water	8
Vinegar	3	Baking Soda	9
Oranges	3.5	Antacids	10
Soda, Grapes	4	Ammonia Water	11
Sour Milk	4.5	Lime Water	12
Fresh Milk	5	Drain Cleaner	13
Human Saliva	6-8	Caustic Soda 4% (NaOH)	14
Pure Water	7		

Determination of pH

- pH of a solution can be determined by using a proper indicator or with the help of a pH meter.
  - A device which gives the accurate value of pH.

Universal Indicator/pH paper

- A mixture of many indicators.
- Shows a specific colour at a given pH.
- A colour guide is provided with the bottle of the indicator or the strips of paper impregnated with it, which are called pH paper strips.
- Test solution is tested with a drop of the universal indicator, or a drop of the test solution is put on pH paper.
- The colour of the solution on the pH paper is compared with the colour chart, and pH is read from it.
- The pH values thus obtained are only approximate.



Importance of pH in everyday life

- **pH in humans and animals**
  - Most of the biochemical reactions taking place in our body are in a narrow pH range of 7.0 to 7.8.
  - Even a tiny change in pH disturbs these processes.
- **Acid Rain**
  - When the pH of rainwater falls below 5.6, it is called acid rain.
  - When acid rain flows into rivers, they also become acidic.
  - Hence, the survival of aquatic life becomes difficult.
- **pH in plants**
  - Plants have healthy growth only when the soil has a specific pH range which should be neither highly alkaline nor highly acidic.
- **In the digestive system**
  - Our stomach produces hydrochloric acid, which helps digest food.
  - When we eat spicy food, the stomach produces too much acid, which causes 'acidity'.
  - To eliminate this, 'antacids' are used as bases like 'milk of magnesia' (suspension of magnesium hydroxide in water).

- **Self-defense of animals and plants**
    - Bee sting causes severe pain and burning sensation.
    - It is due to the presence of methanoic acid in it.
    - Use of a mild base like baking soda can relieve pain.
    - Some plants, like 'the nettle plant' have fine stinging hair which injects methanoic acid.
    - This causes severe pain and a burning sensation.
    - The leaves of the dock plant that grow near the nettle plant, when rubbed on the affected area, provide relief.
- **Tooth decay**
    - Tooth enamel is made of calcium phosphate, which is the hardest substance in our body and can withstand the effect of various food articles that we eat.
    - If the mouth is not appropriately washed after every meal, the food particles and sugar remaining in the mouth undergo degradation due to the bacteria in the mouth.
    - This process produces acids, and the pH goes below 5.5.
    - The acidic condition thus created corrodes the tooth enamel and, in the long run, can result in tooth decay.

Buffers

- A solution whose pH is not altered to any great extent by the addition of small quantities of either an acid or base.
- aka a solution of reserve acidity or alkalinity which resists pH change upon adding a small amount of acid or alkali.
- Many chemical reactions are carried out at a constant pH.
- In nature, many systems use buffering for pH regulation.
    - Eg, bicarbonate acts as a buffer in the ocean.

Characteristics of buffer solution

- Have a definite pH.
- Its pH does not change on standing for long periods.
- Its pH does not change on dilution.
- Its pH is slightly changed by adding a small quantity of an acid or base.

Types of buffer solutions

Acidic Buffer	Formed by a mixture of a weak acid and its salt with a strong base
Basic Buffer	Formed by a mixture of a weak base and its salt with strong acid
Simple Buffer	Formed by a mixture of acid salt and normal salt of a polybasic acid, or a salt of a weak acid and a weak base

Application of Buffer

- **Maintenance of life:** Most biochemical processes work within a relatively small pH range. The body uses buffer solutions to maintain a constant pH. For example, blood contains a carbonate/bicarbonate buffer that keeps the pH close to 7.4.
- **Biochemical Assays:** Enzyme activity depends on pH, so the pH during an enzyme assay must stay constant.
- **In shampoos:** Many shampoos use a citric acid/sodium citrate shampoo to maintain a slightly acidic "pH balance". This counteracts the basicity of the detergents present in the shampoo.
- **In baby lotions:** Baby lotions are buffered to a pH of about 6. This hinders the growth of bacteria within the diaper and helps prevent diaper rash.
- **In the brewing Industry:** Buffer solutions are added before fermentation begins. This prevents the solutions from becoming too acidic and spoiling the product.
- **In the textile Industry:** Many dyeing processes use buffers to maintain the correct pH for various dyes.
- **In laundry detergents:** Many laundry detergents use buffers to prevent their natural ingredients from breaking down.

Important Drugs (Synthetic and Natural)

- Chemicals of **low molecular masses** (~100 – 500u) that interact with **macromolecular targets** and produce a **biological response**.
- When the biological response is **therapeutic** and useful, these chemicals are called **medicines** and are used in **diagnosis**, **prevention** and **treatment** of **diseases**.
- **Chemotherapy** - Use of chemicals for therapeutic effect.

Classification of Drugs

S.No.	Class	Action or Usage
1.	Antipyretics	Reduce body temperature
2.	Anti histamines	Reduce allergy
3.	Analgesics	Reduce pain
4.	Antimalarials	Used for treatment of malaria
5.	Germicides	Kill germs

6.	Antiseptics	Kill germs (can be safely used on living tissue)
7.	Disinfectant	Kill germs (cannot be used on living tissue)
8.	Antacids	Reduce acidity in stomach
9.	Anaesthetics	Loss of sensation
10.	Antimicrobials, Sulpha drugs and Antibiotics	Kill microorganisms
11.	Tranquilizers and hypnotics	Reduce anxiety and bring calmness
12.	Birth Control Medicines	Birth control
	(Contraceptives)	

On the basis of pharmacological effect

- Based on **pharmacological effect** of the drugs.
- **Eg**, analgesics have pain killing effect, antiseptics kill or arrest the growth of microorganisms.

On the basis of drug action

- Based on the **action of a drug** on a particular **biochemical process**.
- **Eg.** All antihistamines inhibit the action of the compound histamine which causes inflammation.

On the basis of chemical structure

- Based on the **chemical structure** of the drug.
- Drugs classified in this way share **common structural features** and often have similar **pharmacological activity**.

On the basis of molecular targets

- **Drugs** usually **interact** with **biomolecules** such as carbohydrates, lipids, proteins and nucleic acids.
  - These are called **target molecules** or **drug targets**.
- Drugs possessing some **common structural features** may have the same **mechanism of action** on **targets**.
- The classification based on **molecular targets** is the most useful **classification** for **medicinal chemists**.

Antacids

- **Over production** of **acid** in the **stomach** causes **irritation** and **pain**.
  - In severe cases, **ulcers** are developed in the stomach.
- Until **1970**, only treatment for **acidity** was administration of **antacids**, such as sodium hydrogen carbonate or a mixture of aluminium and magnesium hydroxide.
  - However, **excessive hydrogen carbonat**e can make the stomach **alkaline** and trigger the **production** of even **more acid**.
- **Metal hydroxides** are better **alternatives** because of being **insoluble**, these do **not increase** the **pH above neutrality.**
  - These treatments **control** only **symptoms**, and not the **cause**.
  - Therefore, with these **metal salts**, the patients **cannot** be **treated easily**.
- In advanced stages, ulcers become **life threatening** and the **affected part** of the stomach needs to be **removed**.

Antihistamines

- A major **breakthrough** in the **treatment** of **hyperacidity** came through the discovery according to which a **chemical**, **histamine**, **stimulates** the **secretion** of **pepsin** and **hydrochloric acid** in the stomach.
- The drug **cimetidine** (Tegamet), was **designed** to **prevent** the **interaction** of **histamine** with the **receptors** present in the **stomach wall**.
  - This resulted in release of **lesser** amount of ac**i**d.
- The **importance** of the **drug** was so much that it remained the **largest selling drug** in the world until another drug, **ranitidine** (Zantac), was discovered.
- **Histamine** is a **potent vasodilator**.
  - It has various **functions**.
    - It **contracts** the **smooth muscles** in the **bronchi** and gut and **relaxes** other **muscles**, such as those in the walls of fine blood vessels.
    - **Histamine** is also responsible for the **nasal congestion** associated with **common cold** and **allergic response** to pollen.
    - Synthetic drugs, brompheniramine (Dimetapp) and terfenadine (Seldane), act as **antihistamines**.

Neurologically Active Drugs: Tranquilizers

- Affect the **message transfer mechanism** from **nerve** to **receptor**.
- A class of **chemical compounds** used for the **treatment** of **stress**, and **mild** or even **severe mental diseases**.
- **Relieve anxiety**, stress, irritability or excitement by inducing a sense of well-being.
- Form an essential **component** of **sleeping pills**.

Antipyretics

- Substances used to reduce body temperature or to control fever.
- Derived from pyro which means fire (means hot) anti means against.

- Thus antipyretic means it counteracts heat (high body temperature).
- Aspirin, paracetamol and phenacetin are commonly used antipyretics.
- Aspirin is the most popular antipyretic in use.
- It gets hydrolyzed in stomach and salicylic acid is released.
- Overdose and using it over a long time may cause side effects.
  - May cause bleeding in the stomach wall and even ulcers.
  - Therefore, overdose and prolonged use should be avoided.
- However, calcium and sodium salts of aspirin are more soluble in water and are less harmful than aspirin.

Antimalarials

- Used to treat malaria.
- Quinine and chloroquine are widely used antimalarials.
- Quinine is one of the earliest drugs, which was first obtained from the bark of a plant (cinchona) and later on synthesized in laboratories.

Fertility Control Medicines / Contraceptives

- Medicines which help prevent pregnancy.
- Generally available in the form of tablets and are to be taken regularly by females.
- Eg. norethindrone and mestranol are used as contraceptives (birth control pills).
- Chemically these are similar to female sex hormones.

Analgesics

- **Reduce** or **abolish pain** without causing **impairment** of **consciousness**, mental confusion, incoordination or paralysis or some other disturbances of nervous system.
- **Classified as**:

Non-narcotic (non-addictive) analgesics

- **Aspirin** and **paracetamol** belong to the class of **non-narcotic analgesics**.
- **Aspirin** is the most familiar **example**.
- Aspirin **inhibits** the **synthesis** of **chemicals** known as **prostaglandins** which stimulate **inflammation** in the **tissue** and cause **pain**.
- These drugs are **effective** in relieving **skeletal pain** such as that due to **arthritis**.
- These drugs have many other **effects** such as **reducing fever** (antipyretic) and preventing **platelet coagulation**.
- Because of its **anti-blood clotting action**, aspirin finds use in **prevention** of **heart attacks**.

Narcotic analgesics

- **Morphine** and many of its **homologues**, when administered in **medicinal doses, relieve pain** and **produce sleep**.
- In poisonous doses, these **produce stupor**, **coma**, **convulsions** and ultimately **death**.
- Morphine narcotics are sometimes referred to as **opiates**, since they are obtained from the **opium poppy**.
- These analgesics are chiefly used for the relief of **postoperative pain**, **cardiac** pain and pains of **terminal cancer**, and in **childbirth**.

Antimicrobials

- **Diseases** in human beings and animals may be **caused** by a **variety** of **microorganisms** such as bacteria, virus, fungi and other pathogens.
- An antimicrobial tends to **destroy/prevent** development or inhibit the **pathogenic action** of microbes such as bacteria (antibacterial drugs), fungi (antifungal agents), virus (antiviral agents), or other parasites (antiparasitic drugs) selectively.
- **Antibiotics**, **antiseptics** and **disinfectants** are antimicrobial drug

Antibiotics

- A **substance** produced **wholly** or **partly** by **chemical synthesis**, which in **low concentrations** inhibits the growth or **destroys microbes** by intervening in their **metabolic processes**.
- The real revolution in **antibacterial therapy** began with the discovery of **Alexander Fleming** in **1929**, of the antibacterial properties of a **Penicillium** fungus.
- **Isolation** and **purification** of active compound to **accumulate sufficient material** for **clinical trials** took thirteen years.
- **Antibiotics** have either **cidal** (killing) effect or a **static** (inhibitory) **effect** on microbes.
- A few examples of the **two types of antibiotics** are as follows:
  - **Chloramphenicol**, isolated in 1947, is a broad spectrum antibiotic.
    - It is rapidly **absorbed** from the **gastrointestinal tract** and hence can be **given orally** in case of typhoid, dysentery, acute fever, certain form of urinary infections, meningitis and pneumonia.
  - **Vancomycin** and **ofloxacin** are the other important broad spectrum antibiotics.
    - The **antibiotic dysidazirine** is supposed to be **toxic** towards certain strains of **cancer cells**.

Antiseptics and disinfectants

- Chemicals which either **kill** or **prevent** the growth of **microorganisms**.
- **Antiseptics** - applied to the living tissues such as wounds, cuts, ulcers and diseased skin surfaces.
  - **Eg**. furacine, soframycin, etc.
  - These are **not ingested** like antibiotics.
  - **Iodine** - powerful antiseptic.
    - 2-3% solution in alcohol water mixture - tincture of iodine.
    - Applied on wounds.

Antifertility drugs

- **Birth control pills** essentially contain a mixture of synthetic **oestrogen** and **progesterone derivatives**.
- Both of these compounds are **hormones**. It is known that progesterone **suppresses ovulation**.
- Synthetic progesterone derivatives are **more potent** than **progesterone**.
- **Norethindrone** is an example of synthetic progesterone derivative most widely used as antifertility drug.
- The **estrogen derivative** which is used in combination with **progesterone** derivative is **ethynylestradiol** (novestrol).

Germicides, Disinfectant and Antiseptic

- **Germicides**
  - Chemicals, which prevent growth of germs (microorganisms).
  - Classified as antiseptic and disinfectant.
  - Both kill microorganisms but the difference lies in the way we use them.
- **Antiseptics**
  - Kill microorganisms and are safe to be used on living beings (tissues).
  - Used on wounds, cuts or skin abrasions.
  - Used to dress wounds, etc.
  - Eg, iodoform (CHI3), tincture of iodine, ethyl alcohol, a 0.2 percent aqueous solution of phenol and boric acid (H3BO3).

Poisons	Oxidising agents	Reducing agents
Dyes		
Acriflavine (a yellow dye)	Bleaching powder	Sulphur dioxide
Gentian violet	Chlorine	
Mercurochrome	Hydrogen peroxide	
Methylene blue	Iodine	
	Tincture of iodine	
Phenols	Iodoform	
	Potassium permanganate	
Phenol	Sodium hypochlorite	
Cresols		
Resorcinol		
Chloroxylenol		
Others		
Formaldehyde		
Boric acid		
Mercuric chloride		
Silver nitrate		

- **Disinfectants**
  - Kill germs (microorganisms) but are used on non-living substances like surgical instruments, floors, bathrooms, lavatories, etc.
  - Harsh and are not safe to be used on living beings as disinfectants can damage living tissues.
  - Chlorine is a powerful oxidizing agent - used for disinfecting water.

Antioxidants and Preservatives

Antioxidants

- The unsaturated fat and oils are readily oxidised on storage, the taste and smell are changed and become rancid.
- To prevent this oxidation, rancidity and spoilage, certain chemical substances are added,k/a antioxidant (food additives).
- When these are added to food items containing fats and oils retard the oxidation because they are more reactive towards oxidation than fats and oils. So the oxidation of food is prevented.
- Antioxidants react with free radicals and stop the oxidation of food.
- The most familiar antioxidants are butylated hydroxyl toluene (BHT) and butylated hydroxyl anisole (BHA)
- These are added to butter, meats, cereals chewing gum, snack gum, baked food and beer etc.
- It increases the life of food from months to years. It shows more active synergetic effect when added with Vitamin C (ascorbic acid) and citric acid.

Food Preservatives

- Chemical substances which are used to protect food materials against microorganisms (bacteria yeasts and moulds) are called preservatives.
- Some commonly used preservatives are
  - Common Salt, Sugar and oils
    - The sufficient amount of salt resist the activity of microorganisms in food it is called salting.
    - It is used to preserve raw mango, bean, fish and meat, etc.