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DDA – Patwari

Preliminary

Delhi Development Authority (DDA)

Volume - 4

General Science & Computer

SIERRA INNOVATIONS

INDEX

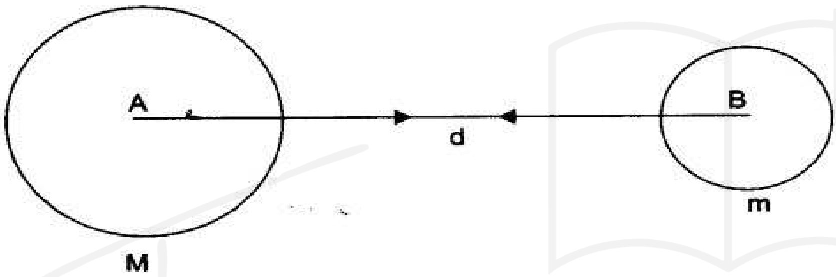
1 Chapter Physics

Gravitation

- **Force** that **attracts** a **body towards centre** of earth, or **towards any other physical body** having mass.
- **Every object** that has **mass exerts** a **gravitational pull** or force on every other mass.
- **Strength** of this pull **depends on** the **masses** of **objects**
- **Gets weaker** with **distance**.
- **Keeps planets in orbit** around sun and moon around the Earth
- **First discovered** in 1687 by Sir Isaac **Newton**.

Universal law of gravitation

- **Every object** in the universe **attracts** every **other object with a force** which is **proportional to** the **product** of their **masses** and **inversely proportional** to the **square** of the **distance** between them.
- The **force** is **along** the **line joining** the **centres** of **two objects**.



Gravitational force between two uniform objects is directed along the line joining their centres.

Formula:

F= Gx M x m

d^2

- Here M and m = masses of the objects interacting
- d- distance between the center of the masses
- G -gravitational constant (6.674×10^−11 m3·kg−1·s−2)

Mass

- **Quantity of matter contained** in a **body**.
- A **scalar** quantity.
- **Unit** - **kilogram**.
- A body **contains** the **same quantity** of **matter whether** it be on the **earth**, **moon** or even in **outer space**. Thus, **mass** is **constant** and **does not change** from place to place.
- **Denoted** by the small letter **'m'**.
- **Cannot be zero**.

Weight

- Measure of **force of gravity** acting on a body.
- **Formula** : w = mg
- **Unit**- Newton (as it is a force).
- **Vector quantity**

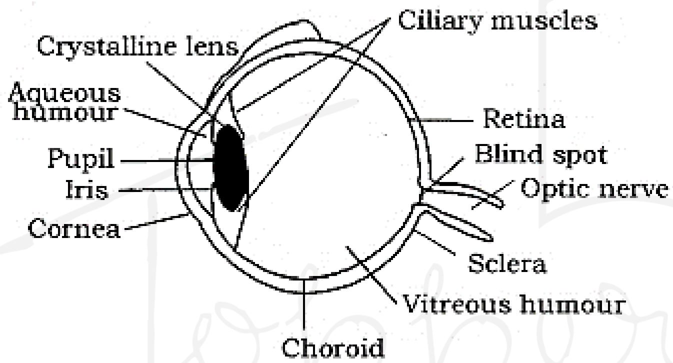
Difference between Mass and Weight

Mass	Weight
● **Quantity of matter** possessed by a body	● **Force** with which a **body** is **attracted towards** the **centre** of the earth.
● **Scalar** quantity.	● **Vector** quantity.
● S.I. unit - **kilogram** (kg.)	● S.I. unit - **Newton** (N).
● **Remains constant** at all places	● **Changes** from place to place.
● **Never zero**.	● **Becomes zero** at the centre of the earth.
● **Measured** by a **beam balance**.	● **Measured** by a **spring balance**.

Human eye and Defects

- **Human Eye** is a natural optical instrument which is used to see the objects by human beings.
  - It is like a camera which has a lens and screen system.

Structure of the Human Eye



The various parts of eye and their functions

Human Eye Part	Functions
Pupil	Opens and closes in order to regulate and control the amount of light.
Iris	Controls light level similar to the aperture of a camera.
Sclera	Protects the outer coat.
Cornea	A thin membrane which provides 67% of the eye’s focusing power.
Crystalline lens	Helps to focus light into the retina.
Conjunctive	Covers the outer surface (visible part) of the eye.
Aqueous humour	Provides power to the cornea.
Vitreous humour	Provides the eye with its form and shape.powe

Retina	Captures the light rays focussed by the lens and sends impulses to the brain via the optic nerve.
Optic nerve	Transmits electrical signals to the brain.
Ciliary muscles	Contracts and extends in order to change the lens shape for focusing.

Persistence of Vision:

- It is the time for which the sensation of an object continue in the eye.
- It is about 1/16th of a second.

Power of Accommodation:

- The ability of the eye lens to adjust its focal length accordingly as the distances is called power of accommodation.

Ciliary muscles

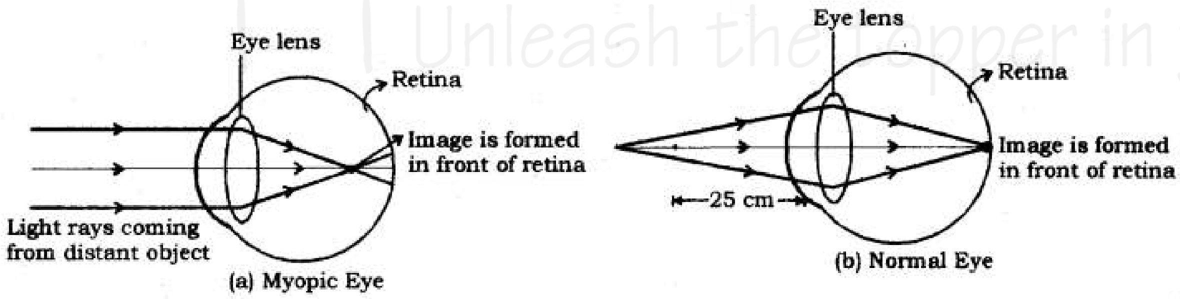
Relaxed	Contract
1. Eye lens become thin.	1. Eye lens become thick.
2. Increases the focal length.	2. Decreases the focal length.
3. Enable us to see distant object clearly.	3. Enable us to see nearby object clearly.

Near point of the Eye	Far point of the Eye
It is 25 cm for normal eye. The minimum distance at which object can be seen most distinctly without strain.	It is infinity for normal eye. It is the farthest point upto which the eye can see object clearly.

Defects of Vision and their Correction

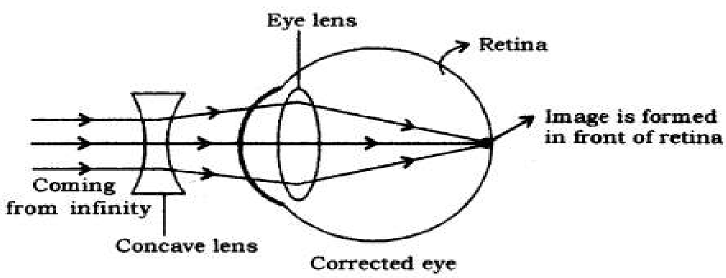
Myopia (Short-sightedness):

- A kind of defect in the human eye due to which a person can see near objects clearly but he cannot see the distant objects clearly. Myopia is due to
  - excessive curvature of the cornea.
  - elongation of eyeball.



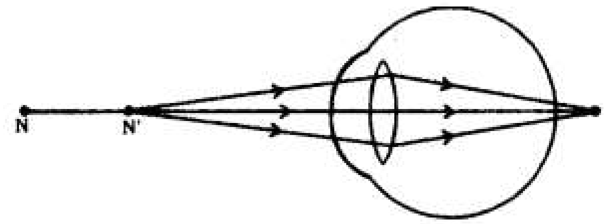
(a) Myopic Eye (b) Normal Eye

- **Correction**
  - Since a concave lens has an ability to diverge incoming rays, it is used to correct this defect of vision.
  - The image is allowed to format the retina by using a concave lens of suitable power as shown in the given figure.



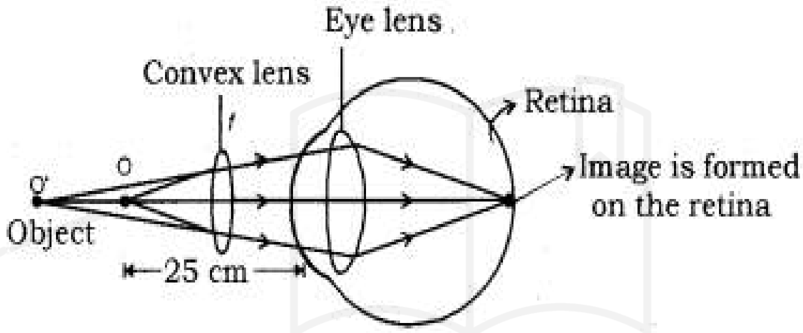
Hypermetropia (Long-sightedness)

- It is a kind of defect in the human eye due to which, a person can see distant objects properly but cannot see the nearby objects clearly. It happens due to
  - decrease in the power of eye lens i.e., increase in focal length of eye lens.
  - shortening of eyeball.



Hypermetropic eye

- A hypermetropic eye has its least distance of distinct vision greater than 25 cm.
- **Correction:**
  - Since a convex lens has the ability to converge incoming rays, it can be used to correct this defect of vision.
  - The ray diagram for the corrective measure for a hypermetropic eye is shown in the given figure.



Heat

- When water is boiled in a kettle the steam built up in the kettle raises its lid up and when the steam escapes out the lid falls down.
- Heat thus can do work, so, it is a form of energy.
- This property of steam was used to build steam engines – the devices which convert heat of steam into mechanical work.
- In fact work done against friction is always converted into heat.
- The equivalence of work and heat was noticed and experimentally established by J. P. Joule.
  - While boring the barrel of a gun with a blunt borer Joule found that so huge amount of heat was produced in the process that even water in which the process of boring was being carried out started boiling.
  - Through further experiments he found that one Calorie (Unit of heat prevalent at that time) of heat is equivalent to 4.2 Joule of work.

Some of the effects of heat:

- Rise in temperature
  - When a body is heated its temperature increases, that is why, it appears warmer when touched.
- Change of state
  - When heat is supplied to a substance in solid state its temperature rises till at a particular temperature it may change into its liquid state without any further change in its temperature.
  - This characteristic constant temperature at which a solid changes into its liquid state is called melting point of the solid.
  - The melting point of a substance is a characteristic, constant value and different substances may have different values of melting points.
  - Conversion of a solid into its liquid state at its melting point is called change of state from solid to liquid (fusion) and the heat that is transferred to the substance during melting is called Latent Heat of Fusion.

- Because, it does not becomes apparent in the form of rise in temperature.

- Latent heat of fusion of a solid substance is defined as the amount of heat (in joules) required to convert 1kg of the substance from solid to liquid state at its melting point.
- Similarly, when heat is supplied to a substance in liquid state its temperature rises but there is a possibility that it changes into its vapour state at a constant temperature.
  - The heat supplied in this case is called Latent Heat of Vaporization.
- Latent heat of vaporization of a liquid is defined as the amount of heat (in joules) required to convert 1kg of the substance from its liquid to gaseous state at a constant temperature.
- Vaporization may take place in two different ways:
  - Evaporation from the surface of a liquid at any temperature
  - Boiling of the whole mass of the liquid at a constant temperature called boiling point of the liquid.

S. No.	Name of Material	Melting Point (°C)	Latent heat of fusion ($\times 10^3$ J/kg)	Boiling Point (°C)	Latent heat of vaporization ($\times 10^3$ J/kg)
1.	Helium	–271	–	-268	25.1
2.	Hydrogen	–259	58.6	–252	452
3.	Air	–212	23.0	–191	213
4.	Mercury	–39	11.7	357	272
5.	Pure Water	0	335	100	2260
6.	Aluminum	658	322	1800	–
7.	Gold	1063	67	2500	–

Static and Current Electricity

- A controllable and convenient **form of energy** used in homes, schools, hospitals, industries,etc **for operating devices**.

We will write down the differences between the two on a number of factors in the form of a table.

Basis of difference	Static electricity	Electric current
Material	It can be developed on any type of material, either it be conductor or an insulator.	The current is produced only in conductors as it is due to movement of electrons.
Time period	Time period is short, as it exists for a very short period of time.	A comparative long time period.
Measuring device	It can be measured with a Gold leaf electroscope.	It can be measured with an Analog or a Digital meter.
Magnetic Field	Static electricity doesn't induce any magnetic field.	A magnetic field is induced every time an electric current is produced.
Example	Lightning in the sky etc.	It can be seen in electrical equipment like TV, bulb etc.

Electric charge:

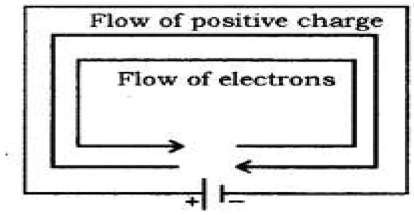
- **Fundamental unit of electricity** (without charge, no electricity).
- **2 types:** Positive & Negative.
- **SI Unit**: Coulomb

Electric current:

- **Rate of flow of electric charges.**
- **Caused by moving electrons** through a conductor.
- **Flows** in the **opposite direction** to the **movement** of **electrons**.

  $$I = \frac{Q}{t}$$

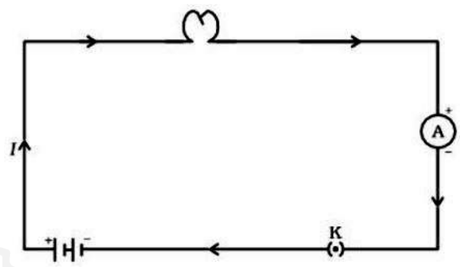
  Where,
  I= Electric current
  Q= Electric charge
  t= time
- **Unit** - ampere (A)
- **Measured**: Ammeter



Conventional flow of electric charge.

Electric circuit

- **Closed conducting path** through which **current flows**.

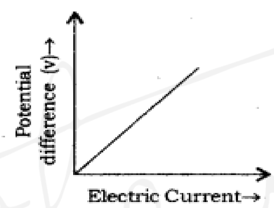


Potential Difference:

- **Work done to move a unit charge from one point to the other** within an electric field..
  $V = W\ Q$
- **SI unit:** volt (V)
- **When** the **cell** is **connected to** a **conducting circuit element**, the potential difference sets the charges in motion in the conductor and produces an electric current.

OHM'S LAW:

- **Potential difference** between **two points** is **directly proportional** to **electric current**, at a **constant temperature**.
  $V \propto I$
  $V = RI$
  $I = V/R$
- Here, R is the constant k/a resistance.



Resistance:

- **Property** of a conductor to **resist flow of charges** through it.
- **SI Unit:** Ohm (Ω).

> **1 Ohm of resistance (R)**
> Equal to flow of 1A of current through a conductor between two points having a potential difference equal to 1V.

Factors on which Resistance of a Conductor depends:

1. **Nature of Material:**
   - **Conductors** & **insulators**.
   - **Silver** - best conductor of electricity.
2. **Length of Conductor:**
   - **Resistance increases** with **increase** in **length** of the conductor.
3. **Area of Cross Section:**
   - **Resistance decreases** with an **increase** in **area** of conductor and **vice versa**.

Resistivity:

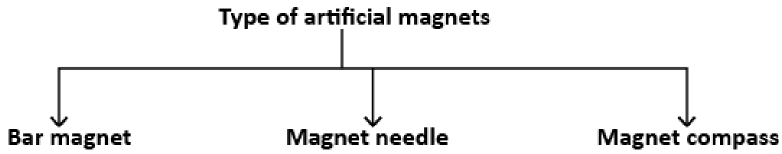
- **Resistance offered by a cube of a material** of side 1m **when current flows perpendicular to its opposite faces.**
- **SI unit** - ohm-meter (Ωm).
- **aka** specific resistance.
- **Depends** on the **nature of** the **material** of the conductor.
- **Varies** with **temperature**.

Heating Effect of Electric Current:

- **When electric current passes** through a **purely resistive conductor**, **energy** of electric current is **dissipated** `entirely in the **form of heat** and as a result, **resistor gets heated**.
- **Eg**. light bulb

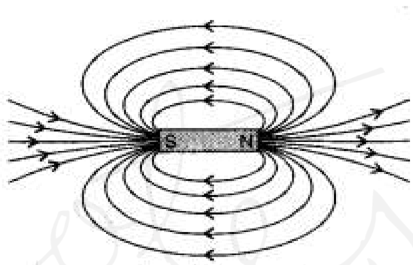
Magnetism

Magnet:



- An **object that attracts objects** made **of iron**, **cobalt** and **nickel**.
- **Use**:
  - in refrigerators.
  - in radio and stereo speakers.
  - in audio and video cassette players.
  - in children's toys and;
  - on hard discs and floppies of computers.
- **Properties**:
  - A **freely suspended magnet** always **points** towards **north** and **south** direction.
  - **Pole** which points **toward north** direction **-north pole**.
  - **Pole** which points **toward south** direction - **south pole**.
  - **Like poles repel** each other while **unlike poles attract** each other.

Magnetic field:



- **Influence of force surrounding** a **magnet**.
- **Force exerted** by a magnet in a magnetic field **detected using** a **compass** or any **other magnet**.
- **Represented** by **magnetic field lines**.

- A **quantity** that has **both direction** and **magnitude**.
- **Properties**:
  - **Inside magnet** - direction of field lines- **south pole to north pole**. Thus magnetic field lines are **closed curves.**
  - **Relative strength** of magnetic field is **shown by** degree of **closeness of field lines**.
  - **No two field-lines cross** each other.

Fleming's Right-Hand Thumb Rule:

- If a **current carrying conductor** is **held by right hand**, **keeping thumb straight** and if the **direction** of **electric current** is **in direction of thumb**, then **direction of wrapping** of **other fingers** will **show** the **direction of magnetic field**.

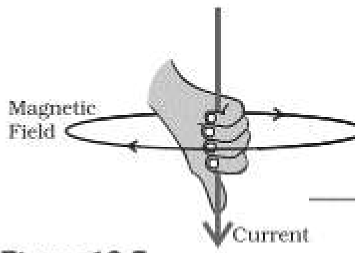


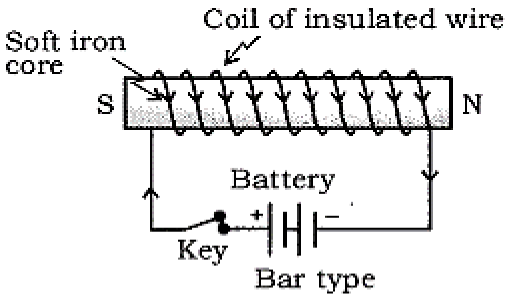
Figure 13.7
Right-hand thumb rule

Electromagnetism

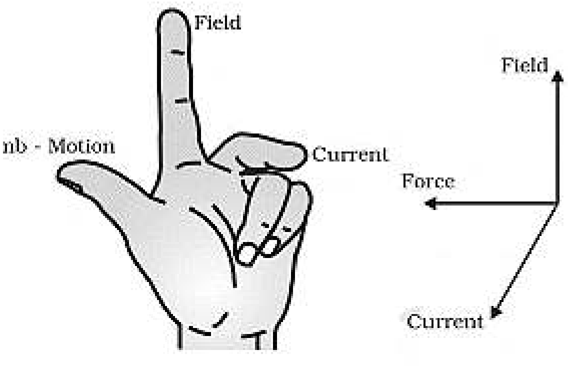
- A phenomenon in which a magnetic field is generated with the help of the current in the conductor.
- Made of two different aspects - electricity and magnetism.
- Electricity and magnetism were considered as different and separate forces up until the 19 th century.
- After more research, they were regarded as interrelated phenomena due to Einstein's Special Theory of Relativity.
- With the help of this theory we can understand that even though both electricity and magnetism possess varying properties, they are still defined by one common phenomenon.
- Electric charges help produce electric forces at rest or while in motion. Meanwhile, magnetic forces can only be formed when there exists a motion of charged particles.

Electromagnet:

- Consists of a **long coil of insulated copper wire wrapped** on a **soft iron**.
- **Formed by producing magnetic field inside** a **solenoid**.



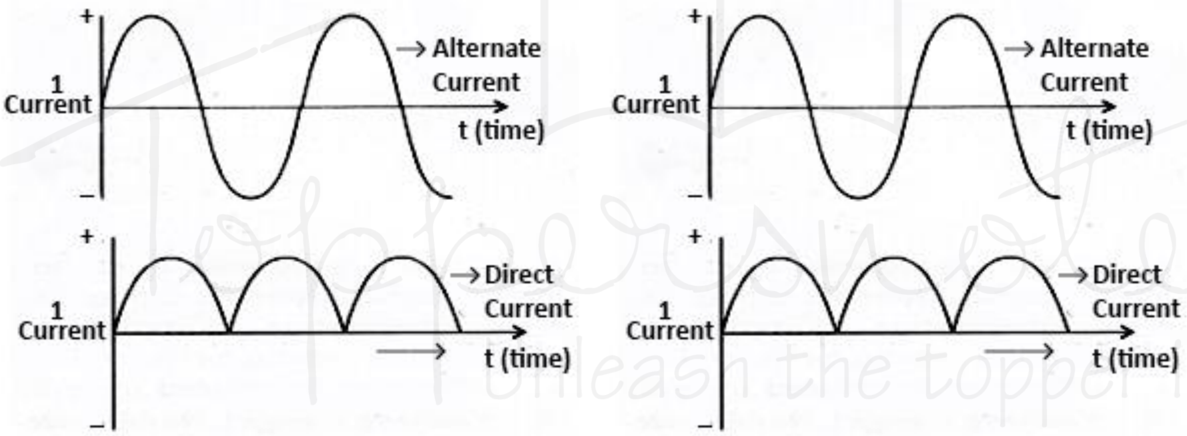
Fleming's left-hand rule:



Fleming's left-hand rule

- If the **left hand** is stretched in a way that the **index finger**, **middle finger** and **thumb** are in **mutually perpendicular directions**, then **index finger** and **middle finger** of a stretched left hand **show direction of magnetic field** and **direction of electric current** respectively and the **thumb shows** the **direction of motion** or **force acting on** the **conductor**.

Alternate Current:



- **Current in which direction** is **changed periodically**.
- **Frequency** of A.C in India is **50 Hz.**
- **Transmitted** to a **long distance without much loss** of **energy**.

Direct Current:

- **Current** that **flows** in **one direction** only.
- **Electrochemical cells** produce direct current.

Advantages of A.C over D.C

- **Cost of generator** of A**.C** << **D.C.**
- A.C **easily converted to D.C.**
- A.C **controlled by use** of **choke** - **less loss** of **power** whereas, **D.C controlled** using **resistances** - **high energy loss**.
- **AC transmitted over long distances without** much **loss** of **energy**.
- **AC machines** are **stout** and **durable** and **do not need** much **maintenance**.

Disadvantages of AC

- Cannot be used for electrolysis or showing electromagnetism as it reverses its polarity.
- More dangerous than DC.

Sound

A form of energy which produces a sensation of hearing in our ears.

Production of Sound

- Sound is produced due to the vibration of objects.
- Vibration is a periodic back-and-forth motion of the particles of an elastic body or medium about a central position. It is also named as oscillation.
- Eg:
  - Stretched strings of a guitar vibrate to produce sound.
  - When membrane of a table is struck, it vibrates to produce sound.

Propagation of Sound

- The travelling of sound is called propagation of sound.
- Sound is propagated by the to and fro motion of particles of the medium.
- When an object vibrates, the particles around the medium vibrate.
- The particle in contact with the vibrating object is first displaced from its equilibrium position.
- Each particle disturbs the other particle in contact.
- Thus, the disturbance is carried from the source to the listener.
- Only the disturbance produced by the vibrating body travels through the medium but the particles do not move forward themselves.

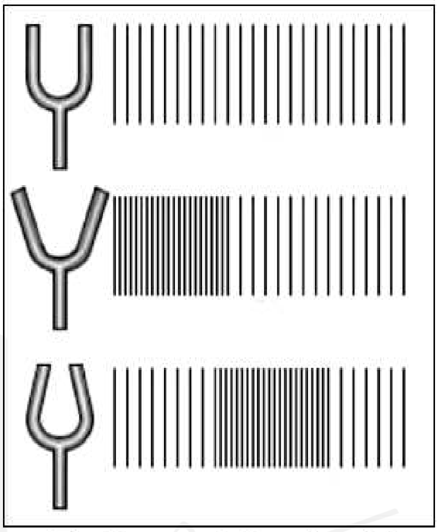


Fig. Representation of particle disturbance moving forward

Medium

- The matter or substance through which sound is transmitted is called a medium.
- A medium is necessary for the propagation of sound waves.
- The medium can be solid, liquid or gas.
- Sound cannot travel in vacuum.

Wave

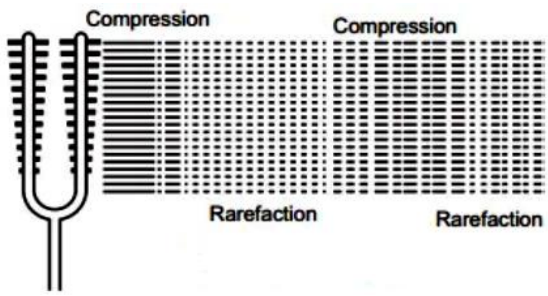
- Wave is a phenomenon or disturbance in which energy is transferred from one point to another without any direct contact between them.
- For example: Heat, light and sound is considered as a wave.

Types of Waves

- **Longitudinal waves:** These are the waves in which the particles of the medium vibrate along the direction of propagation of the wave. For example: sound wave.
- **Transverse waves:** In this type of wave the particles of the medium vibrate in a direction perpendicular to the direction of propagation of the wave. For example: waves produced in a stretched string.
- Another type of waves which do not require any medium for propagation are called electromagnetic waves.
  - These waves can travel through vacuum also.
    - For example, light waves, X-rays.

Compressions and Rarefactions:

- Compression is the- part of wave in which particles of the medium are closer to one another forming the region of high pressure and density.
  - Represented by the upper portion of the curve called **crest.**
- Rarefaction - part of the wave where particles spread out to form a region of low pressure and density.
  - Rarefactions are represented by the lower portion of the curve called **trough.**



Electro- Magnetic Waves

- A wave radiated by an accelerated or oscillatory charge in which varying magnetic field is the source of electric field and varying electric field is the source of magnetic field.
- Thus two fields becomes source of each other and the wave propagates in a direction perpendicular to both the fields.
- Transverse in nature, i.e. electric and magnetic fields are perpendicular to each other and to the direction of wave propagation.
- Electromagnetic waves are not deflected by electric and magnetic fields.

Basic Properties of Electromagnetic Waves

- Electromagnetic waves are transverse in nature.
- They propagate by varying electric fields and magnetic fields, such that these two fields are at right angles to each other and at a right angle with the direction of propagation of the wave.
- Electromagnetic waves travel with a constant velocity in vacuum. The speed of the waves is 3 x 108 m/s.
- Electromagnetic waves are non-mechanical waves. They do not require any material medium for propagation.
- They obey the equation c = fλ. Here, f is the frequency is Hertz and λ is the wavelength metres. The product of wavelength and frequency is equal to a constant c, the speed of light which is equal to 3 x 108 m/s. From this relation between wavelength, frequency and speed of light we can understand that the electromagnetic waves will travel with the speed of light regardless of wavelength and frequency.
- The oscillating electric field and magnetic field are in the same phase. The ratio of the amplitudes of the electric field and the magnetic field is equal to the velocity of the wave.

Seven types of electromagnetic waves

Wave	Wavelength	Uses
Gamma rays	10-14 to 10-10m	It provides information about the structure of atomic nuclei It has medical applications too.
X-rays	10-11to 3 ×10-8m	It reveals the structure of inner atomic electron shells and crystals. Helps in medical diagnosis. Assists in industrial radiography
UV rays	10-8 to 4 × 10-7m	Helps in the detection of invisible writing, forged documents and fingerprints. It helps detect forged currency as real banknotes do not turn fluorescent under UV light. Helps in preserving foodstuffs and detecting adulteration Used in water sterilisation
Visible rays	4 ×10-7to 8 ×10-7m	Reveals structure of molecules and arrangement of electrons in external shells of atoms. Allows you to see objects
Infrared rays	8×10-7 to 5 × 10-3m	In greenhouse effect, it is responsible for keeping plants warm It helps to look through haze, fog, and mist in wars. Helps cure crop diseases Treats muscular strains In astronomy
Microwaves	10-3 to 3 × 10-1m	In radar Long-distance wireless communication via satellites In microwave ovens
Radio waves	10-1 to 10-4m	In radio and television communication systems Marine and navigation use

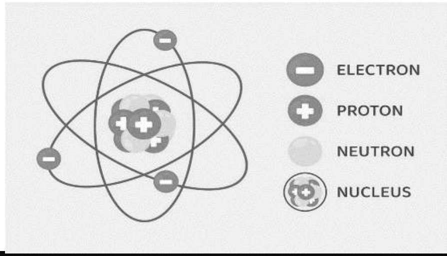
2 CHAPTER

Chemistry

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**.

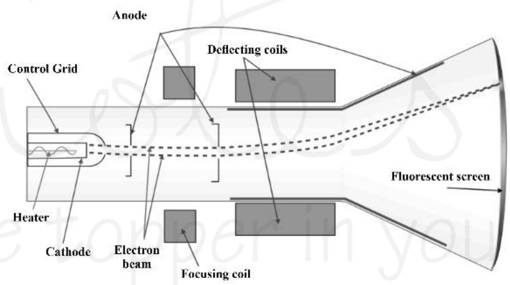


Electron

- **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

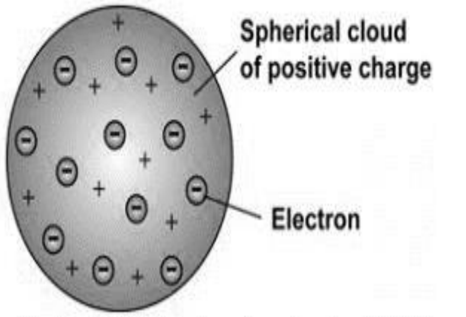
- **J. Chadwick** discovered a subatomic particle with **no charge** and a **mass** equivalent to **protons** in the nucleus of all atoms.
- These **neutrally charged** particles are Neutrons.

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

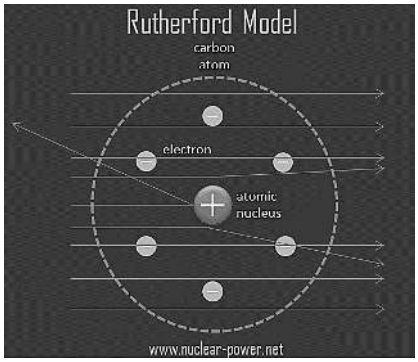
Different Models on Structure of an Atom

Thomson's Model of an Atom



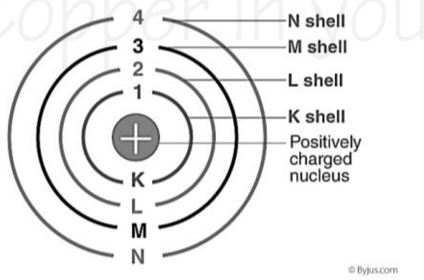
- **J. J. Thomson** proposed that the structure of an atom is similar to that of a **Christmas pudding** where electrons are embedded like currants in the sphere.
- He **proposed** that:
  - The **structure** of an **atom** is a **positively charged sphere** that embeds electrons in it
  - An atom is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

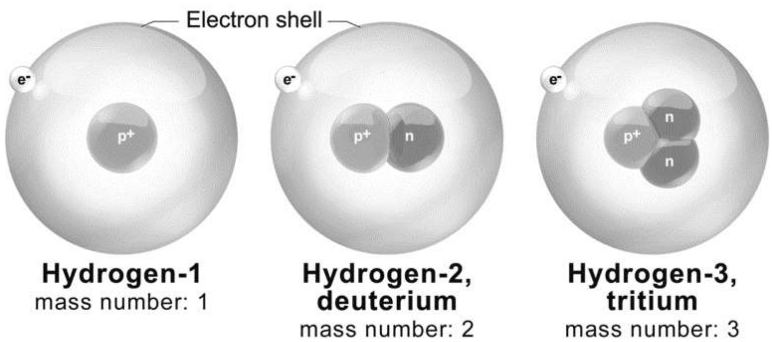
- Atomic number = **number of protons** present in one atom of an element.
- As the atom is **electrically neutral**, the number of **protons** and **electrons** are the same.
- The notation **Z** denotes an **Atomic number**.
- The atomic number of Hydrogen is one as it has **only one proton.**
   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

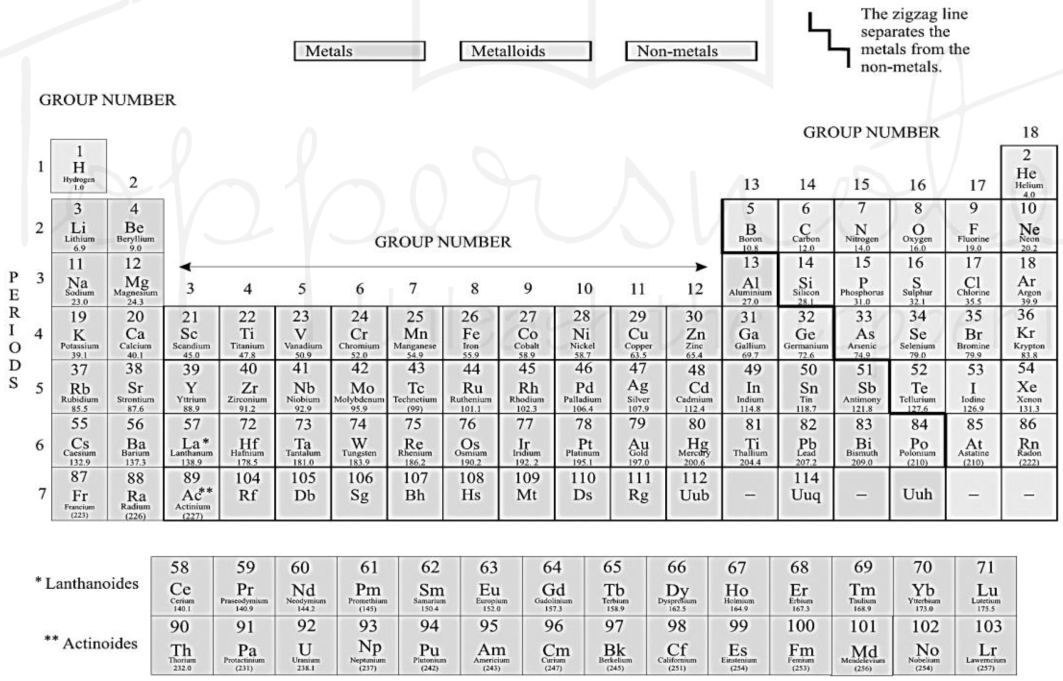
Ionic Compounds

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



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

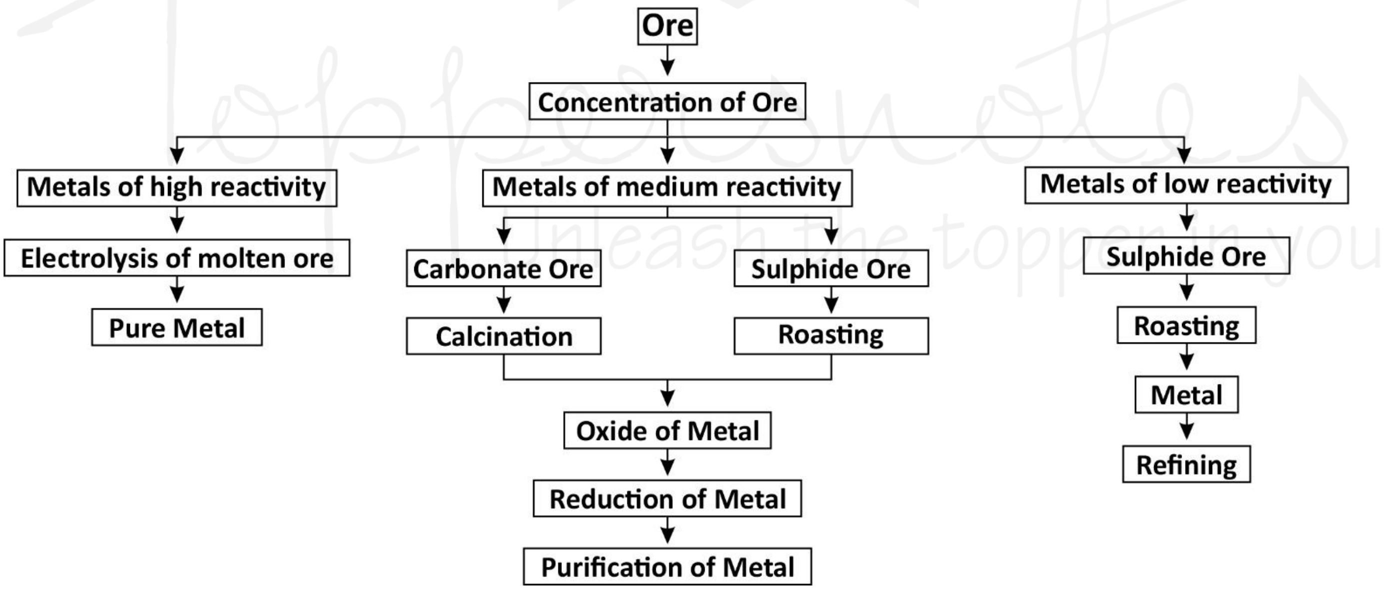
Germanium	938.3
Arsenic	817
Tellurium	449.5
Antimony	631

- 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**.

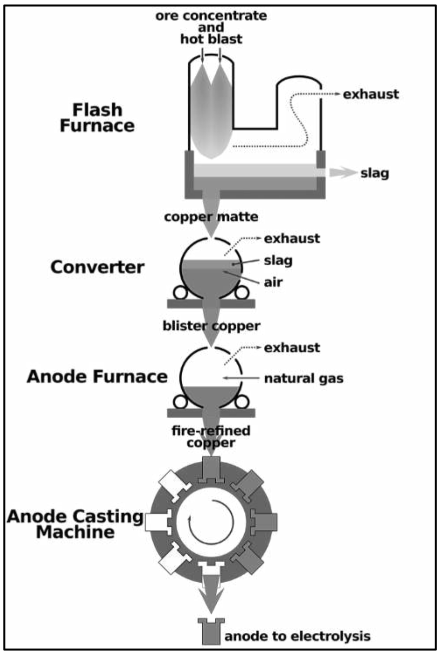


Fig. Copper Flash Smelting Process

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.