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MEASUREMENTS & MOTION

MEASUREMENTS

The process of comparing an unknown physical quantity with respect to a known quantity is known as measurement. When we say that the length of our bedroom is 10 feet it implies that the bedroom is 10 times the known quantity 'foot' (feet is the plural of foot). So, measurement of any physical quantity consists of two parts – (i) a numerical value and (ii) the known quantity. The known quantity is called the unit of that physical quantity. Measurement is an integral part of physics. Physics is the foundation on which engineering, technology and other sciences are based.

PHYSICAL QUANTITIES

Quantities which can be measured are called physical quantities. Velocity, acceleration, force, area, volume, pressure, etc. are some examples of physical quantities.

Kinds of Physical Quantities

There are two kinds of physical quantities

Fundamental physical quantities: Fundamental physical quantities are those which do not depend on other quantities and also independent of each other. They are seven in number *viz*; length, mass, time, thermodynamic temperature, electric current, luminous intensity and amount of substance.

Derived physical quantities: Derived physical quantities are those which are derived from fundamental physical quantities. For example, *velocity* is derived from the fundamental quantities length and time, hence it is a derived physical quantity.

UNITS

To measure a physical quantity it is compared with a standard quantity. This standard quantity is called the unit of that quantity. For example, to measure the length of a desk, it is compared with the standard quantity known as 'metre'. Thus, 'metre' is said to be the unit of length.

Types of Units

There are two types of units :

Fundamental units: Fundamental units are those units which cannot be derived from any other unit, and they cannot be resolved into any basic or fundamental unit. Also, the units of fundamental physical quantities are called fundamental units.

The following table shows the seven fundamental units of S.I. System.

S. No.	Fundamental Physical quantity	Fundamental Unit	Symbol
1.	Length	metre	m
2.	Mass	kilogram	kg
3.	Time	second	s
4.	Electric current	ampere	A
5.	Temperature	kelvin	K
6.	Luminous intensity	candela	cd
7.	Amount of substance	mole	mol

Derived units: Any unit which can be obtained by the combination of one or more fundamental units are called derived unit.

Examples: *Area, speed, density, volume, momentum, acceleration, force* etc.

Derived units of some physical quantities are as follows:

S. No.	Derived Physical quantity	Derived Unit
1.	Area	m ²
2.	Volume	m ³
3.	Density	kg/ m ³
4.	Speed	m/s
5.	Acceleration	m/s ²
6.	Momentum	kg m/ s
7.	Force	kg m/s ² or newton
8.	Work	kg m ² /s ² or joule
9.	Power	kg m ² /s ³ or watt
10.	Charge	ampere-sec or coulomb
11.	Potential	joule/coulomb or volt
12.	Resistance	volt/ampere or ohm

Systems of Units

Depending upon the units of fundamental physical quantities, there are four main systems of units, namely

- **CGS** (Centimeter, Gramme or Gram, Second)
- **FPS** (Foot, Pound, Second)
- **MKS** (Meter, Kilogram, Second)
- **SI** (Système Internationale d' Unites)

The first three of these systems recognize only three fundamental quantities i.e. length (*L*), mass (*M*) and

time (T) while the last one recognizes seven fundamental quantities. i.e. length (L), mass (M), time (T), electric current (I or A), thermodynamic temperature (K or θ), amount of substance (mol) and luminous intensity (I_v). An international organization, the **Conférence Générale des Poids et Mesures, or CGPM** is internationally recognized as the authority on the definition of units. In English, this body is known as “*General Conference on Weights and Measure*”. The **Systeme International de Unites, or SI system** of units, was set up in 1960 by the CGPM.

Characteristics of a Standard Unit

A standard unit must have following features to be accepted world wide. It should

- have a convenient size.
- be very well defined.
- be independent of time and place.

Supplementary Units of SI System

The following table shows the two supplementary units of SI System.

S.No.	Physical quantity	Supplementary Unit	Symbol
1.	Plane angle	radian	rad
2.	Solid angle	steradian	sr

1. **radian (rad):** The radian is the plane angle between two radii of a circle that cut off on the circumference an arc equal in length to the radius.
2. **steradian (sr):** The steradian is the solid angle that, having its vertex at the center of a sphere, cuts off an area of the surface of the sphere equal to that of a square with sides of length equal to the radius of the sphere.

Practical Units of Length

Astronomical unit, AU: The average distance between the sun and the earth about 1.49×10^{11} m is called 1 AU.

Parsec: The parsec is defined to be the distance at which a star would have a parallax angle equal to one second of arc.

1 Parsec = $3.08568025 \times 10^{16}$ m.

Light year : The light year is the distance travelled by light in one year. All electromagnetic waves travel at a speed of 299,792,458 ms^{-1} and an average year being 365.25 days.

One light year is $299,792,458 \times 10^8 \text{ms}^{-1} \times (365.25 \times 24 \times 60 \times 60) \text{s} = 9.46073 \times 10^{15}$ m. or 9.46073×10^{12} km.

Angstrom: An angstrom is a unit of length used to measure small lengths such as the wavelengths of light, atoms and molecules.

One angstrom, $1 \text{ \AA} = 10^{-10}$ m.

Fermi: A unit of length used to measure nuclear distance = 10^{-15} meter, 1 fermi = 10^{-15} m.

PREFIXES FOR SI UNITS

In Physics we have to deal from very small (micro) to very large (macro) magnitudes. To express such large and small magnitudes simultaneously we use following prefixes:

When a prefix is placed before the symbol of unit, the combined prefix and symbol should be considered as one new symbol which can be raised to a positive or negative power without any bracket, e.g., km^3 means $(10^3 \text{ m})^3$ but never 10^3 m^3 .

ERRORS IN MEASUREMENTS

Generally measured value of a quantity is different from the true value of the physical quantity. The difference between the true value and measured value is called error. $\text{Error} = \text{true value} - \text{measured value}$

Before we discuss about errors let us understand two important terms :

Accuracy : It is the measure of how close the measured value is to the true value of the physical quantity.

Precision : It tells us about the limit or resolution upto which the quantity is measured.

Significant Figures

Significant digits or figures give information about the accuracy of a measurement. It tells us about the number of digits in which we have confidence. Suppose a particular measurement is reported to be 9.28 cm, then the two digits 9 and 2 are reliable and certain while the digit 8 is uncertain. *The reliable and first uncertain digits are known as significant digits or figures.*

There are certain rules for counting significant digits or figure:

Rule-1. All the non-zero digits are significant—For example 2134 has four significant figures and 27184 has five significant figures.

Rule-2. All the zeros between two non-zero digits are significant, no matter where the decimal point is, if at all. For example 25089 has five significant figures, 12.0021 has six significant figures.

Rule-3. In a number which is less than one all zeros to the right of decimal point but to the left of a non-zero digit are not significant.

Rule-4. All the zeros on the right of last non-zero digits are significant in a number with a decimal point. For example in 3.500 there are four significant digits and in 0.079000 there are five significant figures.

Rule-5. All the zeros on the right on a non-zero digit are not significant in a number without decimal point. For example 15800 has only three significant figures, 18930000 has only four significant figures.

Rule-6. All the zeros on the right on a non-zero digit are taken to be significant when these come from a measurement. For example some distance is measured to be 7890 m then this number would have four significant figures.

Rule-7. A change of system of units does not change the number of significant digits in a measurement. Also when a number is written in scientific notation ($a \times 10^b$) then the powers of 10 are irrelevant to the determination of significant figures.

Least Count (L.C.)

The smallest division on the scale of the measuring instrument. It is an uncertainty associated with the resolution of the measuring instrument.

DIMENSIONS OF A PHYSICAL QUANTITY

All physical quantities can be expressed in terms of the fundamental quantities. Consider the physical quantity force.

$$\begin{aligned} \text{Force} &= \text{mass} \times \text{acceleration} = \text{mass} \times \frac{\text{velocity}}{\text{time}} \\ &= \text{mass} \times \frac{\text{length} / \text{time}}{\text{time}} = \text{mass} \times \text{length} \times \text{time}^{-2} \end{aligned}$$

$$\therefore \text{Unit of force} = \text{unit of mass} \times \text{unit of length} \times (\text{unit of time})^{-2}$$

FORCE OF GRAVITY

Earth attracts every body towards itself with a force known as ‘gravity’. Due to the force of gravity the ball thrown upwards doesn’t go upwards but it falls downwards after covering some vertical distance. Actually, every object attracts every other object towards itself with a force. This force is called the gravitational force. Gravitational force is one among the four fundamental forces. It is always attractive in nature.

NEWTON’S UNIVERSAL LAW OF GRAVITATION

Newton came to the conclusion that any two objects in the Universe exert gravitational attraction on each other.

Any two particles of matter anywhere in the universe attract each other with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them,

$$\text{i.e. } F \propto \frac{m_1 m_2}{r^2} \quad \text{or} \quad F = \frac{G m_1 m_2}{r^2}$$

Here, the constant of proportionality G is known as the **universal gravitational constant**. It is termed a “universal constant” because it is thought to be the same at all places and all times.

$$G = 6.673 \times 10^{-11} \text{ Nm}^2/\text{kg}^2.$$

Handy Facts

The value of universal gravitational constant, G is very small, hence gravitational force is very small, unless one (or both) of the masses is huge.

Important Characteristics of Gravitational Force

- Gravitational forces are always attractive and always acts along the line joining the two masses.
- Gravitational force is a mutual force hence it is action-reaction force, i.e., $\vec{F}_{12} = -\vec{F}_{21}$.
- Value of G is small, therefore, gravitational force is weaker than electrostatic and nuclear forces.
- Gravitational force is a central force because $F \propto \frac{1}{r^2}$.
- The gravitational force between two masses is independent of the presence of other objects and medium between the two masses.

Importance of the Universal Law of Gravitation

The universal law of gravitation successfully explained several phenomena which were believed to be unconnected.

- the force that binds us to the earth
- the motion of the moon around the earth
- the motion of planets around the Sun and
- the tides due to the moon and the Sun.

MASS AND WEIGHT

The quantity of matter in a body is known as the mass of the body. Mass is quantitative measure of inertia. Mass is an intrinsic property of matter and does not change as an object is moved from one location to another.

Weight, in contrast, is the gravitational force that the earth exerts on the object and can vary, depending on how far the object is above the earth’s surface or whether it is located near another body such as the moon.

The **relation between weight W and mass m**

$$W = \frac{GM_E m}{r^2}; \quad W = mg$$

$$\text{As } g_{\text{moon}} = \frac{1}{6} g_{\text{earth}} \text{ therefore,}$$

$$w_{\text{moon}} = \frac{1}{6} w_{\text{earth}}$$

Inertial and Gravitational Mass

The mass of a body is the quantity of matter possessed by a body.

Inertial Mass: Inertial mass of a body is related to its inertia of linear motion, and is defined by Newton’s second law of motion.

$$F = m_1 a \quad \text{or} \quad m_1 = \frac{F}{a}$$

The mass m_1 of the body in this sense is the inertial mass of the body.

In fact, inertial mass of a body is the measure of the ability of the body to oppose the production of acceleration in its motion by an external force.

Properties of inertial mass

- It is proportional to the quantity of matter contained in the body.
- It is independent of size, shape and state of the body.
- It does not depend upon the temperature of the body.

Gravitational Mass

Gravitational mass of a body is related to gravitational pull on the body and is defined by Newton’s law of gravitation.

If a body of mass m_G is placed on the surface of earth of radius R and mass M , then gravitational pull on the body is given by

$$F = \frac{GMm_G}{R^2} \Rightarrow m_G = \frac{F}{(GM/R^2)}$$

SOUND, OSCILLATIONS HEAT & THERMODYNAMICS

Sound is a form of energy that we hear. A vibrating object i.e., anything that moves back and forth, to-and-fro from side to side, in and out and up and down produces sound, as the object (vibrating) has a certain amount of energy. Sound requires material medium—a solid, a liquid or a gas to travel.

If there is no medium to vibrate then no sound is possible, sound cannot travel in a vacuum. Air is a poor conductor of sound compared with solids and liquids.

WAVE

Due to the vibratory motion of the particles of the medium a periodic disturbance is produced in a material medium. This is called a **wave**. In the absence of medium solid, liquid or gas sound wave is not being propagated but light (electromagnetic) waves travel through the vacuum.

Types of Waves

On the basis of the requirement of medium, waves are of two types

Mechanical Waves

A mechanical wave is a periodic disturbance which requires a material medium for its propagation. The properties of these waves depend on the medium so they are known as *elastic waves*, such as sound-waves, water waves, waves in stretched string etc. On the basis of motion of particles the mechanical waves are classified into two parts.

Transverse wave: When the particles of the medium vibrate in a direction perpendicular to the direction of propagation of the wave, the wave is known as the *transverse wave*. For example, waves produced in a stretched string, waves on the surface liquid. These waves travel in the form of crests and troughs. These waves can travel in solids and liquids only.

Longitudinal wave: When the particles of the medium vibrate along the direction of propagation of the wave then the wave is known as the longitudinal wave. For example sound wave in air, waves in a solid rod produced by scrubbing etc.

These waves travel in the form of compressions and rarefactions. These waves can travel in solids, liquids and gases.

Electromagnetic Waves

The waves which do not require medium for their propagation are called electromagnetic waves. This means that these waves can travel through vacuum also. For example, light waves, X-rays, γ -rays, infrared waves, radio waves, microwaves, etc. These waves are transverse in nature.

Difference between sound waves and electromagnetic waves

- Sound waves are longitudinal whereas electromagnetic waves are transverse.
- Sound waves travel at a speed of 340 m/s whereas

electromagnetic waves travel at a speed of 3×10^8 m/s

- Sound waves do not pass through a vacuum but electromagnetic waves (light) do.

Basic Terms Related to Sound Waves

Time Period (T): Time taken in one complete vibration (full cycle) is called its time period.

Frequency (ν): Frequency is defined as the number of vibrations (or oscillations) completed by a particle in one second.

$$\text{Frequency, } \nu = \frac{1}{T}$$

Its SI unit is hertz

Wavelength (λ): The distance travelled by the wave during the time in which any one particle of the medium completes one vibration about its mean position.

Amplitude: The maximum displacement of the wave particle from its mean position.

Wave Velocity: The distance i.e., wavelength (λ) covered by a wave in one time period

$$\text{Therefore, Wave velocity} = \frac{\text{wavelength}}{\text{time taken}}$$

$$\text{or } \nu = \lambda/T = \nu\lambda$$

$$\text{or } \text{Wave velocity} = \text{Frequency} \times \text{Wavelength}$$

Speed of sound is maximum in solids and minimum in gas.

Factors Affecting the Speed of Sound

Temperature: Speed of sound is directly proportional to the square root of absolute temperature i.e., $\nu \propto \sqrt{T}$.

Pressure: The speed of sound is independent of pressure.

Density: Speed of sound is inversely proportional to the square root of density of the gas.

$$\nu = \sqrt{\frac{\gamma P}{\rho}} \Rightarrow \nu \propto \frac{1}{\sqrt{\rho}} \text{ or, } \frac{\nu_1}{\nu_2} = \sqrt{\frac{\rho_2}{\rho_1}}$$

Humidity: Humid air is lighter than dry air that is why speed of sound increase as humidity increases.

CHARACTERISTICS OF SOUND

Pitch

Pitch is the sensation (brain interpretation) of the frequency of an emitted sound and is the characteristic which distinguishes a shrill (or sharp) sound from a grave (or flat) sound. Faster the vibration of the source, higher is the frequency and higher is the pitch. Similarly low pitch sound corresponds to low frequency. A high pitch sound is called a shrill sound (humming of a bee, sound of guitar).

- (a) AB and BC (b) BC and DE
(c) CD and DE (d) DE and AB
48. Consider the following statements: . [CDS]
1. Steam at 100°C and boiling water at 100°C contain same amount of heat.
2. Latent heat of fusion of ice is equal to the latent heat of vaporization of water.
3. In an air-conditioner, heat is extracted from the room air at the evaporator coils and is rejected out at the condenser coils.
Which of these statements is/are correct?
(a) 1 and 2 (b) 2 and 3
(c) Only 2 (d) Only 3
49. Mr X was advised by an architect to make outer walls of his house with hollow bricks. The correct reason is that such walls [CDS]
(a) make the building stronger
(b) help keeping inside cooler in summer and warmer in winter
(c) prevent seepage of moisture from outside
(d) protect the building from lightning
50. Why are inner lining of hot water geysers made up of copper? [CDS]
(a) Copper has low heat capacity
(b) Copper has high electrical conductivity
(c) Copper does not react with steam
(d) Copper is good conductor of both heat and electricity
51. A Centigrade thermometer and Fahrenheit thermometer are dipped in boiling water. The temperature of water is lowered till the Fahrenheit thermometer registers half of its upper fixed point. What is the corresponding fall temperature registered by the Centigrade thermometer? [NDA]
(a) Half of its range of temperature between the upper and the lower fixed points
(b) Approximately 41°C
(c) Approximately 59°C
(d) 18°C
52. When water is heated from 0°C to 20°C, how does its volume change?
(a) It shall increase
(b) It shall decrease
(c) It shall first increase and then decrease
(d) It shall first decrease and then increase
53. Thermal conductivity of aluminium, copper and stainless steel increases in the order
(a) Copper < Aluminium < Stainless Steel
(b) Stainless Steel < Aluminium < Copper
(c) Aluminium < Copper < Stainless Steel
(d) Copper < Stainless Steel < Aluminium
54. Which of the following statements is/ are false about mode of heat transfer?
I. In radiation, heat is transferred from one medium to another without affecting the intervening medium
II. Radiation and convection are possible in vacuum while conduction requires material medium.
III. Conduction is possible in solids while convection occurs in liquids and gases.
(a) I only (b) II only
(c) II and III (d) I, II and III
55. When pressure on piece of ice is increases its melting point
(a) decreases
(b) increases
(c) remains unchanged
(d) first increases and then decreases
56. Consider the following three statements
1. Heating 1 kg of water from 10°C to 50°C
2. Melting 600 g of ice at 0°C
3. Converting 300 g of ice at 0°C to water at 50°C
Which one of the following shows the correct arrangement of the quantity of heat required in the above process in increasing order of magnitude?
Choose the correct answer from the codes give below
(a) 1, 2, 3 (b) 2, 1, 3
(c) 3, 2, 1 (d) 3, 1, 2
57. **Assertion (A)** : The boiling point of water decreases as the altitude increases.
Reason (R) : The atmospheric pressure increases with altitude. [IAS Prelim]
(a) Both *A* and *R* are true and *R* is the correct explanation of *A*
(b) Both *A* and *R* are true but *R* is not a correct explanation of *A*
(c) *A* is true but *R* is false
(d) *A* is false but *R* is true
58. **Assertion (A)** : A piece of copper and a piece of glass are heated to the same temperature. When touched, thereafter, the copper piece appears hotter than the glass piece.
Reason (R) : The density of copper is more than that of glass. [IAS Prelim]
(a) Both *A* and *R* are true and *R* is the correct explanation of *A*
(b) Both *A* and *R* are true but *R* is not a correct explanation of *A*
(c) *A* is true but *R* is false
(d) *A* is false but *R* is true

ANSWER KEY

1.	(a)	2.	(c)	3.	(a)	4.	(c)	5.	(b)	6.	(a)	7.	(a)	8.	(c)	9.	(c)	10.	(d)
11.	(d)	12.	(d)	13.	(a)	14.	(b)	15.	(d)	16.	(b)	17.	(c)	18.	(c)	19.	(d)	20.	(c)
21.	(d)	22.	(c)	23.	(b)	24.	(c)	25.	(d)	26.	(a)	27.	(a)	28.	(d)	29.	(a)	30.	(c)
31.	(d)	32.	(d)	33.	(b)	34.	(b)	35.	(a)	36.	(b)	37.	(b)	38.	(c)	39.	(a)	40.	(b)
41.	(b)	42.	(b)	43.	(a)	44.	(b)	45.	(a)	46.	(b)	47.	(b)	48.	(d)	49.	(b)	50.	(d)
51.	(b)	52.	(d)	53.	(b)	54.	(b)	55.	(b)	56.	(d)	57.	(c)	58.	(b)				

ELECTRICITY, MAGNETISM

Electricity is the branch of physics in which we study electric charges, at rest (electrostatics or static electricity) and in motion (current electricity).

When we switch on the bulb of our rooms, it glows immediately. An electric signal in a conductor travels at a speed of light in vacuum. An electric current flowing in a conductor produces a magnetic field or magnetism around it.

ELECTRIC CHARGES

Charge is something associated with matter due to which it produces and experiences electric and magnetic effects.

Every atom contains two types of charged particles:

(i) *Positive charge* (Proton) and (ii) *Negative charge* (electron)
The magnitude of elementary positive or negative charge is same and is equal to 1.6×10^{-19} C.

Charge is a scalar quantity and its **SI unit** is ampere second or **coulomb** (C).

Basic Properties of Electric Charge

- Similar charges repel and opposite charges attract.*
- Charge is conserved i.e., the charge can neither be created nor be destroyed but it may simply be transferred from one body to other. Charge is transferable.

CONDUCTORS AND INSULATORS

*The materials which allow electric charge (or electricity) to flow freely through them are called **conductors**.*

*The materials which do not allow electric charge to flow through them are called **nonconductors** or **insulators**.*

Examples of good conductors are metals, impure water etc.

Examples of insulators are quartz, glass, air, rubber, etc.

Silver is the best conductors of electricity.

CLOUD FORMATION, THUNDERING AND LIGHTNING

Clouds are very small droplets of water in the form of vapour. Clouds roam about in the sky with the wind. Generally, a patch of cloud develops an electric charge on it by friction. As a result of friction the upper layers of cloud (which are away from earth) get positively charged and the lower layers of cloud (which are facing earth) get negatively charged.

Dry air and pure water are bad conductors of electricity, hence clouds continue to carry the charge on them till the intensity of charge between the two gets too high.

When two patches of cloud bearing different charges come face

to face they get attracted to one another and the electrons from negatively charged cloud jump to the positively charged cloud. The jumping of electrons between the clouds results in a big spark. The heat from the spark results in sudden expansion of air setting the air in violent waves which are heard by us as **thunder**. The spark is seen as a flash of **lightning** first and then followed by a thunder, a little later.

To protect tall buildings from damage by lightning, a lightning conductor is fixed on them.

COULOMB'S LAW

The force exerted by one *point charge* (when separation between charged bodies is much larger than their linear sizes) on another, acts along the line joining the two charges and it varies inversely as the square of the distance separating the charges and is proportional to the product of the charges. The force is repulsive if the charges have the same sign and attractive if the charges have opposite signs.

$$\text{i.e., } F = \frac{k|q_1q_2|}{r^2}$$

Where k is an experimentally determined constant called the Coulomb constant, which has the value

$$k = 9 \times 10^9 \text{ Nm}^2 / \text{C}^2$$

It is common practice to express k in terms of another constant ϵ_0 , by writing $k = 1/(4\pi\epsilon_0)$; ϵ_0 is called the **permittivity of free space** or **absolute electrical permittivity** and has a value of $\epsilon_0 = 1/(4\pi k) = 8.85 \times 10^{-12} \text{ C}^2 / (\text{Nm}^2)$.

ELECTRIC POTENTIAL AND CURRENT

Electric Potential

Potential at a point can be physically interpreted as the work done by the field in displacing a unit +ve charge from some reference point to the given point.

$$\text{i.e., } V = \frac{w}{q_0}$$

$$V = -\int_{\infty}^r \vec{E} \cdot d\vec{s} \quad \text{i.e. } E = -\frac{dv}{dr}$$

It is a scalar quantity.

Its **SI unit** is volt or joule coulomb⁻¹.

Electrostatic potential produced by a point charge,

$$V = \frac{Kq}{r}$$

Electric current

The time rate of flow of charge or electrons through any cross-section is called electric current.

MODERN PHYSICS

The basic building blocks of all the electronic circuits are the devices in which a controlled flow of electrons can be obtained. This chapter deals with the components of electronics such as semiconductors, diodes, transistors, integrated chips. Also describes the discovery of electron, proton, neutron and explains the latest technologies of the communication system such as Internet, Mobile Telephony etc.

STRUCTURE OF THE ATOMIC NUCLEUS

An atom (size 10^{-10} m) consists of a positively charged nucleus (size 10^{-15} m) which is surrounded by electrons moving around it in different shells. Nucleus of an atom consists of protons and neutrons together called **nucleons** i.e., mass number (A) Radius of nucleus is related to mass number as $R = R_0 A^{1/3}$ where constant $R_0 = 1.25 \times 10^{-15}$ m.

Electron

Electron (e^-) was discovered by sir J.J. Thomson in 1897 when he was studying the properties of cathode rays.

- Electrons are negatively charged particles with e/m ratio 1.76×10^8 c/g
- The charge of an electron was measured by R. Millikan in oil drop experiment as -1.6×10^{-19} C
- Mass of an electron is 9.1×10^{-28} gram.
- Electron is approximately 2000 times lighter than hydrogen

Proton

In 1909, Rutherford discovered proton (p^+) in his gold foil α -particle scattering experiment

- Protons are positively charged particles.
- The charge of a proton is $+1.6 \times 10^{-19}$ C (same as magnitude of an electron).
- Mass of a proton is 1.672×10^{-24} gram.
- The atomic number of an element represents the number of protons in the nucleus.

Neutron

In 1932, James Chadwick discovered neutron (n).

- Neutron is an uncharged particle.
- Mass of neutron is 1.674×10^{-24} gm
- The mass number is the sum of number of protons and neutrons.

PHOTOELECTRIC EFFECT

The phenomenon of emission of electrons from the surface of metal when light of suitable frequency falls on it is called *photoelectric effect*.

The ejected electrons are called **photoelectrons** and the current produced due to emitted electrons is called **photocurrent**.

Einstein's photoelectric equation

$$\frac{1}{2} mv^2_{\max} = h(\nu - \nu_0) = hc \left(\frac{1}{\lambda} - \frac{1}{\lambda_0} \right) = eV_S$$

The Einstein's photoelectric equation is in accordance with conservation of energy.

MASS ENERGY RELATION AND NUCLEAR BINDING ENERGY

Einstein established the equivalence of mass and energy through a relation known as **Einstein's mass-energy equivalence relation**.

$$E = mc^2$$

where $C = 3 \times 10^8$ m/s (speed of light in vacuum)

This relation supports both the *law of conservation of mass* and *law of conservation of energy*.

Nuclear Binding Energy

The energy required to break a nucleus into its constituent nucleons and place them at infinite distance is called *nuclear binding energy* or *binding energy*. This is the energy with which the nucleons are held together.

The difference between the rest mass of nucleus and sum of rest masses of nucleons constituting the nucleus is known as **mass defect**.

Binding Energy per Nucleon

The binding energy per nucleon of a nucleus is the average energy required to extract a nucleon from the nucleus.

Binding energy per nucleon

$$\bar{B} = \frac{\text{Total binding energy}}{\text{Total number of nucleons}} = \frac{BE}{A} = \frac{\Delta mc^2}{A}$$

RADIOACTIVITY

The phenomenon of spontaneous emission of radiations α , β or γ -rays from a substance is called *radioactivity*.

Radioactivity is a spontaneous process which is independent of all external conditions. It is not affected by temperature, pressure, electric or magnetic field.

The number of decays per unit time or decay rate is called *activity*.

$$\text{Activity } A = N\lambda$$

CHEMISTRY, MATTER & ITS
COMPOSITION

CHEMISTRY AND ITS IMPORTANCE

Chemistry is the study of matter and the changes that material substances undergo.

Handy Facts

New branches in chemistry are emerging because of research being carried in the quest to make life more comfortable. One good example is **Green Chemistry**, which deals with development of safer products and manufacturing processes for a sustainable future.

THE IMPORTANCE AND SCOPE OF
CHEMISTRY

Chemistry plays an important role in every aspect of our daily lives. It is a central science that connects all the other sciences and helps them to achieve what they do.

Food Science

Food science is the study of the physical, biological, and chemical make-up of food and the concepts underlying food processing. The contribution of chemistry to Food Science has been manifold.

Science in Action

Not all additives added to food are healthy. For example, potassium bromate (KBrO_3) used in bread-making is an oxidizing agent that is used to “mature” bread flour, which helps strengthen the dough and improve rising, giving it more volume.

Agriculture

In the field of Agriculture, chemistry has provided:

- Better understanding of the processes like photosynthesis, nitrogen fixation, etc. This has led to development of more productive plants.
- Chemical fertilizers like urea, potash, etc. have led to increase food production helping countries to fight food shortage.
- Insecticides, pesticides and fungicides that are used to protect crops.

Medicine

Chemistry has contributed towards the science of Medicine in a number of ways:

- It has given life saving drugs to control dreaded diseases. For example, cis-platin and taxol are useful in cancer therapy. AZT (Azithymidine) is used for AIDS victims.

- Some other categories of medicines synthesized are:
 - (i) **Analgesics**: reduce pain, e.g. paracetamol, aspirin, etc.
 - (ii) **Antibiotics**: cure infections and cure many diseases, e.g. Chloromycetin, streptomycin, etc.
 - (iii) **Tranquillizers**: reduce tension and bring about calm and peace to mental patients, e.g. chlorpromazine, diazepam (Valium), etc.
 - (iv) **Antiseptics**: stop infection of wounds, e.g. Dettol
 - (v) **Anaesthetics**: make patients senseless before surgical operations, e.g. Barbiturates, Benzodiazepines, etc.

Science in Action

Chemistry is providing new materials for medical use. Diseased or weakened arteries can be replaced surgically with tubes made of *Dacron polymers*.

Energy

The use of chemistry in the field of energy has been found contributing in:

- Proper utilization of the fossil fuels – coal and petroleum by understanding its properties. For example, chemistry helps to measure the standard rating- *octane number* of engine or aviation fuel.
- Exploitation of alternate sources of energy like solar and nuclear, etc. Chemistry helped to synthesize uranium hexafluoride making possible for the enrichment of nuclear fuel U-235. Semiconductor materials like gallium arsenide, silicon, etc. are used in making solar panels.

Environmental Science

Environmental changes and chemistry are inextricably linked.

- Chemistry can explain the origin and impacts of phenomena such as air pollution, ozone layer depletion, and global warming.
- Chemistry can help in finding substitution and replacement of gases and products causing above effects. For example, like helping in replacing the refrigerants like chlorofluorocarbons (CFCs) with other environment-friendly products, etc.

Biology and Biotechnology

Chemistry has helped

- in the discovery of the DNA's molecular structure and many of its roles in heredity. This has resulted in major advances in biology and biotechnology.
- to understand biotech processes like *fermentation* used to produce different liquor industry products (*wine, beer, etc.*), various *antibiotics* (e.g. penicillin), antibodies, therapeutic proteins, food products (e.g. cheese, curd, bread, etc), enzymes and others.

ATOMS, MOLECULES & NUCLEAR CHEMISTRY

ATOMS AND MOLECULES

The combination of different elements to form compounds is governed by some basic rules. These rules, collectively called 'laws of chemical combination'.

LAW OF CHEMICAL COMBINATIONS

Law of Conservation Mass:

Lavoisier, who is widely regarded as the father of modern chemistry, gave the the law of conservation of mass. *This law states that in any chemical reaction, the mass of the substances that react equals the mass of the products that are formed.*

Law of Definite Proportions:

This law was given by Joseph Proust, a French chemist, in 1799. Proust's **law of definite proportions** states that *different samples of the same compound always contain its constituent elements in the same proportion by mass.*

Law of Multiple Proportions :

In 1803 Dalton gave this law. *As per this law if two elements combine to form more compounds, the masses of one element that combine with a fixed mass of the other element, are in the ratio of small whole numbers.*

The Law of Gaseous Volume:

When gases react, the volumes consumed and produced, measured at the same temperature and pressure, are in ratios of small whole numbers. This is also known as Gay-Lussac's Law.

Dalton's Atomic Theory

The hypotheses about the nature of matter on which Dalton's atomic theory is based can be summarized as:

- Matter consists of indivisible atoms.
- All the atoms of a given chemical element are identical in mass and in all other properties.
- Different chemical elements have different kinds of atoms and in particular such atoms have different masses.
- Atoms are indestructible and retain their identity in chemical reactions.

Laws of Chemical Combination and Dalton's Theory

- Dalton's fourth postulate explains the law of conservation of mass.
- The fifth postulate is an attempt to explain the law of definite proportions.

ATOMS

Atoms are building blocks of all matter. On the basis of Dalton's atomic theory, we can define an *atom as the basic unit of an element that can enter into chemical combination.*

The size of an atom is extremely small and not visible to eye. The comparative idea regarding the size of atom can be had from the following:

Relative sizes	
Radius (in meter)	Example
10^{-10}	Atoms of hydrogen
10^{-4}	Grain of sand
10^{-1}	Water melon
0.2×10^{-1}	Cricket ball

Atomic Symbols

It was Jon Jacob Berzelius who devised the modern convenient system of using letters of the alphabet to represent elements. The systems of naming the elements are enumerated below:

- The symbols of the most common elements, mainly nonmetals, use the first letter of their English name. Examples: H (hydrogen), B (Boron), C (Carbon), N (nitrogen), O (Oxygen), F(Flourine), P (Phosphorous), S (Sulphur), I (iodine), etc.
- If the name of the element has the same initial letter as another element, then the symbol uses the first and second letters of their English name. Examples: He(Helium), Li(Lithium), Be(Beryllium), Ne(Neon), Al(Aluminum)

Atomic Number, Mass Number and Isotopes

The subatomic particles present in atom are *neutron, proton* and *electron*. All atoms can be identified by the number of protons and neutrons they contain.

Atomic number

The number of protons in the nucleus of an atom decides which element it is. This very important number is called the atomic number (Z). In a neutral atom the number of protons is equal to the number of electrons, so the atomic number also indicates the number of electrons present in the atom. The chemical identity of an atom can be determined solely by its atomic number.

Mass number

The mass number (A) is the total number of neutrons and protons present in the nucleus of an atom of an element.

$$\begin{aligned} \text{Mass number} &= \text{number of protons} + \text{number of neutrons} \\ &= \text{atomic number} + \text{number of neutrons} \end{aligned}$$

The number of neutrons in an atom is equal to the difference between the mass number and the atomic number, or $(A - Z)$.

ISOTOPES

Atoms that have the same atomic number but different mass numbers are called isotopes.

Chapter 3

ELEMENTS CLASSIFICATION & CHEMICAL BONDING

CLASSIFICATION OF ELEMENTS

Four major attempts made for classification of the elements are follows:

- Dobereiner's Triads
- Newlands' Law of Octaves
- Mendeleev's Periodic Law & Periodic Tables
- Modern Periodic Table

Dobereiner's Triads

In 1829, J.W. Dobereiner, a German chemist made groups of three elements each and called them triads.

- All three elements of a triad were similar in their physical and chemical properties. He proposed a law known as *Dobereiner's law of triads*.
- According to this law, when elements are arranged in order of increasing atomic mass, the atomic mass of the middle element was nearly equal to the arithmetic mean of the other two and its properties were intermediate between those of the other two.

Newlands' Law of Octaves

John Alexander Reina Newlands in 1863–64 noted that every eighth element showed similar physical and chemical properties, when the elements are placed in the increasing order of their atomic masses. **This was called the Newlands law of octaves.**

The law states that when elements are placed in the increasing order of atomic masses, the properties of the eighth elements are repeated.

Mendeleev's Periodic Law and Periodic Table

On arranging the elements in the increasing order of atomic masses, it was observed that the elements with similar properties repeat periodically.

In 1869, Mendeleev stated his observation in the form of the following statement which is known as the **Mendeleev's Periodic Law**
The chemical and physical properties of elements are periodic function of their atomic masses.

Mendeleev arranged the elements in the form of a table which is known as the **Mendeleev's Periodic Table** as below:

- Elements were arranged in increasing order of their atomic masses in horizontal rows till element whose properties were similar to those of the first element was came across.

Salient Features of Mendeleev's Periodic Table

The following are the main features of this periodic table:

- The elements are arranged in rows and columns in the periodic table.
- The horizontal rows are called **periods**. There are six periods in the periodic table. These are numbered from 1 to 6 (Arabic numerals). Each one of the 4th, 5th and 6th periods have two series of elements.
- All the elements present in a particular group are chemically similar in nature. They also show a regular gradation in their physical and chemical properties from top to bottom.

Modern Periodic Law and Periodic Table

The Modern Periodic Law states that the chemical and physical properties of elements are periodic functions of their atomic numbers, i.e. if elements are arranged in the order of their increasing atomic number, the elements with similar properties are repeated after certain regular intervals.

The periodic table based on the modern periodic law is called the Modern Periodic Table. Presently, the accepted modern periodic table is the *Long Form of Periodic Table*:

Period	s-Block Elements										d-Block Elements										p-Block Elements									
1	1 IA 1 H Hydrogen 1.008 1s																				17 VIIA 1 H Hydrogen 1.008 1s	18/VIIIA 2 He Helium 4.003 1s ²								
2	3 2 IIA 3 Li Lithium 6.941 2s	4 Be Beryllium 9.0121 2s ²											5 B Boron 10.811 2s ² 2p ¹	6 C Carbon 12.011 2s ² 2p ²	7 N Nitrogen 14.007 2s ² 2p ³	8 O Oxygen 16.000 2s ² 2p ⁴	9 F Fluorine 18.998 2s ² 2p ⁵	10 Ne Neon 20.180 2s ² 2p ⁶												
3	11 3 IIA 11 Na Sodium 22.990 3s	12 Mg Magnesium 24.305 3s ²											13 3 IIA 13 Al Aluminum 26.982 3s ² 3p ¹	14 3 IIA 14 Si Silicon 28.086 3s ² 3p ²	15 3 IIA 15 P Phosphorus 30.974 3s ² 3p ³	16 3 IIA 16 S Sulphur 32.06 3s ² 3p ⁴	17 3 IIA 17 Cl Chlorine 35.453 3s ² 3p ⁵	18 3 IIA 18 Ar Argon 39.948 3s ² 3p ⁶												
4	19 4 IIA 19 K Potassium 39.098 4s	20 Ca Calcium 40.078 4s ²	21 3 IIB 21 Sc Scandium 44.956 3d ¹ 4s ²	22 4 IIB 22 Ti Titanium 47.887 3d ² 4s ²	23 5 VB 23 V Vanadium 50.942 3d ³ 4s ²	24 6 VB 24 Cr Chromium 51.996 3d ⁵ 4s ¹	25 7 VIIB 25 Mn Manganese 54.938 3d ⁵ 4s ²	26 8 26 Fe Iron 55.845 3d ⁶ 4s ²	27 9 VIII 27 Co Cobalt 58.933 3d ⁷ 4s ²	28 10 28 Ni Nickel 58.693 3d ⁸ 4s ²	29 11 IB 29 Cu Copper 63.546 3d ¹⁰ 4s ¹	30 12 IIB 30 Zn Zinc 65.39 3d ¹⁰ 4s ²	31 3 IIA 31 Ga Gallium 69.723 3d ¹⁰ 4s ² 4p ¹	32 4 IIA 32 Ge Germanium 72.61 3d ¹⁰ 4s ² 4p ²	33 5 IIA 33 As Arsenic 74.922 3d ¹⁰ 4s ² 4p ³	34 6 IIA 34 Se Selenium 78.96 3d ¹⁰ 4s ² 4p ⁴	35 7 IIA 35 Br Bromine 79.904 3d ¹⁰ 4s ² 4p ⁵	36 8 IIA 36 Kr Krypton 83.80 3d ¹⁰ 4s ² 4p ⁶												
5	37 5 IIA 37 Rb Rubidium 85.468 5s	38 Sr Strontium 87.62 5s ²	39 4 IIB 39 Y Yttrium 88.906 4d ¹ 5s ²	40 5 IIB 40 Zr Zirconium 91.224 4d ² 5s ²	41 6 VB 41 Nb Niobium 92.906 4d ⁴ 5s ¹	42 7 VIIB 42 Mo Molybdenum 95.94 4d ⁵ 5s ¹	43 8 43 Tc Technetium 98.906 4d ⁵ 5s ²	44 9 VIII 44 Ru Ruthenium 101.07 4d ⁷ 5s ¹	45 10 45 Rh Rhodium 102.906 4d ⁸ 5s ¹	46 11 IB 46 Pd Palladium 106.42 4d ¹⁰	47 12 IIB 47 Ag Silver 107.868 4d ¹⁰ 5s ¹	48 3 IIA 48 Cd Cadmium 112.411 4d ¹⁰ 5s ²	49 4 IIA 49 In Indium 114.818 4d ¹⁰ 5s ² 5p ¹	50 5 IIA 50 Sn Tin 118.710 4d ¹⁰ 5s ² 5p ²	51 6 IIA 51 Sb Antimony 121.757 4d ¹⁰ 5s ² 5p ³	52 7 IIA 52 Te Tellurium 127.60 4d ¹⁰ 5s ² 5p ⁴	53 8 IIA 53 I Iodine 126.905 4d ¹⁰ 5s ² 5p ⁵	54 9 IIA 54 Xe Xenon 131.29 4d ¹⁰ 5s ² 5p ⁶												
6	55 6 IIA 55 Cs Cesium 132.905 6s	56 Ba Barium 137.327 6s ²	57 Lanthanides 57 La Lanthanum 138.905 5d ¹ 6s ²	72 Hf Hafnium 178.49 5d ² 6s ²	73 Ta Tantalum 180.948 5d ³ 6s ²	74 W Tungsten 183.84 5d ⁴ 6s ²	75 Re Rhenium 186.207 5d ⁵ 6s ²	76 Os Osmium 190.23 5d ⁶ 6s ²	77 Ir Iridium 192.222 5d ⁷ 6s ²	78 Pt Platinum 195.078 5d ⁹ 6s ¹	79 Au Gold 196.967 5d ¹⁰ 6s ¹	80 Hg Mercury 200.59 5d ¹⁰ 6s ²	81 Tl Thallium 204.383 5d ¹⁰ 6s ² 6p ¹	82 Pb Lead 207.2 5d ¹⁰ 6s ² 6p ²	83 Bi Bismuth 208.980 5d ¹⁰ 6s ² 6p ³	84 Po Polonium (209) 5d ¹⁰ 6s ² 6p ⁴	85 At Astatine (210) 5d ¹⁰ 6s ² 6p ⁵	86 Rn Radon (222) 5d ¹⁰ 6s ² 6p ⁶												
7	87 Fr Francium (223) 7s	88 Ra Radium (226) 7s ²	89 Actinides 89 Ac Actinium (227) 6d ¹ 7s ²	104 Rf Rutherfordium (261) 5f ¹⁴ 6d ² 7s ²	105 Db Dubnium (262) 5f ¹⁴ 6d ³ 7s ²	106 Sg Seaborgium (263) 5f ¹⁴ 6d ⁴ 7s ²	107 Bh Bohrium (264) 5f ¹⁴ 6d ⁵ 7s ²	108 Hs Hassium (265) 5f ¹⁴ 6d ⁶ 7s ²	109 Mt Meitnerium (266) 5f ¹⁴ 6d ⁷ 7s ²	110 Ds Darmstadtium (269) 5f ¹⁴ 6d ⁸ 7s ²	111 Rg Roentgenium (271) 5f ¹⁴ 6d ⁹ 7s ²	112 Uub Ununbium (272) 5f ¹⁴ 6d ¹⁰ 7s ²	113 Uuq Ununquadium 5f ¹⁴ 6d ¹⁰ 7s ² 7p ¹	114 Uuq Ununquadium 5f ¹⁴ 6d ¹⁰ 7s ² 7p ²	115 Uuh Ununhassium 5f ¹⁴ 6d ¹⁰ 7s ² 7p ³	116 Uuq Ununhexium 5f ¹⁴ 6d ¹⁰ 7s ² 7p ⁴	117 Uuq Ununseptium 5f ¹⁴ 6d ¹⁰ 7s ² 7p ⁵	118 Uuo Ununoctium 5f ¹⁴ 6d ¹⁰ 7s ² 7p ⁶												
																			f-Block Elements											
																			Lanthanides											
																			Actinides											

NON - METALS

Non-metals occupy the upper right hand corner of the periodic table.

Seventeen elements are generally classified as nonmetals. Their names as per their states in the normal conditions are:

Gases : hydrogen, helium, nitrogen, oxygen, fluorine, neon, chlorine, argon, krypton, xenon and radon.

Liquid : bromine.

Solid : carbon, phosphorus, sulfur, selenium, and iodine.

PROPERTIES OF NON-METALS

Physical Properties

- Non-metals are neither malleable nor ductile.
- They are brittle (break easily).
- They do not conduct heat and electricity.
- They are not lustrous (not shiny). They are dull.
- They are generally soft (except diamond which is extremely hard non-metal).
- They may be solid, liquid or gases at the room temperature.
- They have comparatively low melting points and boiling points (except diamond which is a non-metal having a high melting point and boiling point).
- Non-metals have low densities, that is, non-metals are light substances.
- Non-metals are non-sonorous. They do not produce sound when hit with an object.

Chemical Properties of Non-Metals

Non-metals are more reactive with metals than with other non-metals. Generally non-metals react with each other at a high temperature.

Action of Air :

Non-metals do not react with air at room temperature except white phosphorus.

Action of water:

Generally, non-metals do not react with water. However, chlorine dissolves in water and form an acidic solution.

Displacement of one non-metal by another from salt solution :

Just like metals, non-metals also differ in their reactivities. Among halogen family (*i.e.* Cl, Br, I and F) the most reactive is chlorine (Cl). The order of reactivity is $Cl > Br > I$. Thus chlorine can displace Br and I from solutions of bromides (NaBr) and Iodides (NaI).

Reaction with metals :

Non metals with high electronegativity (F, Cl, Br etc.) generally reacts with alkali and alkaline earth metals to form ionic compounds.

Handy Facts

Allotropes are different form of the same element. Different bonding arrangements between atoms result in different structures with different chemical and physical properties. For example : The allotropic forms of carbon are white, red and black phosphorous. The term allotropy is referred to element only another term polymorphism is used to mean the ability of solid to exist in more than one form or crystal structure.

SOME IMPORTANT NON-METALLIC ELEMENTS

Hydrogen

The discovery of hydrogen is credited to *Henry Cavendish* in 1766, although it had been isolated as early as 1671 by Robert Boyle.

Isotopes of Hydrogen

Three isotopes of hydrogen exist and all occur naturally.

- ^1H is sometimes called **Protium**, It is abundant in nature. It is the only hydrogen isotope lacking neutrons.
- The second isotope, ^2H , is called **deuterium**

Handy Facts

D-element bonds are more difficult to break than H-element bonds and this fact allows the mechanisms of many chemical reactions to be examined. D_2O itself is important as a material that slows neutrons in nuclear reactors.

- The third isotope, ^3H , **Tritium** is radioactive.

Properties

- Hydrogen occupies a unique place in the periodic table, and while it usually appears above the alkali metals or the halogens (or both), its properties don't fall well within either group.
- The ionization energy of hydrogen is much higher than any of the alkali metals.
- Hydrogen is a colorless, odorless, tasteless gas at ambient temperature. It has very low boiling and melting points (only helium boils colder). It is poorly soluble in most solvents.

Uses

- Over two-thirds of this hydrogen produced is used to prepare ammonia (NH_3) by the Haber process. The large majority of this ammonia is then used in fertilizer production.

ORGANIC CHEMISTRY

Organic chemistry is the study of carbon containing compounds and their properties. This includes the great majority of chemical compounds on the planet, but **some substances** such as **carbonates** and **oxides of carbon** are considered to be **inorganic** substances even though they contain carbon. There exists a large number of organic compounds.

Differences Between Organic and Inorganic Compounds

Following table compares the properties of the organic and inorganic compounds:

Organic Compounds	Inorganic Compounds
Use mostly covalent bonding	Mostly ionic bonding
Are gases, liquids or solids with low melting points	Are generally solids with high melting points
Mostly insoluble in water	Many are water soluble
Many are soluble in organic solvents such as petroleum, benzene and hexane	Most are not soluble in organic solvents

Solution in water generally do not conduct electricity	When dissolved in water conducts electrical current
Almost all burn	Most not combustible
Slow to react with other chemicals	Often undergo fast chemical reactions

CATENATION IN CARBON

Majority of organic compounds contain chains or rings of carbon atoms that contain other elements such as O, N, P, S, Cl, Br and I. The compounds of carbon are far more numerous than the known compounds of all the other elements put together. ***This is because that carbon has the power to combine with other carbon atoms to form long chains; this property is not shown to such an extent by any other element. This property of carbon is known as catenation.***

FUNCTIONAL GROUPS

Classes of organic compounds can be distinguished according to functional groups they contain. *A functional group is a group of atoms that is largely responsible for the chemical behavior of the parent molecule.*

Important Functional Groups and the Corresponding Classes of Organic Compounds :

S.No.	Functional Group		Class of compounds
	Formula	Name	
1.	-X (-F, Cl, -Br, -I)	Halo (fluoro, chloro, bromo, iodo)	Alkyl halides or halogen compounds
2.	-OH	Hydroxy	Alcohol
3.	-OR	Alkoxy	Ethers
4.	-SH	Mercapto	Thioalcohols, mercaptans or thiols
5.	-SR		Thioethers or sulphides
6.	-CHO	Aldehydic	Aldehydes
7.	-CO-	Ketonic	Ketones
8.	-COOH	Carboxyl	Carboxylic acids
9.	-COOR	Ester	Esters
10.	-COX (X = Cl, Br or I)	Acyl halide	Acid halides or Acyl halides
11.	-CONH ₂	Amide	Amides or acid amides
12.	-CO.O.CO-	Anhydride	Acid anhydrides
13.	-NH ₂	Amino	Amines
14.	-NH-	Imino	Imines
15.	-C ≡ N	Cyano	Cyanides or Nitriles

CHEMISTRY AND MANKIND

- Living systems are made of a number of complex organic compounds which are called bio-molecules. The various biomolecules are carbohydrates, amino acids, proteins, enzymes, lipids, hormones; etc. We may call these molecules of life also.

SOME IMPORTANT MOLECULES OF LIFE

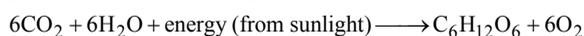
Carbohydrate

The chemicals used by the body may be divided into two categories;

- Macronutrients:** those substances that we need to eat regularly in fairly large quantities.
- Micronutrients:** those substances that we need only in small quantities.

Carbohydrates are the main energy sources for the human body. Chemically, carbohydrates are organic molecules in which carbon, hydrogen, and oxygen bond together in the ratio : $C_X(H_2O)_Y$, where X and Y are whole numbers.

Animals obtain carbohydrates by eating foods like potatoes, rice, breads, and so on. These carbohydrates are manufactured by plants during the process of photosynthesis. Plants harvest energy from sunlight to run the reaction just described in reverse :



There are two types of carbohydrates, the simple sugars and those that are made of long chains of sugars - the complex carbohydrates.

Simple Sugars

All carbohydrates are made up of units of sugar (also called saccharide units). Carbohydrates that contain only one sugar unit (monosaccharides) or two sugar units (disaccharides) are referred to as simple sugars. Simple sugars are sweet in taste and are broken down quickly in the body to release energy. Two of the most common monosaccharides are glucose and fructose. Glucose is the primary form of sugar stored in the human body for energy. Fructose is the main sugar found in most fruits. Both glucose and fructose have the same chemical formula ($C_6H_{12}O_6$); however, they have different structures. Disaccharides have two sugar units bonded together. For example, common table sugar is sucrose, a disaccharide that consists of a glucose unit bonded to a fructose unit.

Sweetening power of common sugars :

Fructose > Invert sugar > Sucrose > Glucose > Maltose > Lactose

Complex Carbohydrates

Complex carbohydrates are polymers of the simple sugars. In other words, the complex carbohydrates are long chains of simple sugar units bonded together. Therefore the complex carbohydrates can also be referred to as polysaccharides. Starch is an example of complex carbohydrate.

Handy Facts

Both starch and glycogen are polymers of glucose; however, starch is a long, straight chain of glucose units, whereas glycogen is a branched chain of glucose units. Another important polysaccharide is **cellulose**. Cellulose is yet a third polymer of the monosaccharide glucose. Cellulose differs from starch and glycogen in terms of extra stability. Cellulose, also known as plant fiber, cannot be digested by human beings, therefore cellulose passes through the digestive tract without being absorbed into the body. Cellulose fiber is essential in the diet because it helps exercise the digestive track and keep it clean and healthy.

AMINO ACIDS AND PROTEINS

Amino Acids

Amino acids play central roles both as building blocks of proteins and as intermediate in metabolism. There twenty amino acids which are present in the protein. Humans can produce 10 of the 20 amino acids. The others must be supplied by food.

Structure of Amino Acids

- Structure :** The amino acid is an organic acid in which one or more hydrogen atoms are replaced by NH_2 group.

Proteins

Proteins (also known as **polypeptide**) are *organic compounds* made of *amino acids* arranged in a linear chain and folded into a globular form. The amino acids in a *polymer* are joined together by the *peptide bonds* between the *carboxyl* and *amino* groups of adjacent amino acid *residues*.

Like other biological macromolecules such as polysaccharides and nucleic acids, proteins are essential parts of organisms and participate in virtually every process within cells. Many proteins are enzymes that catalyze biochemical reactions and are vital to metabolism. Proteins also have structural or mechanical functions, such as actin and myosin in muscle and the proteins in the cytoskeleton, which form a system of scaffolding that maintains cell shape. Other proteins are important in cell signaling immune responses, cell adhesion, and the cell cycle. Proteins are

Chapter 1

BIOLOGICAL CLASSIFICATION/ CELL & ITS DIVISION

BIOLOGICAL CLASSIFICATION

Biological classification is the scientific procedure of arranging organisms into groups and subgroups on the basis of their similarities and dissimilarities and placing the groups in a hierarchy of categories. The purpose of biological classification is to organize the vast number of known plants and animals into groups that could be named, remembered and studied.

NEED FOR THE BIOLOGICAL CLASSIFICATION

Classification is Needed to

- help in establishing relationship between different organisms and to know about their evolution.
- help in the identification of organisms.
- study one or two organisms of one particular group and give the sufficient information of that group. It gives an idea of whole range of diversity found in organisms.
- it gives an idea of the evolution of various groups of organisms.

Systematics

Systematics is the study of the units of biodiversity. It is the study of the diversification of organisms and their relationship among living things through time. It includes the following parts:

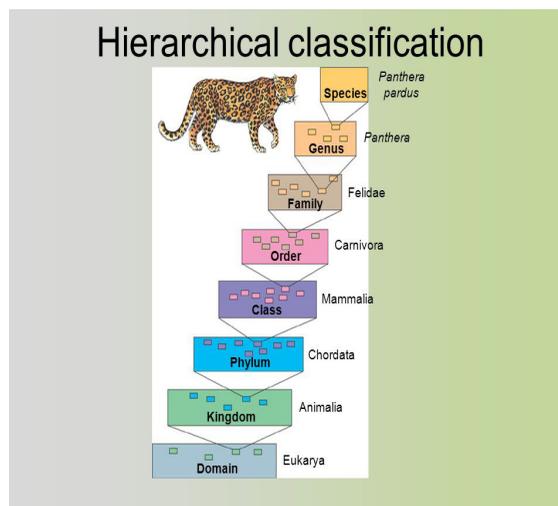
- **Identification:** It is a process of finding the correct name and place of an organism in a system of classification.
- **Classification:** It is the arrangement of an organism in a particular group on the basis of their similarities and dissimilarities.
- **Nomenclature:** It is a system of providing proper and distinct name to one particular organism which helps in recognizing that organism.
- **Taxonomy:** It is a science dealing with the description, identification, naming and classification of organism.

Classification of Organisms

It is the arrangement of organisms into taxonomic group according to their similarities and dissimilarities. System of classification is an attempt to organize different organisms into different categories that we can use to study.

Hierarchy in Classification

Hierarchy in classification involves many steps. Each step represents a rank or category. All categories or steps together constitute the taxonomic hierarchy.



Species

The smallest taxon is species. At the species level organisms look alike and are able to breed with one another.

Genus

The next largest taxon is genus. At the genus level, there is a group of similar species that are closely related.

Family

A group of two or more genera with common characteristics make a family. For example, lion (*Panthera leo*), tiger (*Panthera tigris*) and the domestic cat (*Felis domesticus*) make the family **Felidae**.

Order

A group of related families make an order. For example the family of cat (Felidae) and the family of dogs, foxes, etc. (Canidae) is grouped under the Carnivora.

Class

Related orders make a class. For example several orders like those of the tigers, cats, dogs, monkey, bats and human belong to class *Mammalia*.

Phylum

A phylum is the largest category with related classes grouped together. For example the classes of mammals, birds, reptiles, amphibians and fishes together constitute the phylum *Chordata*. In plants, the corresponding category is named division.

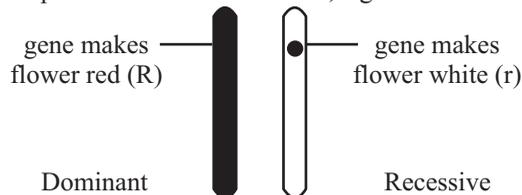
GENETICS

Heredity is the transmission of genetic characters from parent to offsprings. Individuals of same species have some differences, these are called variation.

MENDEL'S FINDINGS

1. Mendel's Law of Dominance and Recessive

- Each of the f_1 generation plant shows inheritance of Y allele from one parent and a G allele from the other. When the f_1 plants breed, each has equal chance of passing on either Y or G allele to each offspring.
- In all the seven traits that Mendel examined, one form appeared dominant over the other i.e., it marked the presence of the other allele, e.g.



BASIC TERMS USED IN INHERITANCE STUDIES

- Allele:** It is an alternative form of a gene which are located on same position (loci) on the homologous chromosome. Term allele was coined by Bateson.
- Homozygous:** A zygote is formed by fusion of two gametes having identical factors is called homozygote and organism developed from this zygote is called homozygous. Ex. TT, RR, tt.
- Heterozygous:** A zygote is formed by fusion of two different types of gamete carrying different factors is called heterozygote (Tt, Rr) and individual developed from such zygote is called heterozygous.
- Hemizygous:** If individual contains only one gene of a pair then individual is said to be hemizygous. Male individual is always hemizygous for sex linked gene.
- Phenotype:** It is the external and morphological appearances of an organism for a particular character.
- Genotype:** It is the genetic constitution or genetic make-up of an organism for a particular character.
- Back cross:** A back cross is a cross in which F_1 individuals are crossed with any of their parents.
- Test cross:** When F_1 progeny is crossed with recessive parent then it is called test cross.

- Monohybrid test cross:** The progeny obtained from the monohybrid test cross are in equal proportion, means 50% is dominant phenotypes and 50% is recessive phenotypes.

It can be represented in symbolic forms as follows.

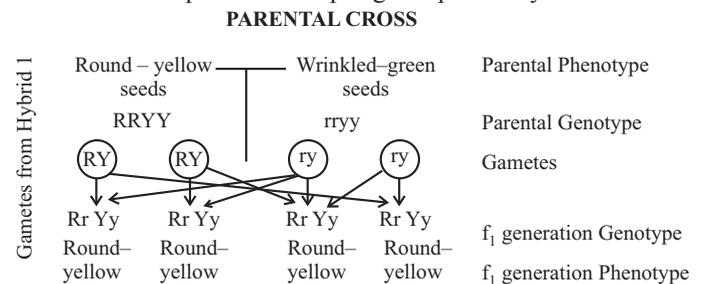
F_1 progeny (hybrid) \times Recessive parent



Monohybrid test cross ratio = 1 : 1

- Dihybrid test cross:** The progeny is obtained from dihybrid test cross are of four types and each of them is 25%.

- Law of Segregation:** According to this law, for any particular trait, the pair of alleles of each parent separate and only one allele passes from each parent to an offspring. Allele in a parent's pair of allele is inherited as a matter of chance (we now know segregation of alleles occurs during the process of meiosis).
- Law of Independent Assortment:** This is also known as 'Inheritance law'. According to this law, different pairs of alleles are passed to offspring independently of each other.



	RY	Ry	rY	ry
RY	RRYY Round-yellow	RRYy Round-yellow	RrYY Round-yellow	RrYy Round-yellow
Ry	RRYy Round-yellow	Rryy Round-green	RrYy Round-yellow	Rryy Round-green
rY	RrYY Round-yellow	RrYy Round-yellow	rrYY wrinkled yellow	rrYy wrinkled yellow
ry	RrYy Round-yellow	Rryy Round-green	rrYy wrinkled yellow	rryy wrinkled green

Punnett Square

EVOLUTION

The branch of life science for the study of 'origin of life' and evolution of different forms of life on earth was called **bioevolution or evolutionary biology** by Mayer, (1970). The word evolution means to unfold or unroll or to reveal hidden potentialities. Evolution simply means an orderly change from one condition to another. Evolution is slow but continuous process which never stop.

ORIGIN OF LIFE

- Origin of life is the process by which living organisms developed from inanimate matter which is generally thought to have occurred on Earth between 3800 - 4200 millions years ago. First life evolved 3800-4200 million years back. There are several theories about the origin of life, like big bang theory, theory of special creation, theory of eternity, cosmozoic theory etc.

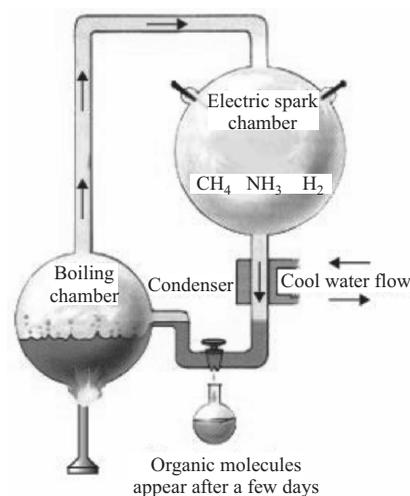
Chemosynthetic Theory of Origin of Life

The widely accepted theory is the Chemosynthetic theory of origin of life proposed by **A.I. Oparin**. It states that life has

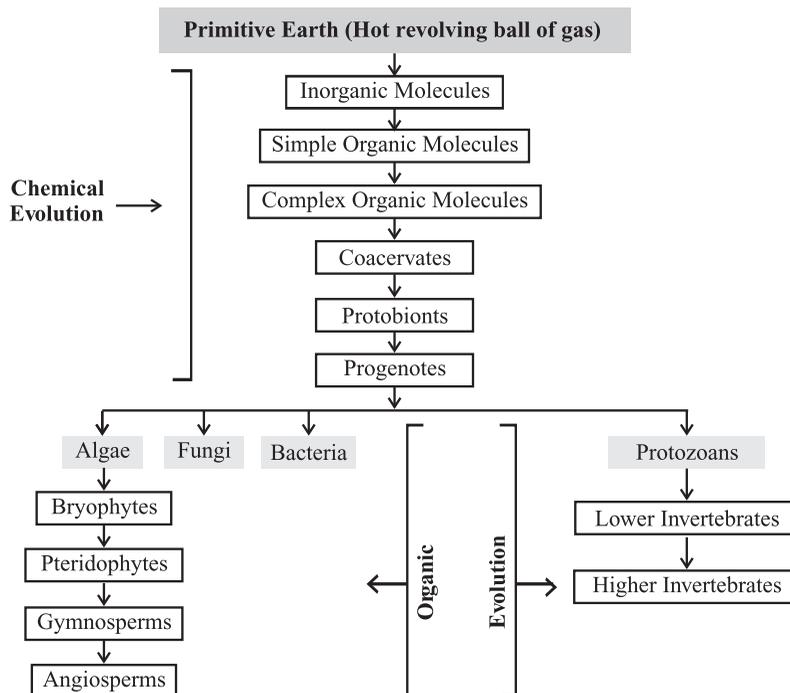
originated on earth through a series of combinations of chemical substances in the distant past. All these processes took place in water.

- The early atmosphere contained ammonia (NH_3), water vapour (H_2O), hydrogen (H_2), methane (CH_4). At that time there was no free oxygen.

Miller and Urey Experiment



CHEMICAL EVOLUTION AND ORGANIC EVOLUTION



TISSUE

Tissue is a group of cells with common origin, structure and function that work together to perform a particular function. For example, Blood, bone, cartilage are some examples of

animal tissues while xylem, phloem, parenchyma etc are different types of tissues found in plants. *The study of tissue is called histology. The term was coined by Meyer.*

PLANT TISSUES

On the basis of their ability to divide, plant tissues are divided into two types:

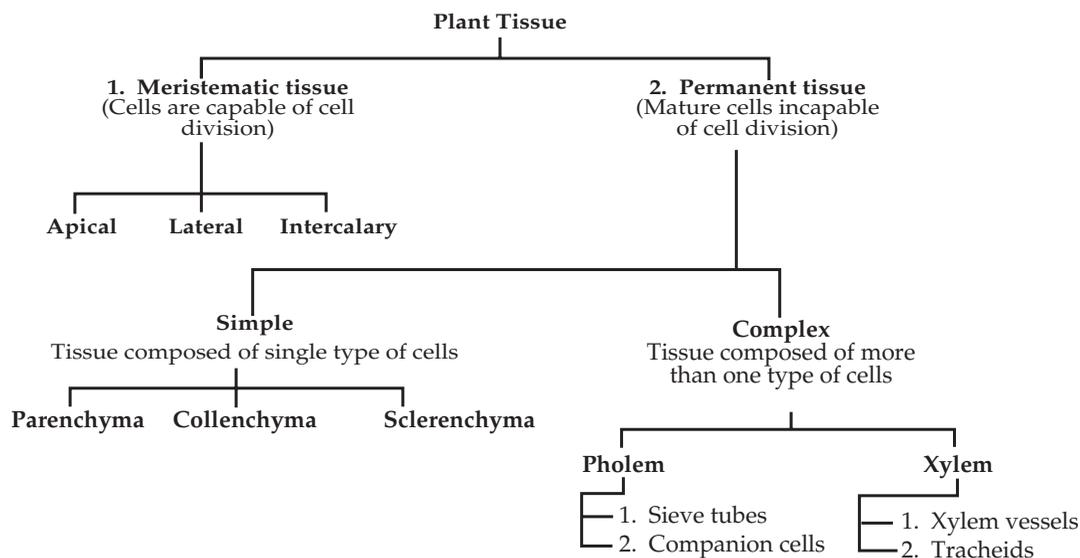
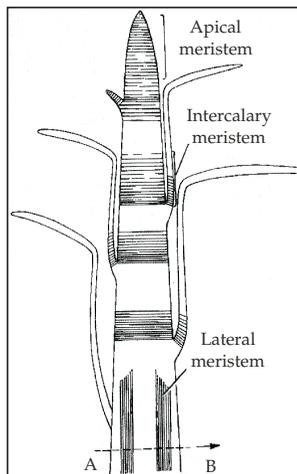


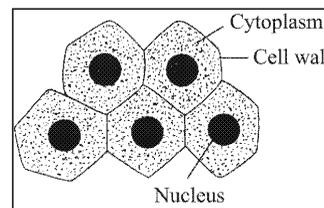
Fig. Classification of plant tissue- at a glance

Meristematic Tissues

- Meristematic tissues are thin-walled compactly arranged, immature cells that keep on dividing continuously. The new cells produced are initially Meristematic. Slowly, they grow, differentiate and mature into permanent tissues.



- The meristematic cells are spherical, or polygonal in shape and the cells are compactly arranged without intercellular spaces. The cell wall is thin, elastic and is made of cellulose. Each cell has abundant cytoplasm and prominent nuclei. These cells are always living.



Classification of meristematic tissue

On the basis of origin and development		
Promeristem	Primary meristem	Secondary meristem
<ul style="list-style-type: none"> Represents primary stages of meristematic cells Present at the tip of radicle and plumule 	<ul style="list-style-type: none"> Originate from promeristem that continue to divide to form different tissues. Always in active state of division and give rise to primary permanent tissues for growth in length as well as width e.g., apical meristems, intercalary meristems, lateral meristems (intra-fascicular cambium in the vascular bundle of dicot stem). 	<ul style="list-style-type: none"> Developed from primary permanent tissue. They are developed at a later stage by differentiation and acquire power of division. e.g., interfascicular cambium in stem, cambium in roots and also cork cambium (phellogen).

On the basis of function		
Protoderm	Periblem	Procambium
<ul style="list-style-type: none"> It is the outermost layer meant for producing the single layered epidermis, hairs, velamen, stomata i.e., epidermal tissue system. 	<ul style="list-style-type: none"> It produces hypodermis, cortex and endodermis or ground tissue system. 	<ul style="list-style-type: none"> It is the innermost part of the meristem. It gives rise to the stele which comprises primary vascular tissues and ground tissues like pith, medullary rays and the pericycle.

PERMANENT TISSUE

Permanent tissues are tissues that have lost the ability to divide, and have attained a definite form and size. They are actually derived from Meristematic cells. Different type of permanent tissues is formed due to differences in their specialization. Differentiation is the process whereby cells take up a definite shape, size, structure and function. These tissues are divided into simple, Complex and special.

Table : Difference between Meristematic tissue and Permanent tissue

SI No.	Meristematic Tissue	Permanent Tissue
1.	Meristematic tissues are composed of cells that divide continuously.	Permanent tissues are composed of cells that are derived from Meristematic tissue.
2.	Cells are small, undifferentiated and isodiametric in shape.	Cells are large, differentiated with different shapes.
3.	Cell wall is thin and living.	Cell wall may be thin (living) or thick (dead).
4.	Cells are compactly arranged without inter-cellular spaces.	Intercellular spaces are often present.
5.	Nucleus is large and prominent.	Nucleus is less conspicuous.
6.	Cells of Meristematic tissue take part in growth.	Permanent tissue provides protection, support, conduction of substances, storage, photosynthesis etc.

Simple Tissue

It is made up of only one kind of cells forming a uniform mass. The cells are similar in structure, origin and function. *Simple permanent tissues are of three types: Parenchyma, Collenchyma and Sclerenchyma*

Parenchyma	Collenchyma	Sclerenchyma
<p>Parenchyma: Parenchyma is widely distributed in plant body such as stem, roots, leaves and flower.</p> <ul style="list-style-type: none"> They are found in the cortex of root, ground tissue in stems and mesophyll of leaves, cells are isodiametric. It may contain chlorophyll. Parenchyma containing chlorophyll is called <i>chlorenchyma</i>. It is the site of photosynthesis. Parenchyma that encloses large air cavities is known as <i>aerenchyma</i>. Aerenchyma provides buoyancy to aquatic plants. 	<p>Collenchyma: Collenchyma is a strong and flexible tissue that provides flexibility to soft aerial parts.</p> <ul style="list-style-type: none"> Collenchyma provides mechanical support, flexibility to soft aerial parts so that they can bend without breaking and may contain chloroplasts and thus take part in photosynthesis. 	<p>Sclerenchyma: It is found in and around the vascular tissue, under the skin i.e. the epidermis in dicot stems.</p> <ul style="list-style-type: none"> Cells are long, narrow, thick and lignified usually pointed at both ends. The cell wall is evenly thickened with lignin. Lignin is a water proof material. It gives mechanical support to the plant by giving rigidity, flexibility and elasticity to the plant body.

REPRODUCTION

Reproduction is the process by which all living organisms give rise to new organisms similar to themselves. It is essential for the survival of the species since all the living beings have a similar life span. Organisms reproduce by two modes: asexual and sexual reproduction.

Asexual Reproduction

Asexual reproduction produces offspring that are genetically identical to the parent because the offspring are all clones. The main process of asexual reproduction is mitosis. This type of reproduction is common among some single cell organisms for example, amoeba, etc. Many plants also reproduce asexually.

Sexual Reproduction

Sexual reproduction is a biological process that creates a new organism by combining the genetic material of two organisms in a process that starts with meiosis, a specialized type of cell division.

Difference between asexual and sexual reproduction

	Asexual reproduction	Sexual reproduction
1.	It occurs only in invertebrates and lower chordates.	It occurs almost in all types of animals.
2.	It is always uniparental.	It is usually biparental.
3.	Gametes are not formed.	Two types of gametes are formed.
4.	It involves only mitosis.	It involves both meiosis and mitosis.
5.	Daughter organisms are genetically identical to the parent.	Daughter organisms genetically differ from their parents.
6.	Since there is no variation, so it does not contribute to evolution of the species.	Because of variations, it contributes to the evolution of species.
7.	Occurs by fission, budding or fragmentation.	Occurs by the formation of haploid gametes which fuse to form a diploid zygote.
8.	It is a quick method of multiplication.	It is a slower method of multiplication.

REPRODUCTION IN PLANTS

In plants, asexual reproduction is of 3 types – *agamospermy, spore formation and vegetative reproduction.*

Vegetative Propagation

Vegetative propagation or vegetative reproduction is the process of multiplication in which a portion or fragment of the plant body functions as propagules and develop into a new individual.

Artificial Vegetative Propagation

- Cutting - e.g – sugarcane
- Grafting - e.g – grafted mango, roses, orange, seedless grapes, guava, apple and pear.

Underground stem

- Rhizome – Ginger, banana, turmeric, Lotus, Musa, etc.
- Corm – Gladiolus, colocasia, crocus, Alocasia, etc.
- Bulbs – Onion, garlic and lilies.
- Tubers – Potato, Helianthus tuberosus etc
- Suckers – Mint and chrysanthemum.

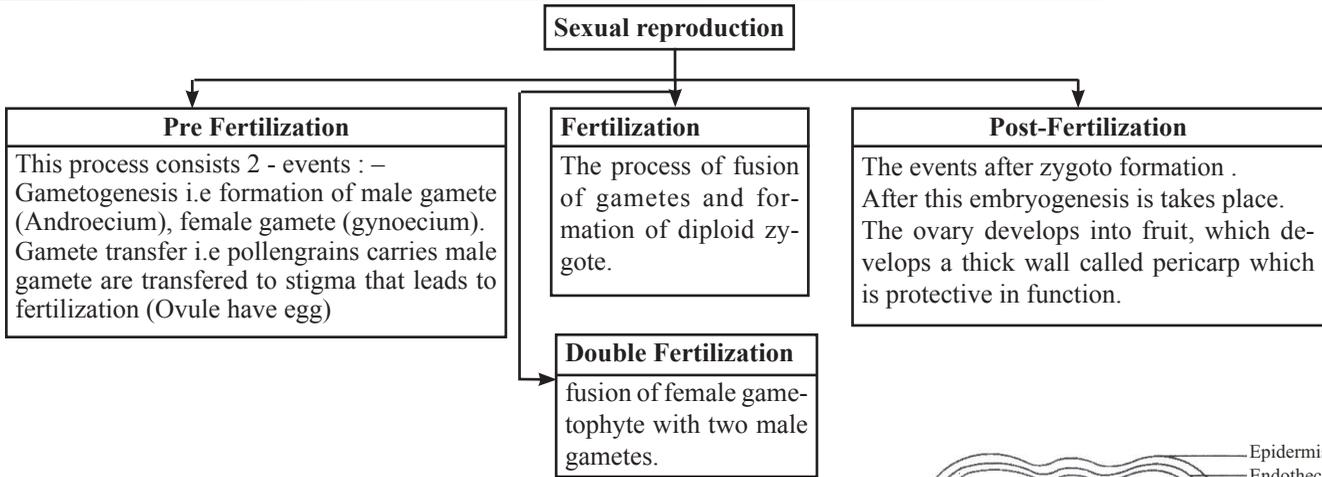
Creeper stem

- Runners – Cyndon, oxalis and centella
- Stolon – Fragaria, Vallisneria
- Offset – Pistia, Eichkornia, etc
- Aerial stem - Opuntia.

Leaves – ex– Bryophyllum, Begonia, streptocarpus, saint paulia

SEXUAL REPRODUCTION IN FLOWERING PLANT

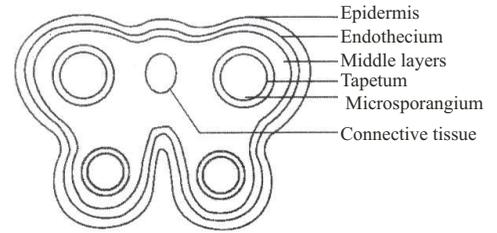
Sexual reproduction is the process of development of new organisms through the formation and fusion of gametes. In flowering plants, stamens are male reproductive organs while carpels are female reproductive organs. Sexual reproduction can be summarised as :



Male Reproduction Unit

It includes

- Stamen – unit of male gamete, consists anther, connective and filament.
- Microsporangium – sporangium containing micropores.
- Microsporogenesis – Formation of micropores or pollen grains
- Pollen-grains – it consists male reproductive bodies of flower.

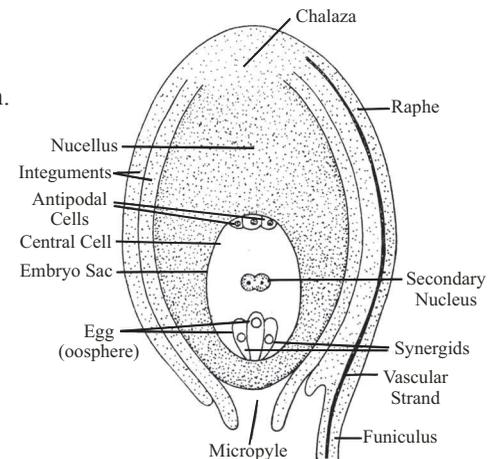


T. S. of young anther

Female Reproduction Unit

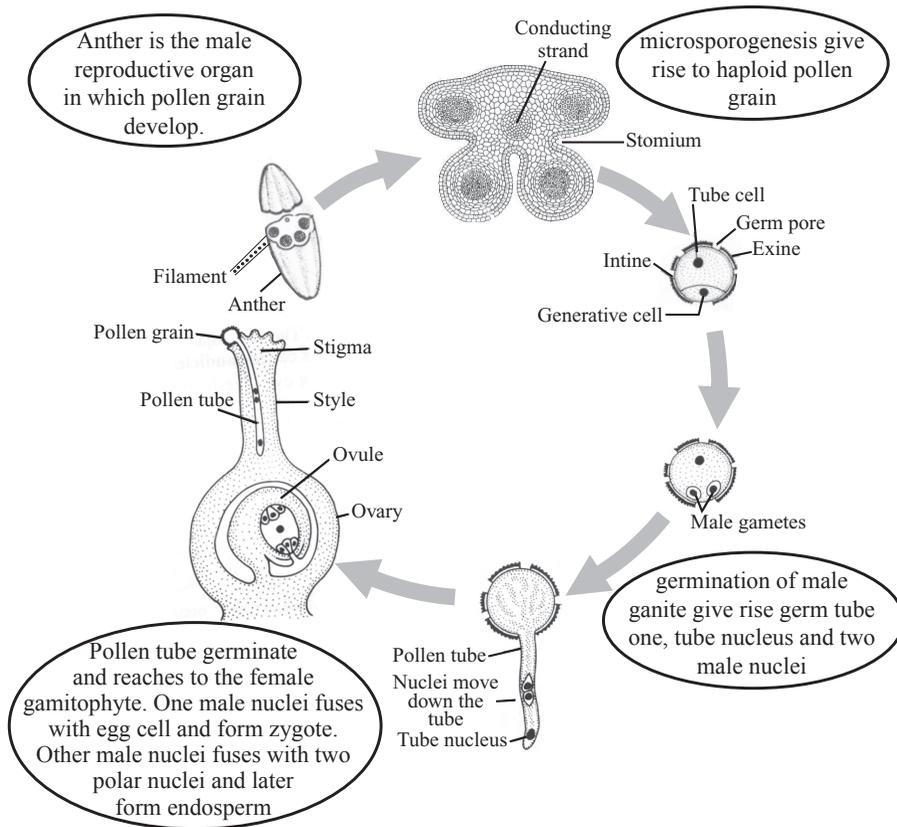
It includes

- Gynoecium/Pistil –Female reproductive part and carpel is a unit of gynoecium. Carpel consists three parts–stigma, style and ovary.
- Megasporangium (Ovule) – The integumented nucellus or megasporangium
- Megasporogenesis – The process of formation of megaspore mother cell.
- Embryo sac – Female gametophyte



Structure of a typical ovule (anatropous ovule) prior to fertilization

Sexual Reproduction Cycle



FOOD PRODUCTION

All living organisms require food for survival. Food is the basic need for existence of life on earth. Our country is over-populated and supports around one billion people. Therefore, in order to feed such a large population, we need to produce several million tones of grains every year along with higher requirement of milk, eggs and meat. Therefore, we need to increase production of both plant and animal products. The only possibility is to increase production efficiency of both plants and animals. We can increase the production by the development and use of improved varieties with high yield and better agricultural practices.

<i>Agriculture revolution</i>	<i>Production</i>
Green revolution	Cereals
White revolution	Milk
Blue revolution	Fish
Grey revolution	Fertilizers
Red revolution	Meat/Tomatoes
Golden revolution	Horticulture

Pink revolution	Prawn/Onion/pharmaceutical (India)
Silver revolution	Eggs and Chicken
Round revolution	Potato
Yellow revolution	Oil seeds

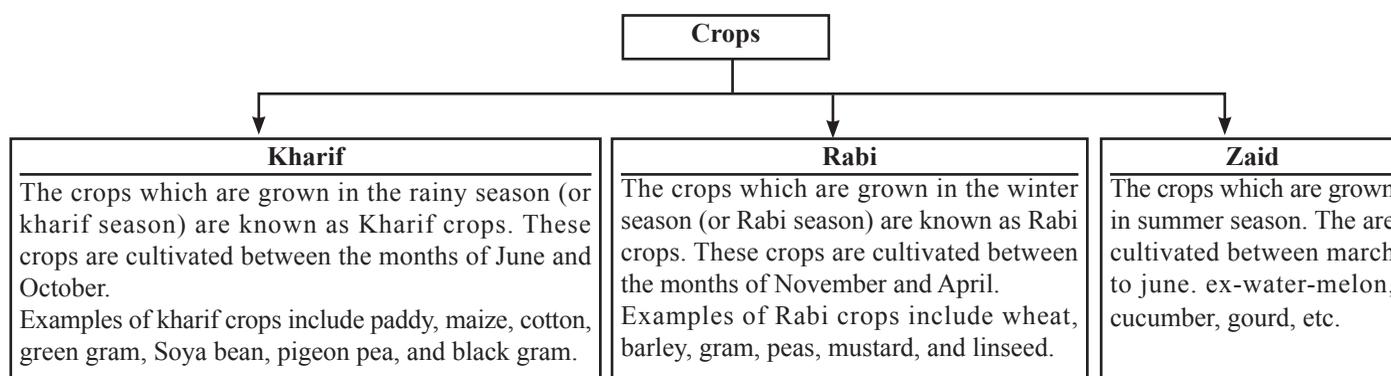
AGRICULTURE

The term “agriculture” is derived from two Latin words: *Ager-field and cultra-cultivation*. Thus, agriculture is the branch of science that deals with the mass production of plants and animals useful to human beings. It involves study of:

CROP

Crop is a plant grown in the fields on a large scale to obtain food. *For example*, if all the plants of rice are grown in the field, then it is called a rice crop. Similarly, if all the plants of wheat are grown, then it is called a wheat crop. Crops are cultivated by humans for food, fodder and other materials. **Let us discuss some important types of crops:**

Classification of crops on the basis of season



IMPROVEMENT IN CROP PRODUCTION

The yield of a crop can be increased by adopting a number of improved agricultural activities, which includes three scientific approaches :-*Crop variety improvement, Crop production improvement and Crop protection management*

Crop Variety Improvement Methods

The high yield from the crops is directly related with the inputs and the agricultural practices which the farmers adopt. Higher the inputs, more is the yield.

The various aspects for which crop variety improvement is carried out are as follows:

- (i) To obtain higher yield of crop
- (ii) To enhance the desirable quality of food items.
- (iii) To produce crop variety that is resistant to biotic and abiotic factors.
- (iv) To change the maturity duration of crop.
- (v) To induce desirable agronomic traits.
- (vi) To develop plant varieties with wider adaptability.

GM CROPS

Food items	Crop	Varieties
Cereals	Rice	Kasturi, Jaya, Padma, IR-8, Ponne, Pusa Basmati rice - 1509, Casalath
	Wheat	Sharbati Sonora, Sonalika, Kalyan Sona, Hira Moti, Pusa Lerma
	Maize	Vikram, Navjot, Shakti, Ganga 101, Deccan hybrid
Pulses	Pigeon pea	Pusa 84, Manak
	Chick pea	Pusa 240, Pant 114
Oil seeds	Sunflower	Arun, Pusa
	Mustard	Kranti, Pusa Bold
Vegetables	Lady Finger	Pusa Savani
	Brinjal	Pusa Purple, Pusa Kranti

Nutrient Management

The plants absorb the nutrients and inorganic raw materials from their surroundings and utilize the same building up their organic matter. The main sources of nutrients for plants are air, soil and water. In total, there are sixteen nutrients required by plants.

- Out of these, two nutrients (Carbon and Oxygen) are obtained from air.
- Hydrogen is obtained from water.
- These three elements - Carbon, Oxygen and Hydrogen are called non-essential elements as they are not obtained from soil.
- The remaining thirteen nutrients are obtained from soil with the help of roots. They are called mineral nutrients or essential nutrients.
- *Micronutrients*: Nutrients required in small quantities are called micronutrients. (Ph, Mg, K, N, Ca, S)
- *Macronutrients*: Nutrients required in larger quantities are called macronutrients. Nutrients are essential elements, which are used by plants in large quantities. (Mo, Mn, Cl, Cu, B, Zn, Fe)

Manure

Manure is a natural fertilizer. It is prepared by the decomposition of plant and animal waste.

Composition of manure

- Manure is a source of many plant nutrients.
- It is composed of organic matter and minerals. Ammonia, nitrate, organic substances, *etc.* are predominant organic matters found in manures.
- These are mostly composed of micronutrients such as zinc, manganese, copper, magnesium, sodium, *etc.*

Advantages of manure

- It enriches the soil with organic material called humus to the soil.

- It increases the water holding capacity of soil.
- It aerates the soil by making it porous.
- It helps in growth of micro-organisms. The organic matter of manures provides food for the soil organisms which help in making nutrients available to plants.
- It improves the soil texture.
- It increases the crop production.

Disadvantages of manure

- Manures are bulky with low nutrient content.
- They are inconvenient to handle, store and transport.
- Manures are not nutrient specific. Hence, it is not much useful when a particular nutrient is required in the soil for a particular crop.
- The nutrients of manures are released slowly, not keeping pace with high and rapid demand of nutrients by crops.

Fertilizers

Fertilizers are plant nutrients, which are commercially available. They can be organic or inorganic in nature. They ensure healthy growth and development in plants by providing them with nitrogen, phosphorus, potassium, *etc.*

Advantages of fertilizers

- They are mostly inorganic compounds, which can readily dissolve in water. They are easily available for plants.
- They are a good source of nitrogen, phosphorus, and potassium. However, they are good only for a short term use.
- They are nutrient specific.
- They are compact, easy to store and transport.
- They are required in very small amount.

Disadvantages of fertilizers

- They get washed away because of irrigation. Hence, they are a cause of water pollution.
- Continuous use of fertilizers causes harm to useful or symbiotic micro-organisms living in soil.
- They can also result in the reduction of soil fertility.
- They cannot replenish the organic matter of soil.
- They are quite expensive.
- They have only short term benefits
- Therefore, to get an optimum yield, it is necessary to use a balanced combination of manures and fertilizers.

Organic Farming

Organic farming is the practice of raising unpolluted crops through limited use of chemicals such as fertilizers, pesticides, herbicides, genetically-modified organisms, *etc.* Sometimes they are not used at all.

Advantages of organic farming

- It does not cause pollution of crop plants, soil, air and water.
- It helps in recycling of waste materials.
- The food obtained from organic farming is free from pesticides and chemicals.
- It maintains the health of soil.
- It keeps insects, pests and weeds under check.

Chapter 1

COMPUTER AND TECHNOLOGY

The word computer originated from the English word compute, which means to do calculation. The new definition of the computer can be defined as an electronic device through which different kinds of informations are processed on the basis of definite set of instructions called program and with this device both mathematical and non –mathematical informations can be processed.

HISTORY

Abacus is considered as first calculating device, which was originated in China during 16th century. But first calculating machine was invented by Blaise Pascal in 1642, which was named as *Pascalene*. Later in 1833 *Charles Babbage* made an automatic calculator. He is also known as *father of modern computer*.

COMPUTER GENERATIONS

Till today five generations of computers have been developed.

Computer Generations

Generation	Period	Main Electronic Component	Main Computers
I	1951-1958	Electronic tube/Vacuum tubes	EDSAC, EDVAC, UNIVAC
II	1959-64	Transistor	IBM-700, IBM-1401, IBM-1620, CDC-1604, CDC-3600 ATLAS, ICL-1901
III	1965-1971	Integrated circuit (IC)	IBM-360, IBM-370, NCR-395, CDC-1700, ICL-2903
IV	1971-2010	Large Integrated Circuits, Microprocessor VLSI	APPLE, DCM

Fifth Generation (2010 to Present)

Artificial Intelligence

Fifth generation computing devices, based on artificial intelligence, are still in development, though there are some applications, such as voice recognition, that are being used today. The goal of fifth-generation computing is to develop devices that respond to natural language input and are capable of learning and self-organization.

TYPES OF COMPUTER

Computers are classified on the basis of its size and its uses.

On the Basis of Size

Micro computers: In such computers ALU are based in same chip.

Personal computers: It is single user system which is used in offices, workshops, business etc.

Mini computers: It is power full than micro computer. It can be used by many users at same time. Its processing speed is very fast.

Main frame computers: These are larger in size and fabricated in steel frames. They can process an ample amount

of data very rapidly. Banks, educational institute and insurance company mainly use this type of computer.

Super computers: These are the most powerful computers, which can process extremely complex data very quickly and its storage capacity is also very large. It is the costliest and fastest working computer. Super computers are used in weather forecasting, space research, computerized nuclear tests, satellite launching, etc.

The super computer developed in India are Flo Solver. (developed by NAL, Bangalore), Multi Micro (developed by IIS, Bangalore), Param -10,000 (by C-DAC Pune), Mach (by IIT, Mumbai)

On the Basis of Uses

(i) **Digital computer:** These computers do calculations digitally by algebraic addition. The special feature of these computers is accurate numerical calculations. These are used mainly in banking.

(ii) **Analog computers:** It measures temperature, length, pressure, etc. (all physical quantities) and converts it into numerical values. These are used in scientific and engineering works.

(iii) **Hybrid computers:** In hybrid computers digital and analogue both types of computers are utilized. These are used in automatic operating devices like a versatile robot, in factories and machines etc.

COMPONENTS OF A COMPUTER

Input Unit

It receives data and instructions from the user.
It sends converted instructions to CPU for processing

CPU (Central Processing Unit)

It controls all the parts of computer processing
It performs processing works of computer.

The CPU consists of three components are :

1. ALU (Arithmetic and Logic Unit)

It performs all arithmetic and logic operations.

2. Control Unit

It controls the transfer of data from the input device to memory and from memory to ALU. It also transfers the results from memory to output unit.

3. Memory

It holds the received data from input device temporarily/permanently.

Example : RAM (Random Access Memory) & ROM (Read only Memory)

Output Unit

It receives processed data from CPU.
It converts the output into simple language and displays result on the screen.

HARDWARE

All the components and mechanical equipments that we can touch are known as hardware.

Input Devices

The devices which are used to give instructions and data to the computer are called input device. Some of main input devices are: Scanner, Touch screen, Optical Character Reader Magnetic Ink character Reader(MICR), Bar code Reader, Optical Mark-Reader (OMR), Voice input device, etc.

Output Devices

These are the devices through which computer gives output. Some of the main output devices are monitor, printer, projector, sound card, speaker, video card etc.

INFORMATION TECHNOLOGY

Information technology (also referred to as IT) is the application of computers and telecommunications equipment to *store, retrieve, transmit and manipulate data*, often in the context of a business or other enterprise. Several industries are associated with information technology, such as computer hardware software, electronics, semiconductors, internet, telecom equipment, e-commerce and computer services.

Application

Information Technology has applications in almost all aspects of our life. Some of the important ones are:

Science and Engineering, Business & Commerce, Education, Governance, Medicine, Entertainment, Geographic information system (GIS), E-Banking, Core Banking, Electronic Clearing Service (ECS), Multi-application Smart Cards, etc.

STORAGE DEVICES

Storage devices are also called storage media. It is a hardware device that can hold information. Two main storage devices are used in computers.

- The primary storage device also known as RAM,
- The secondary storage device such as a computer hard drive.

Secondary storage can be either internal or external storage.

Storage device is required by the computer to save any settings or additional information.

Example :

TYPE OF SECONDARY STORAGE DEVICES

There are following different types of storage devices Includes :

Magnetic Disks, Optical Disks, Magnetic Tape , Floppy Diskette CD-ROM disc, CD-R and CD-RW disc, Recordable DVD Drives, Jump drive and USB Flash Drive, Hard Drive, Memory Card, Memory Stick, Zip Diskette, Blue Ray Disk, etc

INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT)

ICT refers to all the technology used to handle telecommunications, broadcast media, intelligent building management systems, audiovisual processing and transmission systems, and network-based control and monitoring functions.

COMPUTER TECHNOLOGY

Computer technology is the activity of designing and constructing and programming computers.

The first major development in computer technology was in 1946, with a vacuum tube-based computer model that was produced to aid in military efforts. Since the invention of computers and the internet, technology including operating systems, platforms, hardware and software has rapidly advanced.

Type of computer technology

They are some computer technology includes :

An Embedded Systems, Microcomputer, Workstation, Mini-computer, Supercomputer, A Parallel Processing System, etc.

COMPUTER SOFTWARE

Computer Programs are called as Computer software, or just software. A computer Software is set of programs that guides the hardware through its job.

Types of Software

Computer softwares are mainly divided into two parts:

- (a) System Software (b) Application Software

Chapter 2

COMMUNICATION

Communication is the transfer of information from one place to another and some means of ensuring that what is sent is also received. Technology increases the ways in which information can be communicated, the speed of transmission, and the total volume that can be handled at any one time.

RECENT COMMUNICATION TECHNOLOGY

5G (Fifth Generation)

As the next step in the continuous innovation and evolution of the mobile industry, 5G will not only be about a new air interface with faster speeds, but it will also address network congestion, energy efficiency, cost, reliability, and connection to billions of people and devices.

Cognitive Networks, Big Data

Communication systems handle volumes of data generated by embedded devices, mobile users, enterprises, contextual information, network protocols, location information and such. It is a vast amount of information: A global IP backbone generates over 20 billion records per day, amounting to over 1 TB per day! Processing and analyzing this “big data” and presenting insights in a timely fashion are becoming a reality with advanced analytics to understand the environment, to interpret events, and to act on them.

Cyber Security

2014 was most remarkable for demonstrating that everything connected to the Internet can, and will be hacked. On daily basis we heard of retailers (Target, Home Depot, Neiman Marcus), financial institutions (Chase), technology companies (Snapchat, eBay, Sony) being hacked. No one is cyber-safe, and the road to the future leads through new cybersecurity technologies beyond current perimeter firewall-like defenses.

Green Communications

It is being reported that communications technologies are responsible for about 2-4% of all of carbon footprint generated by human activity. This highlights the need to focus on managing these numbers, and Green communications is doing just that. The trend is tackling first mobile networks because of their high energy use. Basestations and switching centers could count for between 60% and 85% of the energy used by an entire communication system.

Smarter Smartphones, Connected Sensors

The indisputable rock-start of devices is the smartphone, and its future can't be brighter. In 2014 we saw that only a few

days after the iPhone 6 was released, there are already articles being written about the next-generation iPhone 7. Size, shape, and capabilities of these ubiquitous communication devices continue evolving, and so are prices which, driven by cost and performance improvements in digital technologies, are falling rapidly. The average selling price of a smart-phone went down in 2014, and we expect this to continue in coming days with low-cost OEMs such as Xiaomi and Lenovo leading the trend.

Network Neutrality, Internet Governance

The Internet has been operating since its inception under “open” principles, i.e. an open standards-based network that treats all traffic in roughly the same way, i.e. no connection blocking, bandwidth transparency, universal connectivity, and best effort service. Can these principles be sustained in a new world of data-hungry applications and services? Is regulation needed to prevent traffic throttling, unfair raise of fees, and construction of preferential high-speed Internet lanes? In 2014, Network Neutrality (NetNeutrality) discussions covered these questions in the context of ISPs transit and peering, and CDNs. Governments and institutions around the world will continue working on it during days to come.

Molecular Communications

Molecular communication is an emerging paradigm where bio-nano-machines (e.g., artificial cells, genetically engineered cells) communicate to perform coordinated actions. Unlike traditional communication systems which utilize electromagnetic waves, molecular communications utilize biological molecules both as carriers and as information. The advantages provided by this “molecular” approach to communications are size, biocompatibility, and bio-stability.

MODERN TELECOMMUNICATION SYSTEM

Most modern day telecommunications systems are best described in terms of a network. There are six basic components to a telecommunications network.

1. Input and output devices, also referred to as ‘terminals’.

These provide the starting and stopping points of all communication. A telephone is an example of a terminal. In computer networks, these devices are commonly referred to as ‘nodes’ and consist of computer and peripheral devices.

2. Telecommunication channels, which transmit and receive data.

This includes various types of cables and wireless radio frequencies.

3. Telecommunication processors, which provide a number of control and support functions.

For example, in many systems, data needs to be converted from analog to digital and back.

4. Control software, which is responsible for controlling the functionality and activities of the network.

5. Messages represent the actual data that is being transmitted.

In the case of a telephone network, the messages would consist of audio as well as data.

6. Protocols specify how each type of telecommunication systems handles the messages.

For example, GSM, CDMA, 3G and 4G are protocols for mobile phone communications, and TCP/IP is a protocol used for communications over the Internet.

INFORMATION COMMUNICATION TECHNOLOGY (ICT) APPLICATIONS

ICT applications, such as e-Government, e-commerce, e-Education, e-Health and e-Environment, are seen as enablers for development, as they provide an efficient channel to deliver a wide range of basic services in remote and rural areas. ICT applications can facilitate the achievements of millennium development targets, reducing poverty and improving health and environmental conditions in developing countries.

ICT applications can deliver basic services in a wide range of sectors including: health, agriculture, education, public administration, commerce, etc. ICT applications constitute one of the priority domains for ITU-D programme 2 (2010) and the ITU-D ICT Applications and Cyber-security Division. Improving social conditions and building an entry ramp into the information society are amongst the purposes of ITU's ICT Applications work Programme for Developing Countries.

NEAR FIELD COMMUNICATION TECHNOLOGY

Near field communication (NFC), is a form of contactless communication between devices like smart-phones or tablets. Contactless communication allows a user to wave the smart-phone over a NFC compatible device to send information without needing to touch the devices together or go through multiple steps setting up a connection. Fast and convenient, NFC technology is popular in parts of Europe and Asia, and is quickly spreading throughout the United States.

WIRE COMMUNICATION

Every telecommunications system involves the transmission of an information-bearing electro-magnetic signal through a physical medium that separates the transmitter from the receiver. All transmitted signals are to some extent degraded by the environment through which they propagate. Signal degradation can take many forms, but generally it falls into three types: noise, distortion, and attenuation (reduction in power).

Types of wires

There are many types of wires used in wire communication these are :

Single-wire Cable

In the early days of the telegraph, a single un-insulated iron wire, strung above ground, was used as a transmission line. Return conduction was provided through an earth ground. This arrangement, known as the single-wire line, was quite satisfactory for the low-frequency transmission requirements of manual telegraph signaling

Multi Pair Cable

In multi pair cable anywhere from a half-dozen to several thousand twisted-pair circuits are bundled into a common sheath. The twisted pair was developed in the late 19th century in order to reduce cross talk in multi pair cables.

Coaxial Cable

By enclosing a single conducting wire in a dielectric insulator and an outer conducting shell, an electrically shielded transmission circuit called coaxial cable is obtained.

Optical Fibre System

Like all other communication system, the primary objective of optical fiber communication system also is to transfer the signal containing information (voice, data, and video) from the source to the destination. The source provides information in the form of electrical signal to the transmitter. The electrical stage of the transmitter drives an optical source to produce modulated light wave carrier.

NETWORKING DEVICES

Networking hardware's are also known as computer networking devices, are physical devices which are required for communication and interaction between devices on a computer network. Specifically, they mediate data in a computer network.

Networking devices may include gateways, routers, network bridges, modems, cable modem, wireless access points, networking cables, line drivers, switches, hubs, and repeaters; and may also include hybrid network devices such as multilayer switches, protocol converters, bridge routers, proxy servers, firewalls, network address translators, multiplexers, network interface controllers, wireless network interface controllers, ISDN terminal adapters and other related hardware.

NANOTECHNOLOGY IN TELECOMMUNICATION

Nanotechnology is set to have a profound impact on telecommunications leading to easier convergence of related technologies, massive storage data, compact storage devices, and higher performance computing. Nanotechnology for Telecommunications covers research and developmental issues as well as future directions of MEMs and nanotechnology as they apply to telecommunications. It discusses the impact of nanotechnology on devices such as photonic crystals lasers, light emitters (LED), compact fluorescent lamp (CFL), sensors.

The Republic of India has world's 3rd largest military force and has the world's largest volunteer army. The President of India is the Supreme Commander of the Indian Armed Forces and is looked after by the Ministry of Defence (MoD). It is led by the Union Cabinet Minister of Defence. It consists of three professional uniformed services: the Indian Army, Indian Navy, and Indian Air Force.

The President of India is the Supreme Commander of the Armed Force. However, the Cabinet is responsible for National Defence. The Administrative control of armed forces is exercised by the Ministry of Defence, which constitutes the following.

- Department of Defence
- Department of Defence Production and Supplies
- Department of Defence Research and Development (DDR D).
- The department of ex-servicemen welfare.

DEPARTMENTS OF DEFENCE

ARMY

Headed by Chief of the Army Staff
Headquarters New Delhi
Approximate strength of 1,200,000 approximately army personnel

Further, the three services Headquarters, which were used to be attached offices of Ministry of Defence are now integrated with the Ministry and known as Integrated Headquarters of the Ministry of Defence.

Number of Commands		
	Command	Headquarters
1.	Western Command	Chandimandir
2.	Eastern Command	Calcutta
3.	Northern Command	Udhampur
4.	Southern Command	Pune
5.	Central Command	Lucknow
6.	Training Command (added in 1991)	Mhow
7.	South Western Command (added in 2005)	Jaipur

Each command is under a General Officer Commanding-in-Chief who is of the rank of Lt General. The command is further divided into areas and independent sub-areas, commanded by a Major-General and a Brigadier, respectively.

AIR FORCE

Headed By Chief of the Air Staff
Headquarters New Delhi
Approximate strength of 115,000 approximately
Air Force personnel : -

Number of Commands		
	Command	Headquarters
1.	Western Air Command	Delhi
2.	South-Western Air Command	Gandhinagar
3.	Central Air Command	Allahabad
4.	Eastern Air Command	Shillong
5.	Southern Air Command	Thiruvananthapuram

In addition to the above main command, there are two support commands, or functional commands, namely:

- Training Command – Bangalore
- Maintenance Command – Nagpur

Today, the Air Force has an array of modern aircraft on its inventory besides other hi-tech electronic and support equipment. The aircraft fleet consists of fighter-bombers, air-superiority fighters, interceptors, transport, and logistic aircraft and helicopters.

NAVY

Headed by Chief of Naval Staff
Headquarters New Delhi
Approximate Strength 62,000 approximately

Number of Commands		
	Command	Headquarters
1.	Western Naval Command	Mumbai
2.	Eastern Naval Command	Visakhapatnam Operational command
3.	Southern Naval Command	Kochi used for training

Each command is commanded by a flag officer commanding-in-chief.

The Indian Navy is a well-balanced three-dimensional force consisting of sophisticated missile-capable warships, aircraft carriers, minesweepers, advanced submarines, and the latest aircraft in its inventory. At present, the Navy has two major Naval bases at Mumbai and Visakhapatnam. Goa and Arkonnam are the major Naval air bases.

LOCATION OF DEFENCE ESTABLISHMENTS

Army

Indian Military Academy	Dehradun
The College of Military Engineering	Kirkee (Pune)
The School of Signals	Mhow
The Infantry School	Mhow
The Corps of Military Police Centre and School	Faizabad
The Army Education Corps and Training College	Pachmarhi

Navy

Indian Naval Academy	Kochi
Naval Air Station Garuda	Kochi
INS Agrani (Petty Officer's School)	Coimbatore
Naval Gunnery School	Kochi
Torpedo Anti-Submarine School	Kochi
Navigation Direction School	Mormugao

Air Force

Pilot Training Establishment	Allahabad
Jet Training and Transport Training Wings, Air Force Station	Hyderabad
The Air Force Technical Training College	Jalahalli
Paratroopers Training School	Agra

Inter-services Institutes

National Defence Academy	Khadakvasla
National Defence College	New Delhi
Defence Services Staff College	Wellington
School of Land/Air Warfare	Secunderabad
Rashtriya Indian Military College	Dehradun
Armed Forces Medical College	Pune

DEFENCE PRODUCTION UNDERTAKINGS

Eight public sector undertakings (PSUs) currently function under the Department of Defence Production and Supplies. They are HAL, Bharat Electronics Limited (BEL), Bharat Earth Movers Limited (BEML), Mazgaon Dock Limited (MDL), Garden Reach Shipbuilders and Engineers Limited (GRSE), Goa Shipyard Limited (GSC), Bharat Dynamic Limited (BDL), and Mishra Dhatu Nigam Limited (MIDHANI).

NODAL AGENCIES OF DEFENCE SECTOR

India's defence mechanism is growing stronger with the advancement of science and technologies. Various nodal agencies have been created and maintained by minister of Defence of India which aimed at obtaining policies from central government so as to implement the defence related research on its several branches

DEFENCE RESEARCH AND DEVELOPMENT ORGANISATION (DRDO)

Looks after various areas of military technology such as aeronautic armament, combat vehicles, electronics instrumentation engineering systems, missiles, materials, naval systems, advanced computing, simulation and life sciences.

It was established in 1958 by amalgamating Defence Science Organization and some of the Technical Development Institutions.

The major achievements towards indigenous development of defence weapons and systems are (i) development leading to production of surface-to-surface missile, Prithvi; (ii) state-of-the-art MBT, Arjun; (iii) flight simulators for aircraft; (iv) pilotless target aircraft, Lakshya; (v) parallel super-computer; and (vi) the submarine sonar and weapon control system, Panchendriya.

DEFENCE RESEARCH AND DEVELOPMENT LABORATORY (DRDL)

It works as multi-disciplinary missile system which aims at designing, developing and evaluating the fleet of various types of missiles used by armed forces.

DEFENCE AVIONICS RESEARCH ESTABLISHMENTS (DARE)

It was initially a project laboratory known as advanced systems integration and Evaluation Organisation (ASIEO), which aimed at enhancing the operational capabilities of Indian Air force with the help of modern technology. But over the time it has witnessed a rapid progress in the area of Airborne Electronic warfare Airborne Processors, testing Evaluation of Electronics warfare etc.

INDIAN SPACE RESEARCH ORGANISATION (ISRO)

It is the parent agency of Indian space agencies which was established on 15th August 1969. The head quarter of this organisation is at Bangalore and it was founded by Vikram Sarabhai with a vision to harness space technology for national development, while pursuing space science research and planetary exploration. The first satellite made by ISRO was Aryabhata and it was launched by Russia on 19th April 1975. Thereafter it has developed numerous satellites and spacecrafts for serving different technology such as communication Earth's observation, navigation, climatic observations etc.

INDIA'S INTERNAL SECURITY

Police

Police is a state subject under the Constitution. The head of a police force in a state is the Director-General of Police (DGP) or Inspector-General of Police (IGP). For administrative purposes, each state is divided into ranges headed by the Deputy-Inspector General of Police (DIG) and a range is further divided into districts, each under the control of a Superintendent of Police (SP). All senior police posts in various states are included in the Indian Police Service (IPS) cadres, recruitment for which is made on an All-India basis. However, for lower ranks up to Deputy Superintendent (DSP), the recruitment is done at the state levels.

It is the technology developed by the aerospace industry for implementation in spaceflight, satellites, space exploration, space stations and support infrastructure. plenty of daily services such as weather forecasting, remote sensing, GPS systems, satellite television, and long distance communications systems rely on space technology.

APPLICATION OF SPACE TECHNOLOGY

There are many applications of space technology such as:

Earth Observation

Satellite Communication

Disaster Management Support

Satellite Navigation

Climate and Environment

SPACE SHUTTLE

The primary vehicle for research and exploration is the space shuttle. The space shuttle takes off like a rocket, orbits the earth like a spacecraft and lands, like an aeroplane. It consists of an orbiter, an external tank and two solid rocket boosters.

ARTIFICIAL SATELLITES

An artificial satellite is a manufactured 'moon'. It circles the earth in space along a path called an orbit. An artificial satellite may be designed in almost any space. It does not have to be streamlined, because there is little or no air where it travels in space. Artificial satellite may be classified according to the jobs they do as : weather satellites, communications satellites, navigation satellites, scientific satellites and military satellites.

SPACE PROBES

Space Probes are the automated space craft which are operated and managed by robots so as to explore space after leaving Earth's orbit. They can reach the moon; enter into inter-planetary space; act as fly by and last but not the least they can land on other planetary bodies.

ORBIT

An orbit can be a circular or elliptical path which is generally followed around an object in space. In object in an orbit is continuously moving unless and until some external force will be applied to it. More or less every celestial body in space has their own orbit.

A GEOSYNCHRONOUS ORBIT

A geosynchronous orbit (GEO) is an orbit about the Earth of a satellite with an orbital period that matches the rotation of the Earth on its axis (one sidereal day) of approximately 23 hours 56 minutes and 4 seconds, The synchronization of rotation and orbital period means that, for an observer on the surface of the Earth, an object in geosynchronous orbit returns to exactly the same position in the sky after a period of one sidereal day.

Geosynchronous Orbit (GEO) is the region in which satellites orbit at approximately 22,236 miles above the Earth's surface, in the plane of the equator, where near-geostationary orbits may be implemented. At this altitude, the orbital period is equal to the period of rotation of the Earth, so the satellite appears to move neither East nor west. When a geosynchronous orbital path remains above the Earth's equator (00 latitude) at all times, with a period and an orbital eccentricity of approximately zero.

JET ENGINE

A Jet engine is a machine that converts energy-rich, liquid fuel into a powerful pushing force called thrust. The thrust from one or more engines pushes a plane forward forcing air past its scientifically shaped wings to create an upward force called lift powers it into the sky its known as jet engine. It is also known as Reaction engine.

Reaction Engines idea was to design a device that could use the oxygen already present in the atmosphere through combustion like an ordinary jet engine. So jet engine uses the surrounding air for its oxygen supply and so is unsuitable for motion in space.

SPACECRAFT

A spacecraft is a vehicle, or machine designed to fly in outer space. Spacecraft are used for a variety of purposes, including communications, earth observation, meteorology, navigation, space colonization, planetary exploration, and transportation of humans and cargo. There are two types of spacecraft:

1. Manned spacecraft

As of 2016, only three nations have flown manned spacecraft: USSR/Russia, USA, and China. The first manned spacecraft was, Vostok which carried Soviet cosmonaut Yuri Gagarin into space in 1961, and completed a full Earth orbit. There were five other manned missions which used a Vostok spacecraft. The second manned spacecraft was named Freedom 7, and it performed a sub-orbital spaceflight in 1961 carrying American astronaut Alan Shepard to an altitude of just over 187 kilometers (116 mi), other manned spacecraft include the Voskhod, Soyuz, Mir manned space stations.

2. Unmanned spacecraft

Unmanned spacecraft are spacecraft without people ("man") on board, used for unmanned spaceflight. The unmanned spacecraft stations are Salyut 7 and Cassini, and the ISS module Zarya were capable of unmanned remote guided station-keeping, and docking maneuvers with both resupply craft and new modules.

Cassini is an unmanned spacecraft sent to the planet Saturn. It is a Flagship-class NASA-ESA-ASI robotic spacecraft. Cassini is the fourth space probe to visit Saturn and the first to enter orbit, and its mission is ongoing as of 2017. It has studied the planet and its many natural satellites since arriving there in 2004.

NASA'S DEEP IMPACT SPACECRAFT

Deep Impact is a NASA space probe, it was launched on a clear winter day in 12 January 2005 from Cape Canaveral Air Force Station. NASA's Deep Impact spacecraft spanned 268 million miles (431 million kilometers) of deep space in 172 days, then reached out and touched comet Tempel 1.

NASA's Deep Impact space mission was employed to take detailed pictures of Tempel-1 comet nucleus.

The collision between the coffee table-sized impact and city-sized comet occurred on July 4, 2005, at 1:52 a.m. EDT.

SELENE-1

SELENE-1 is a lunar mission of JAXA (Japan Aerospace Exploration Agency). The mission objectives are the global survey of the moon, and to develop technologies for the lunar orbit insertion and spacecraft attitude and orbit control. The global survey of the moon is made for better understanding the origin and evolution of the moon, measuring the gravity field, elemental/chemical composition, etc. It also includes the measurement of the lunar and solar-terrestrial environment, and research on the possibility of future utilization of the moon. The nominal SELENE observation period is planned for one year.

BHUVAN

Bhuvan is a software application which allows users to explore a 2D/3D representation of the surface of the earth. ISRO launched the beta version of its web-based GIS tool, bhuvan, on August 12, 2009. Bhuvan offers detailed imagery of Indian locations compared to other virtual Globe software, with spatial resolutions ranging up to 1 meter.

Bhuvan, which uses high-resolution images, will comply with India's remote sensing data policy, which does not allow online mapping services to show sensitive locations such as military and nuclear installations. High-resolution images are those that show locations of 1 sq. m or less on earth.

THEMIS-MISSION

The time history of events and macro scale interactions during substorms (Themis) mission was originally a constellation of five NASA Satellites. These five NASA Satellites are Themis A to Themis E.

The name of the mission is acronym alluding to the titan, is known as Themis.

The Themis mission, comprising five identical probes, aims to gain new insights into the colourful displays in high-latitude skies.

A US space agency (Nasa) mission to study auroras - the Northern Lights - has blasted off from Cape Canaveral in Florida, after it was delayed by wind.

GALILEO IS EUROPE'S GLOBAL SATELLITE NAVIGATION SYSTEM

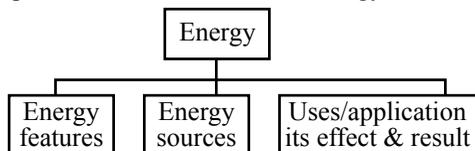
Galileo is Europe's Global Satellite Navigation System (GNSS), providing improved positioning and timing information with significant positive implications for many European services and users. For example:

- Galileo allows users to know their exact position with greater precision than what is offered by other available systems.
- The products that people use every day, from the navigation device in your car to a mobile phone, benefit from the increased accuracy that Galileo provides.
- Critical, emergency response-services benefit from Galileo.
- Galileo's services will make Europe's roads and railways safer and more efficient.
- It boosts European innovation, contributing to the creation of many new products and services, creating jobs and allowing Europe to own a greater share of the EUR 175 billion global GNSS market (Source: GSA Market Report Issue IV).

SPACE CENTRES AND UNITS

- Vikram Sarabhai Space Centre (VSSC) - Thumba (Thiruvananthapuram)
- ISRO Satellite Centre (ISAC) - Bengaluru
- SHAR Centre - Shriharikota (Andhra Pradesh)
- Liquid Propulsion Systems Centre (LPSC) - Bengaluru
- Space Application Centre - Ahmedabad
- Developmental and Educational Communication - Ahmedabad unit (DECU)
- ISRO Telemetry Tracking and Command Network (ISTRAC) - Bengaluru
- National Remote Sensing Agency (NRSA) - Hyderabad
- Master Control Facility (MCF) - Hassan (Karnataka)
- The Antrix Corporation Limited - Bengaluru
- North Eastern-Space Applications Centre (NE-SAC) - Shillong
- Physical Research Laboratory (PRL) - Ahmedabad
- Laboratory for Electro Optical System (LEOS)
- ISRO Internal System Unit (IISU)
- Indian Institute of Remote Sensing
- Regional Remote Sensing Service Centre (RRSC)
- Development and Education Communication (DECU)
- Space Application Centre (SAC)
- National Remote Sensing Centre (NRSC)
- ISRO Telemetry Tracking and Command Network (ISTRAC)
- Indian Institute of Space Science and Technology (IIST)
- Antrix Corporation Limited.
- National Atmospheric Research Laboratory (NARL)
- Semi-Conductor Laboratory (SCL)

Energy is a property of objects which can be transferred to other objects or converted into different forms. The “ability of a system to perform work” is known as energy.



Feature of Energy

Energy is measured in J (Joules) and power in W (Watts). Electric energy is generally measured in kWh.

The features of energy are:

Energy can be transferred from one object to another.

Energy comes in many different forms, which can generally be divided into Potential or Kinetic energy.

Energy can be converted from any one of these forms into any other, and vice versa.

Energy is never created or destroyed - this is called the First Law of Thermodynamics

Energy is capacity to do work

Source of Energy

Source of energy can be classified as:

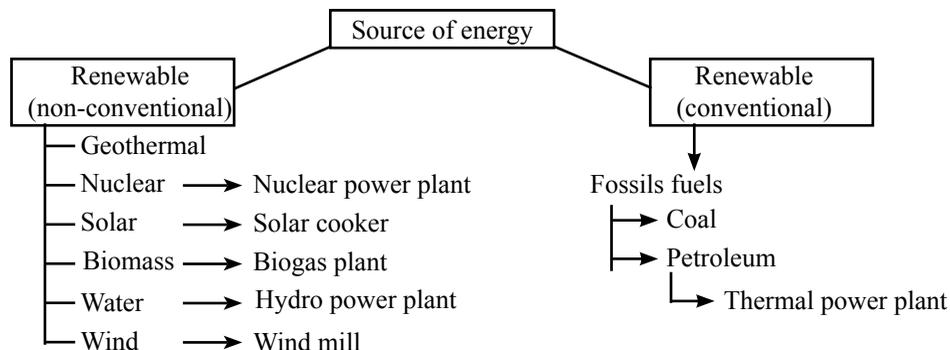
- Artificial sources
- Natural sources

ARTIFICIAL SOURCES

Artificial energy can be defined in contradiction with natural energy. It must be produced without transformation of material, by the mere functioning of material implements, A possibility of production of artificial energy is in the form of mechanical work.

A mechanical work requires the action of a force and must therefore call an implement of propulsion. The analysis of relations between force and power shows that only particular propulsion implements can generate artificial energy, e.g. dynamo, generator, etc.

NATURAL SOURCES OF ENERGY



NATURAL SOURCE

Natural source of energy can be classified as two ways

1. Conventional source.
2. Nonconventional source.

Conventional Source

Sources which are being used since long time like: coal, oil and gas, wood etc.

Non-Conventional Source of Energy

Sources whose use has started only recently like sun (**Solar energy**), wave (**Wind energy**), geothermal energy, hydroelectric energy, biogas, biomass etc.

Application of Energy

General uses of energy are divided into three economic sectors; they are:

Nuclear energy is the energy that comes from the core or the nucleus of an atom. The bonds which hold the atoms together contain a massive amount of energy. This energy must be released in order to make electricity. This energy can be freed in two ways: nuclear fission and nuclear fusion.

Uses of Nuclear energy

Today most people are aware of the important use of nuclear energy makes in cleanly providing a significant proportion of the world's electricity.

Applications of Nuclear Energy

Nuclear energy is the production of electric energy. Nuclear power plants are responsible for generating electricity. Nuclear fission reactions are generated in the nuclear reactors of the nuclear power plants. With these reactions thermal energy is obtained which will be transformed into mechanical energy and later into electrical energy.

There are many applications of nuclear energy where nuclear technology is used directly or indirectly. These are:

1. Military applications, nuclear weapons.
2. Nuclear medicine.
3. Gamma Sterilisation.
4. Smoke detectors
5. Radio therapy
6. Gamma radiography.
7. Industrial tracers.
8. Dating.

NUCLEAR REACTORS

A nuclear reactor, formerly known as an atomic pile, it is a device used to initiate and control a sustained nuclear chain reaction. Nuclear reactors are used at nuclear power plants for electricity generation and in propulsion of ships.

Nuclear reactors are divided into two categories:

- **Thermal Reactors:** Almost all of the current reactors which have been built use thermal neutrons to sustain the chain reaction. These reactors also contain neutron moderator that slows neutrons from fission
- **Fast Neutron Reactors:** Fast reactors contains no neutron moderator and use less-moderating primary coolants, because they use fast neutrons to cause fission in their fuel.

Types of Nuclear Reactors

Breeder Reactor

A breeder reactor is essentially a particular configuration of a fast reactor. The most common breeding reaction is an absorption reaction on uranium-238, where a plutonium-239 from non-fissionable uranium-238 is produced.

Pressurized Water Reactor – PWR

Pressurized water reactors use a reactor pressure vessel (RPV) to contain the nuclear fuel, moderator, control rods and coolant. They are cooled and moderated by high-pressure liquid water.

Boiling water reactor – BWR

A boiling water reactor is cooled and moderated by water like a PWR, but at a lower pressure (7MPa), which allows the water to boil inside the pressure vessel producing the steam that runs the turbines.

CANDU – Heavy Water Reactor

The CANDU reactor design (or PHWR – Pressurized Heavy Water Reactor) has been developed since the 1950s in Canada, and more recently also in India. These reactors are heavy water cooled and moderated pressurized water reactors. Instead of using a single large reactor vessel as in a PWR or BWR, the nuclear core is contained in hundreds of pressure tubes. PHWRs generally use natural uranium (0.7% U-235) oxide as fuel, hence needs a more efficient moderator, in this case heavy water (D₂O).

NUCLEAR POWER

Nuclear power for civil use is well established in India. Since building the two small boiling water reactors at Tarapur in the 1960s, its civil nuclear strategy has been directed towards complete independence in the nuclear fuel cycle, necessary because it is excluded from the 1970 Nuclear Non-Proliferation Treaty (NPT) due to it acquiring nuclear weapons capability after 1970.

ORGANISATION OF INDIA NUCLEAR ENERGY PROGRAM:

The Atomic Energy Commission was set up in August 1948 to look after atomic energy activities in the country. The functions of the Atomic Energy Commission are:

- (i) To organize research in atomic science in the country;