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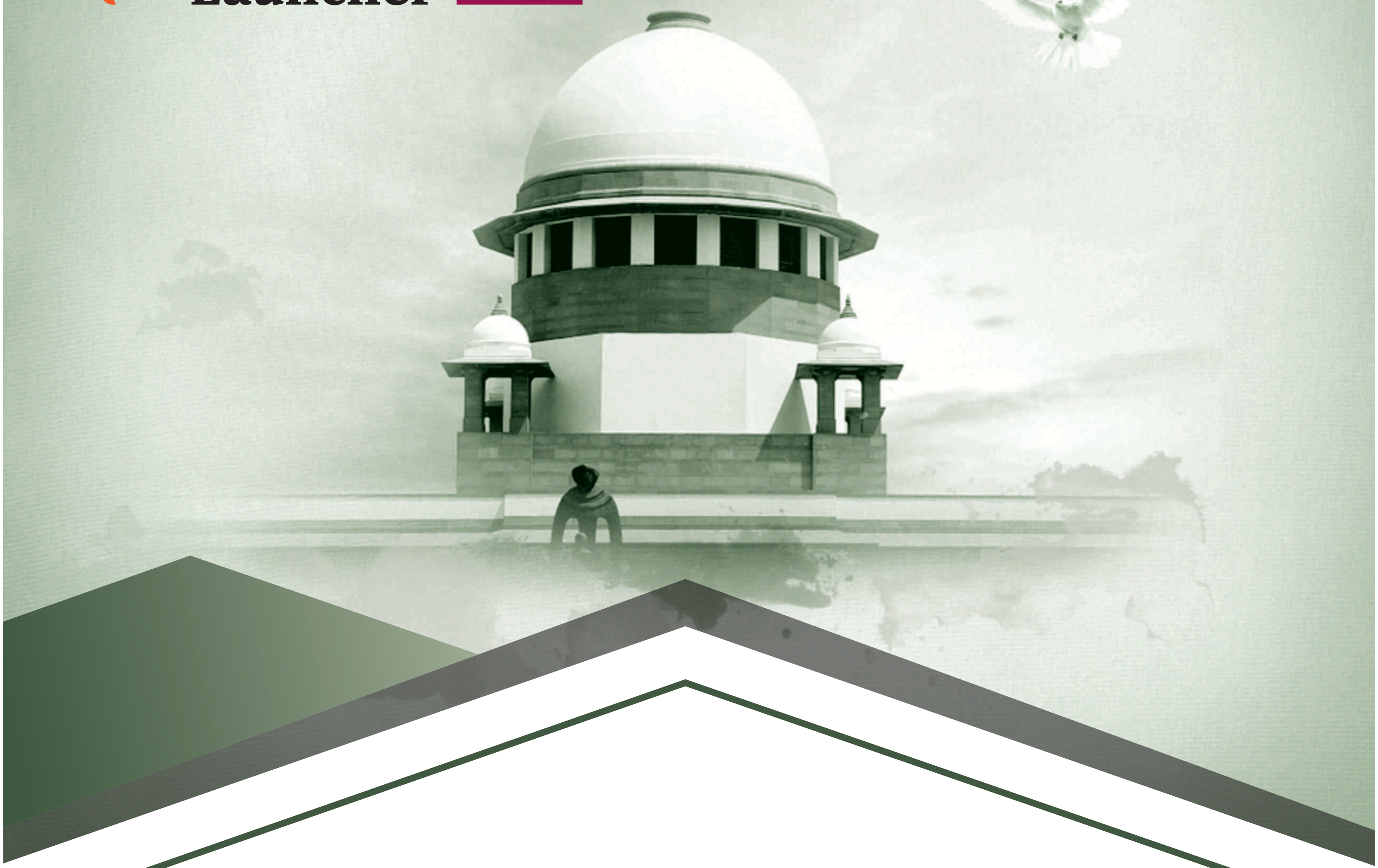

Compilation of NCERTs

Physics, Chemistry & Biology

For UPSC Civil Services Prelims and Main

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Contents

PART - A

PHYSICS

AIR AROUND US

- Air is present everywhere on earth. in motion is called wind ATMOSPHERE
- Our earth is surrounded thin layer of air. This layer extends upto many kilometres above the surface of the earth and is called atmosphere
- As we move higher in the atmosphere, the air gets rarer Air is a mixture of many gases

WATER VAPOUR

- When air comes in contact with a cool surface, it condenses and drops of water appear on the cooled surfaces The presence of water vapour in air important for the water cycle in nature

OXYGEN

- Air contains oxygen. We need oxygen to breathe it helps in respiration process Oxygen supports burning

NITROGEN

- Nitrogen is a major part of the air, It does not support burning

CARBON DIOXIDE

- Carbon dioxide makes up a small component of the air around us, Plants and animals consume oxygen for respiration and produce carbon dioxide
- Plant and animal matter also consume oxygen on burning and produces mainly carbon dioxide and a few other gases
- The burning of fuel also produces smoke. Smoke contains a few gases and fine dust particles Harmful to living organisms

MOTION AND MEASUREMENT OF DISTANCES

- A body is said to be in motion if its position changes with time with respect to an observer (or a reference point)
- Motion in a straight line is called rectilinear motion
- In circular motion an object moves such that its distance from a fixed point remains the same. Circular motion is the motion of a body that moves along a circular path
- Motion that repeats itself after some period time is called periodic motion

LIGHT, SHADOWS AND REFLECTIONS

- Objects like the sun that give out or emit light of their own are called luminous objects. The light emitted by luminous objects enables us to see things around us
- Objects that do not emit light on their own are called non luminous objects The light emitted by luminous objects falls on non-luminous objects, and the bounces back to our eye, which enables us to see non luminous objects.

  Examples of non-luminous objects are the moon, a book, a pen, a wooden box, a cupboard and a chair
- Opaque objects do not allow light to pass through them. If we cannot see through an object at all it is an opaque object.
- IF you are able to see clearly through an object, it is allowing light to pass through it and is transparent
- There are some objects through which we can see, but not very clearly Such objects are known as translucent Translucent objects allow light to pass through them partially

SHADOWS

- Shadows are formed when an opaque object comes in the path of light. A shadow is a dark region and is formed only when a light source, an opaque object and a screen are present
- Shadows are seen more clearly on light screens Whatever the colour of the object, its shadow is always black because it is not illuminated by light

MIRRORS AND REFLECTIONS

- An image can be seen in the mirror because the light reflected from an object falls on the mirror and it is reflected So, light Incident on any smooth shiny surface like a mirror bounces back into the same medium This bouncing of light by any smooth surface is called reflection of light

ELECTRICITY AND CIRCUITS

- All electric cells have two terminals a positive terminal and a negative terminal, An electric cell produces electricity from the chemicals stored Inside it

BULB

- A filament is a spirally wound wire inside the bulb supported by two thick wires at its ends. An electric cell is connected to the terminals of a bulb so that electricity from the cell can pass through the bulb. This electricity makes the filament in the bulb glow and emit light

ELECTRIC CIRCUIT

- The electric circuit provides a complete path for electricity to pass (current to flow) between the two terminals of the electric cell The bulb glows only when current flows through the circuit In an electric circuit, the direction of current is taken to be from the positive to the negative terminal of the electric cell.
- When the terminals of the bulb are connected with that of the electric cell by wires, the current passes through the filament of bulb. This makes the bulb glow

ELECTRIC CONDUCTORS AND INSULATORS

- Materials that allow electric current to pass through them are called conductors
- Conductors conduct electric current Science metals are good conductors of electricity, electric wires are made of metals These electric wires act as conducting materials. So, they are used to make electrical circuits
- Some common conductors that conduct electric current are copper silver, gold and aluminium Copper is the most popular material used for wires, Sometimes we receive electric shocks because our bodies are also good conductors of electricity
- Materials that do not allow electric current to pass through them are called insulators Insulators oppose electric current and so they are used as protection from the dangerous effects of electricity Same common insulators are glass air plastic cotton, thermocol wood and rubber.

MAGNETIC AND NON-MAGNETIC MATERIAL

- Magnetite is a natural magnet. Magnet attracts materials like iron, nickel, cobalt. These are called magnetic materials. Materials that are not attracted towards magnet are -magnetic

POLES OF MAGNET

- Each magnet has two magnetic poles-North and South and they are called dipoles. A magnet with a single pole doesn't exist. Since poles have high magnetic power, they attract objects easily. The poles of a magnet are named as the north pole and the south pole in order to identify the poles, the north pole is usually painted in red colour The other end of the magnet will, therefore, be the south pole. In laboratories, magnets are painted completely red in colour with a white dot to indicate the north pole The other end will, therefore, be the south pole. A magnet can be cut pieces Each piece will behave like an independent magnet, with a north pole and a south pole
- A freely suspended magnet always aligns in N-S direction. Opposite poles of two magnets attract each other whereas similar poles repel one another

WINDS, STORMS AND CYCLONES

Air Pressure

- The pressure exerted by air on all bodies at all times in all directions is called air pressure When air moves at high speeds, it creates a low pressure area.
- On heating the air expands and occupies more space. When the same thing occupies more space, it becomes lighter. The warm air is, therefore, lighter than the cold air
- Air expands on heating and contracts on cooling
- Warm air rises up whereas comparatively cooler air tends to sink towards the Earth's surface
- As warm air rises, air pressure at that place is reduced and the cooler air moves to that place.

Wind

- The moving air is called the wind Winds are caused by variations in air pressure
- A wind blows from a region of high pressure to a region of low pressure
- The speed of the wind mainly depends on the difference between pressures of the air in the two regions
- A change in direction of wind is caused by the rotation of the earth
- The instrument that measures the wind speed is called an anemometer.
- Winds moving at high speeds are known as gales

Thunderstorms

- A storm with lightning and thunder.
- Thunderstorms develop in hot humid tropical areas like India very frequently
- The rising temperatures produce strong upward rising winds These winds carry water droplets upwards, where they freeze, and fall down again. The swift movement of the falling water droplets along with the rising air create lightning and sound. It is this event that we call a thunderstorm

Cyclone

- High-speed winds and air pressure difference can cause cyclones
- Before cloud formation water takes up heat from the atmosphere to change into vapour. When water vapour changes back to liquid form as raindrops, this heat is released to the atmosphere. The heat released to the atmosphere warms the air around. The air tends to rise and causes a drop in pressure More air rushes to the centre of the storm. This cycles repeated
- The chain of events ends with the formation of a very low pressure system with very high-speed winds revolving around it. It is this weather condition that we call a cyclone
- The formation of a cyclone depends on the speed and direction of the wind, temperature and humidity A cyclone is known by different names in different parts of the world, it is called a hurricane in the American continent. In Philippines and japan, it is called a typhon
- The calm and clear area at the centre of a cyclone is called the eye of the Cyclone

Humidity

- Humidity is the amount of water vapour in the atmosphere As the humidity in a region increases the difference in temperature also increases. This results in the formation of a cyclone

Tornado

- A dark funnel shaped cloud that reaches from the sky to the ground. A tornado may form within a cyclone
- A tornado forms due to the effect of low pressure in the eye of a cyclone
- In India they are not very frequent Most occur in the United States
- Tornadoes occur regularly in the regions around the Atlantic Ocean
- Weak tornadoes travel with wind speeds of 50 to 60 km/hr, while a Violent tornado can travel at a speed of about 300 km/hr

HEAT

Temperature

- The degree or intensity of heat present in a substance or object, especially as expressed according to a comparative scale and shown by a thermometer or perceived by touch
- Temperature is measured in different scales, including Fahrenheit F) and Celsius (or centigrade, C).
- The units of the Fahrenheit and Celsius scales are called degrees
- The normal temperature of human body is 37°C

Thermometer

- Temperature is measured by a device called thermometer
- Clinical thermometer is used to measure our body temperature. The range of this thermometer is from 35°C to 42°C For other purposes, we use the laboratory thermometers The range of these thermometers is usually from - 10°C to 110°C
- India has adopted the celsius scale The other scale with the range 94-108 degrees is the Fahrenheit scale
- The temperature of human body normally does not go below 35°C or above 42°C
- There is kink near the bulb in clinical thermometer which prevent mercury level from falling on its own

Temperature

- There are three ways in which heat can flow from one object to another
- These are conduction convection and radiation in all cases heat flows from a hotter object to a colder object
- The process by which heat is transferred from the hotter end to the colder end of an object is known as conduction
- The materials which allow heat to pass through them easily are conductors of Heat
- Poor conductors are known as insulators such as Plastic and Heat
- The water and air are poor conductors of heat
- When water is heated, the water near the flame gets hot Hot water rises up. The cold water from the sides moves down towards the source of heat. This water also gets hot and rises and water from the sides moves down. This process continues till the whole water gets heated. This mode of heat transfer is known as convection.
- Convection is the process in which heat moves through a gas or liquid as the hotter part rises and the cooler, heavier part sinks
- In solids, generally, the heat is transferred by conduction in liquids and gases, the heat is transferred by convection No medium is required for transfer of heat by radiation.
- From the sun the heat comes to us by another process known as radiation The transfer of heat by radiation does hot require any medium Sea Breeze and Land Breeze
- During the day in the coastal areas, the land gets heated faster than the water. The air over the land becomes hotter and rises up. The cooler air from the sea rushes in towards the land to take its place The warm air from the land moves towards the sea to complete the cycle. The air from the sea called the sea breeze
- At night is exactly the reverse. The water cools down more slowly than the land. So, the cool air from the land moves towards the sea. This is called the land breeze

MOTION AND TIME

Speed and Time

- The Speed is the total distance covered divided by the total time taken if the speed of an object moving along a straight line keeps changing its motion is said to be non-uniform
- An object moving along a straight line with constant speed is said to be in uniform motion
- The basic unit for time is second and it can be calculated in minutes and hours, too, dependent on the need

- The basic unit for distance is metre So, the unit for speed is metres per second (m/s
- Large speeds are measured in kilometre per hour (km/h). The symbols for units are written in singular form only

Measurement of Time

- The time between one sunrise and the next was called a day. Similarly, a month was measured from one new moon to the next
- A year was fixed as the time taken by the earth to complete one revolution of the sun Oscillation
- Movement back and forth in a regular rhythm The to and fro motion of a simple pendulum is an example of a periodic or an y motion

Speedometer and Odometer

- Speedometer is an instrument used in vehicles to show speed It records the speed directly in km/h
- An odometer is a device on vehicles to track distance covered

ELECTRIC CURRENT AND ITS EFFECTS

Electrical Circuit

- A closed path formed by interconnection of electrical components through which electric current flows is called an electrical circuit

Battery

- A combination of two or more cells connected together is called a battery it is formed by connecting the positive terminal of one cell to the negative terminal to another

Heating Effect of Electric Current

- When an electric current flow through the filament of a bulb it generates heat, and so the bulb becomes hot. This is the heating effect of the electric current

Heating Elements

- The electric appliances have coils of wire that produce heat, which are known as heating elements.
- As current flows through these electrical appliances, the coils of wire inside turn bright orange red in colour. This is because a huge amount of heat is produced
- The electric fuse works on the principle of the heating effect of electric current. An electric fuse is a safety device to prevent damage to an electrical circuit when excessive current flows through it

Miniature Circuit Breakers (MCB)

- Instead of fuses, MCBS are used nowadays because these are switches that turn off automatically when there is an overload or a short circuit After solving the problem in the circuit, the switch can be turned back on and then the current flows as usual

LIGHT

Reflection of Light

- When light falls on a mirror, the mirror changes the direction of light that fails on it This change of direction by a mirror is called reflection of light The path of light is always straight and never curved. Light doesn't bend
- Due to the reflection of light the impression of an object formed in a mirror is called the image of the object As the distance of the object from the mirror increases the distance of the image also increases images that cannot be captured on a screen are called virtual images
- An image formed by a plane mirror is erect and of the same size as the object. In a plane mirror the image is formed behind the mirror it is at the same distance from the mirror as the object is in front of it
- In an image formed by a mirror, the left side of the object is seen on the right side in the image and right side of the object appears to be on the left side in the image

Spherical Mirrors

- These have curved reflecting surfaces and are also called curved mirrors These mirrors are made from a hollow sphere
- There are two types of curved surfaces at each hemisphere. The inner curved surface is termed as concave while the outer is called convex
- Spherical mirrors are different from plane mirrors due to their reflecting Surface
- A concave mirror can form a real and inverted image When the object is placed very close to the mirror, the image formed is virtual erect and magnified.
- Image formed by a convex mirror is erect, virtual and smaller in size than the object
- Concave mirrors are used for many purposes. You might have seen doctors using concave mirrors for examining eyes, ears, nose and throat
- Concave mirrors are also used by dentists to see an enlarge image of the teeth. The reflectors of torches, headlights of cars and scooters are concave in shape
- The mirrors used as side mirrors in automobiles are convex mirrors. Convex mirrors can form images of objects spread over a large area. So, these help the drivers to see the traffic behind them Images formed by Lenses
- Lenses are widely used in spectacles, telescopes and microscopes
- Those lenses which feel thicker in the middle than at the edges are convex lenses
- Those which feel thinner in the middle than at the edges are concave lenses
- The lenses are transparent and light can pass through them.

Rainbow

It appears usually after the rain when the sun is low in the sky The rainbow is seen as a large arc in the sky with many colours

There are seven colours in a rainbow. These are red orange, yellow, green,blue, indigo and violet. The sunlight is said to be white light. This means the white light consists of seven colours.

WEATHER, CLIMATE AND ADAPTATIONS OF ANIMALS TO CLIMATE

Weather

- The day to day condition of the atmosphere at a place with respect to the temperature, humidity, rainfall, wind-speed, etc, is called the weather at that place. The temperature, humidity, and other factors are called the elements of the weather
- The sun is responsible for all the changes in the weather. The sun is a huge sphere of hot gases and has a very high temperature
- The sun is the chief source of light and heat for the earth. It is also the primary source of energy and causes changes in the weather
- The energy absorbed and reflected by the earth& earth's surface, the oceans and the atmosphere play an important role in determining the weather at any place Also, gases like carbon dioxide, methane and water vapour play role in determining the weather
- Rainfall is measured by an instrument called the rain gauge it is basically a measuring cylinder with a funnel on top to collect rainwater

Climate

- The average weather pattern taken over a long time, say 25 years, is called the climate of the place

Types of Climate

- There are five major types of climates are recognised, based on the annual and monthly averages of temperature and precipitation Moist Tropical Climates are known for their high temperatures and large amount of rain around the year
- Dry Climates are characterised by little rain and a high daily temperature Range
- Humid Middle Latitude Climates have warm, dry summers, and cool, wet Winters

- Continental Climate is characterised by winter temperatures low enough to support a fixed period of snow cover every year, a relatively moderate precipitation occurring mostly in summer, and an even distribution of precipitation
- Polar areas have cold climates as they are covered by ice almost all the year round. Most areas are covered by glaciers or by a semi-permanent layer of ice.
- The polar regions are very cold throughout the year The sun does not set for six months in a year and in the other six months it does not rise

Adaptation

- The tropical and the polar regions are the two regions of the earth, which have severe climatic conditions.
- Animals are adapted to the conditions in which they live
- Animals (Polar bears, Penguins etc) in the polar region are adapted to the extremely cold climate by having some special characteristics such as white fur, strong sense of smell a layer of fat under the skin,wide and large paws for swimming and walking, etc

Force and Pressure

- In science, a push or a pull on an object is called a force the motion imported to objects was due to the action of a force.
- At least two objects must interact for a force to come into play. Thus, an Interaction of one object with another object results in a force between the two objects.
- *Exploring Forces:* A force could be larger or smaller than the other. The strength of a force is usually expressed by its magnitude.
- In general, more than one force may be acting on an object. However, the effect on the object is due to the net force acting on it.

A force can change the state of motion:

- A force applied on an object may change its speed. If the force applied on the object is in the direction of its motion, the speed of the object increases. If the force is applied in the direction results in decrease in the speed or to the direction of motion, then it the object.
- A change in either the speed of an object, or its direction of motion, or both, is described as a change in its state of motion. Thus, a force may bring a change
- In the state of motion of an object State of motion of an object is described by its speed and the direction of motion. The state of rest is considered to be the state of zero speed. An object may be at rest or in motion: both are its states of motion.

Force can change the shape of an object:

- A force may make an object move from rest
- May change the speed of an object if it is moving
- May change the direction of motion of an object.
- May bring about a change in the shape of an object

Contact forces

- Muscular Force: The force resulting due to the action of muscles. Animals also make use of muscular force to carry out their physical activities and other tasks
- Since muscular force can be applied only when it is in contact with an object, it is also called a contact force.
- Friction: The force responsible for changing the state of motion of objects is the force of friction. The force of friction always acts on all the moving objects and its direction is always opposite to the direction of motion. Since the force of friction arises due to contact between surfaces, it is also an example of a contact force.
- The force exerted by a charged body on another charged or uncharged body is known as electrostatic force. This force comes into play even when the bodies are not in contact
- Gravitational Force: objects or things fall towards the earth because it pulls them. This force is called the force of gravity. This is an attractive force it acts on all objects

- Pressure: The force acting on a unit area of a surface is called pressure. Pressure = force area on which it acts
- Liquids and gases exert pressure on the walls of their containers The pressure exerted by air around us is known as atmospheric pressure.

Friction

- Friction is caused by the irregularities on the two surfaces in contact. Even those surfaces which appear very smooth have a large number of minute Irregularities on them.
- Irregularities on the two surfaces lock into one another. When we attempt to move any surface, we have to apply a force to overcome interlocking. On rough surfaces there are a larger number of irregularities. So the force of friction is greater if a rough surface is involved.
- The force required to overcome friction at the instant an object starts moving from rest is a measure of static friction on the other hand, the force required to keep the object moving with the same speed is a measure of sliding friction

Friction: A necessary Evil

- If an object started moving. It would never stop if there were no friction. Had there been no friction between the tyres of the automobiles and the road, they could not be started or stopped or turned to change the direction of motion.
- On the other hand, friction is an evil, too it wears out the materials whether they are screws, ball bearings or soles of shoes, friction can also produce heat.
- Increasing and reducing Friction: We want to reduce friction in order to increase efficiency. When oil, grease or graphite is applied between the moving parts of a machine, a thin layer is formed there and moving surfaces do not directly rub against each other
- The substances which reduce friction are called lubricants. In some machines, it may not be advisable to use oil as lubricant. An air cushion between the moving parts is used to reduce friction
- When one body rolls over the surface of another body, the resistance to its motion is called rolling friction. Rolling reduces friction. It is always easier to roll than to slide a body over another.
- Since the rolling friction is smaller than the sliding friction, sliding is replaced in most machines by rolling by the use of ball bearings. In many machines, friction is reduced by using ball bearings.
- The frictional force exerted by fluids is also called drag. The force on an object in a liquid depends on its speed with respect to the fluid. The frictional force also depends on the shape of the object and the nature of the fluid.
- Fluid friction can be minimised by giving suitable shapes to bodies moving in fluids

Sound

- Sound plays an important role in our lives. It helps us to communicate with one another. We hear a variety of sounds in our surroundings.

Sound is produced by vibrating objects

- The to and fro or back and forth motion of an object is called Vibration.
- In some cases, the vibrations are easily visible to us. But in most cases, their amplitude is so small that we cannot see them. However, we can feel them.
- Sound needs a medium for propagation: Sound travels through a medium
- We hear sound through our Ears. The shape of the outer part of the ear is like a funnel. When sound stretched tightly. It is called the eardrum Systems

Amplitude, Time Period and Frequency of a Vibration:

- The to and fro motion of an object is known as vibration. This motion is also called oscillatory motion
- The number of oscillations per second is called the frequency of oscillation. Frequency is expressed in hertz. Its symbol is H
- Amplitude and frequency are two important properties of any sound.

Loudness and Pitch:

- The loudness of sound depends on its amplitude. When the amplitude of vibration is large, the sound produced is loud. When the amplitude is small, the sound produced is feeble.
- The frequency determines the shrillness or pitch of a sound. If the frequency of vibration is higher we say that the sound is shrill and has a higher pitch

Audible and Inaudible Sounds

- The fact is that sounds of frequencies less than about 20 vibrations per second (20Hz) cannot be detected by the Human ear, such sounds are called inaudible. On the higher side, sounds of frequencies higher than about 20,000 vibrations per second (20 KHz) are also not audible to the human ear. Thus, for human ear, the range of audible frequencies is roughly from 20 to 20,000 Hz.
- Some animals can hear sounds of frequencies higher than 20,000 Hz. Dogs have this ability the ultrasound equipment, familiar to us for investigating and tracking many medical problems, works in frequencies higher than 20,000 Hz.
- Unpleasant sounds are called noise. Excessive or unwanted sounds lead to noise pollution. It may pose health problems for human beings

Light

- Eyes alone cannot see any object. It is only when light from an object enters our eyes that we see the object. The light may have been emitted by the object, or may have been reflected by it

Laws of Reflection:

- The light ray, which strikes any surface, is called the incident ray. The ray that comes back from the surface after reflection is known as the reflected ray
- A ray of light is an idealization. In reality, we have a narrow beam of light which is made up of several rays. For simplicity, we use the term ray for a narrow beam of light.

Angle of incidence and angle of erection

- The angle of incidence is always equal to the angle of reflection. This is known as the law of reflection.
- The incident ray, the normal at the point of incidence and the reflected ray all lie in the same plane. This is another law of reflection
- An Image formed by a mirror the left of the object appears on the right and the right appears on the left. This is known as lateral inversion.
- Regular and Diffused Reflection: When all the parallel rays reflected from a plane surface are not parallel, the reflection is known as diffused or irregular reflection. On the other hand, reflection from a smooth surface like that of a mirror is called regular reflection.
- Nearly everything we see around is seen due to reflected light. E.g. moon. The objects which shine in the light of other objects are called illuminated objects.
- The objects which emit their own light are known as luminous objects
- Image formed in a plane mirror undergoes lateral inversion.
- Two mirrors inclined to each other give multiple images
- Beautiful patterns are formed in a kaleidoscope because of multiple reflections
- Sunlight, called white light, consists of seven colours

Stars and the Solar System

- The stars, the planets, the moon and many other objects in the sky are called celestial objects.
- The Moon: The day on which the whole disc of the moon is visible is known as the full moon day. Thereafter, every night the bright part of the moon appears to become thinner and thinner. On the fifteenth day the moon is not visible. This day is known as the new moon day
- The next day, only a small portion of the moon appears in the sky. This is known as the crescent moon. Then again the moon grows larger every day. On the fifteenth day once again we get a full view of the moon. The time period between one full moon and the other full moon is slightly longer than 29 days. In many calendars this period is called a month

- The moon completes one rotation on its axis as it completes one revolution around the earth.
- The Moon's surface is dusty and barren. There are many craters of different sizes. It also has a large number of steep and high mountains. Some of these are as high as the highest mountains on the earth.
- The moon has no atmosphere. It has no water. On July 21, 1969 (Indian time) the American Astronaut, Neil Armstrong, landed on the moon for the first time. He was followed by Edwin Aldrin.
- The Stars: Stars are celestial bodies that emit light their own. Our sun is also a star
- The sun is nearby 150 million km way from the Earth. The next nearest stars Alpha Centauri It is at a distance of about 40,000,000,000,000 km from the earth.
- Such large distances are expressed in another unit known as light year. It is the distance travelled by light in one year. The distance of Alpha Centauri is about 4.3 light years.
- Stars appear to move from East to West. The pole star appears to be stationary from the Earth, because it is situated close to the direction of the axis of rotation of the earth.
- The stars forming a group that has a recognisable shape is called a constellation. Eg Ursa Major, also known as the Big Dipper, the Great Bear or the Saptarshi.
- Orion is another well-known constellation that can be seen during winter in the late evenings. It is also called the hunter. The star Sirius, which is the brightest star in the sky, is located close to Orion.
- Cassiopeia is another prominent constellation in the Northern sky. It is visible during winter in the early part of the night.
- The Sun: The sun is the nearest star from us. It is continuously emitting huge amounts of heat and light
- The Planets: In 2006, the International Astronomical Union (IAU) adopted a new definition of a planet. Pluto does not fit this definition. It is no longer a planet of the solar system.
- Planets do not have light of their own. A planet has a definite path in which it revolves around the sun. This path is called an orbit. The period of revolution increases as the distance of the planet increases from the sun.
- Besides revolving around the sun, a planet also rotates on its own axis. The time taken by a planet to complete one rotation is called its period of rotation.
- Some planets are known to have moons/satellites revolving round them. Any celestial body revolving around another celestial body is called its satellite.

  Eg. moon is a satellite of the earth. There are many man-made satellites revolving round the earth. These are called artificial satellites

(1) Mercury (Budh):

- It is nearest to the sun and smallest planet of our solar. Mercury has no satellite of its own. Because it is very close to the sun, it is very difficult to observe it, as most of the time it is hidden in the glare of the sun.

(2) Venus (Shukra):

- Venus is earth's nearest planetary neighbor. It is the
- brightest planet in the night sky. Sometimes venus appears in the eastern sky before sunrise. Sometimes it appears in the Western sky just after sunset. Therefore it is often called a morning or an evening star, although it is not a star. It has no moon.

(3) The earth (Prithvi)

- The earth is the only planet in the solar system on which life is known to exist. Mainly because it is just the right distance from the sun, so that it has the right temperature range, the presence of water and suitable atmosphere and a blanket of ozone. The axis of rotation of the earth is not perpendicular to the plane of its orbit. The tilt is responsible for the change of seasons on the Earth.

(4) Mars (Mangal):

- The next planet, the first outside the orbit of the earth is mars. It appears slightly reddish and, therefore, it is also called the red planet. Mars has two small natural satellites.

(5) Jupiter (Brihaspati):

- It is the largest planet and so large that about 1300 earth's can be placed inside this giant planet, it rotates very rapidly on its axis, it has a large number of satellites. It also has faint rings around it.

(6) Saturn (Shani)

- Beyond Jupiter is Saturn which appears yellowish in colour. It has beautiful rings. Saturn also has a large number of satellites. It is the least dense among all the planets. Its density is less than that of water.

Matter in Our Surroundings

- Everything in this universe is made up of material which scientists have named & quote . The air we breathe, the food we eat, stones everything is matter. All such things occupy and have mass, In other words, they have both mass and volume
- Early Indian philosophers classified matter in the form of five basic elements, the Panch Tatva- air, earth, fire, sky and water. According to them everything, living or non-living, was made up of these five basic elements Ancient Greek philosophers had arrived at a similar classification of matter
- Modern day scientists have evolved two types of classification of matter based on their physical properties and chemical nature.

Physical Nature of Matter

- Matter is made up of particles For a long time, two schools of thought prevailed regarding the nature of matter. One school believed matter to be contiguous like a rick of wood, whereas, the other thought that matter was made up of particles like sand Eg when we dissolve salt water, the particles of salt get into the spaces between particles of water.
- The particles of matter are very small-they are small beyond our imagination!! Characteristics of Particles of Matter
- Particles of matter have space between them: When we make tea. lemonade, particles of one type of matter get into the spaces between particles of the other. This shows that there is enough space between particles of matter
- Particles of matter are continuously moving, that is, they possess what are call the kinetic energy. As the temperature rises particles move faster. So we can say that with increase in temperature the kinetic energy of the particles also increases
- The intermixing of particles of two different types of matter on their own is called diffusion. We also observe that on beating, diffusion becomes faster
- Particles of matter attract each other- the particles of matter we force acting between them. This force of this force of attraction varies from one kind of matter to another

States of Matter

- The matter around us exists in three different states Solid, Liquid and Gs. These states of matter arise due to the variation in the characteristics of the particles of matter

The Solid State

- Solids have a definite shape, distinct boundaries and fhted volumes, that is, huge negligible compressibility, solids have a tendency to maintain the shape when subjected to outside force. Solids may break under force but it is difficult to change shape, so they are rigid

The Liquid State

- Liquid have no fixed shape but have a fired volume. They take up the shape of the container in which they are kept. Liquids flow and change shape, so they are not rigid but can be called fluid
- Solids and liquids can diffuse into liquids. The gases from the atmosphere diffuse and dissolve in water. These gases, especially oxygen and carbon dioxide, are essential for the survival of aquatic animals and plants

The Gaseous State

- Gases are highly compressible as compared to solids and liquids. The LPG cylinder that we get in our home for cooking or the oxygen supplied to hospitals in cylinders is compressed gas. CNG used as fuel these days in vehicles. Due to its high compressibility, age volumes of a gas can be compressed into a small cylinder and transported easily.

- In the gaseous state, the particles move about randomly at high speed. Due to this random movement, the particles hit each other and also the walls of the container. The pressure exerted by the gas is because of this force exerted by gas particles per unit area on the walls of the container

Effect of Change of Temperature

- On increasing the temperature of solids, the kinetic energy of the particles increases
- Due to the increase in kinetic energy, the particles start vibrating with greater speed
- The energy supplied by heat overcomes the forces of attraction between the particles
- The particles leave their fixed positions and start moving more freely. A stage is watch when the solid melts and is converted to a liquid. The minimum temperature at which a solid melts to become liquid at the atmospheric pressure is called its melting point. The melting point of solid is an indication of the strength of the force of attraction between its particles
- The melting point of ice is 273.15 K. The process of melting, that is change of solid state into liquid state is also known as fusion. When a solid melts, its temperature remains the same
- Kevin is the SI unit of temperature. To change a temperature on the Kelvin scale to the Celsius scale you have to subtract 273 from the given temperature, and to convert a temperature on the Celsius scale to the Kelvin scale you have to add 273 to the given temperature
- The word latent means hidden. The amount of heat energy that is required to change 1 kg of a solid into liquid at atmospheric pressure at its melting point is known as the latent heat of fusion.
- The temperature at which a liquid starts boiling at the atmospheric pressure is known as its boiling point. Boiling is a bulk phenomenon. Particles from the balk of the liquid gain enough energy to change into the vapor state.
- A change of state directly from solid to gas without changing into liquid state is called sublimation and the direct change of gas to solid without changing into liquid is called deposition

Effect of Change of Pressure

- Applying pressure and reducing temperature in liquefy gases
- Solid Carbon dioxide gets converted directly to gaseous state on decrease of pressure to 1 atmosphere without coming into liquid state. This is the reason that solid carbon dioxide is also known as dry ice.
- We can say that pressure and temperature determine the state of a substance, whether it will be solid, liquid or gas

Mixture

- Mixtures are constituted by more than one kind of pure form of matter. Mixtures .can be separated into pure substances using appropriate separation techniques

Types of mixtures

- Depending upon the nature of the components that form a mixture have different Solution
- A solution is a homogeneous mixture of two or more substances. We can also have solid solutions (alloys) and gaseous solutions. In solution there is homogeneity at the particle level

Alloys

- Alloys are mixtures of two or more metals or alloy and metal and cannot be separated into their components by physical methods. But still an alloy is considered as a because it shows the properties of its constituents variable composition

Solution

- A solution has a solvent and a solute as its components. The component of the solution that dissolves the other component in it usually the component present in larger amount) is called the solvent. The component of the solution that is dissolved in the solvent (usually present in lesser quantity is called the solute
- A solution of sugar in water is a solid in liquid solution. In this solution, sugar is the solute and water is the solvent

Suspension

- Materials that are insoluble in a solvent and have particles that are visible to naked eyes, form a suspension A suspension is a heterogeneous mixture Properties of a Suspension
- The particles of a suspension scatter a beam of light passing through it and make its path visible
- The solute particles settle down when a suspension is left undisturbed, that is, a suspension is unstable. They can be separated from the mixture by the process of filtration.
- When the particles settle the suspension brakes and it does not scatter light any more

Colloidal Solution

- The particles of a colloid are uniformly spread throughout the solution, Due to the relatively smaller size of particles, as compared to that of a Suspension, the mixture appears to be homogeneous. But actually, a colloidal solution is a heterogeneous picture, for example, milk.
- Because of the small size of colloidal particles, we cannot see them with naked eyes, But, these particles can easily scatter a beam of visible light. Such scattering of a beam of light is called the Tyndall effect
- Tyndall effect can also be observed when a fine beam of light enters a room through a small hole. This happens due to the scattering of light by the particles of dust and smoke in the air.

Properties of a Colloid

- A colloid is a heterogeneous mixture
- The size of particles of a colloid is too small to be individually seen by naked Eyes
- Colloids are big enough to scatter a beam of light passing through it and make its path visible.
- They do not settle down when left undisturbed, that is a colloid is quite stable
- They cannot be separated from the mixture by the process of filtration. But a special technique of separation known as centrifugation can be used to separate the colloidal particles

LIGHT - REFLECTION AND REFLECTION

Reflection of Light

- A highly polished surface, such as a mirror, reflects most of the light falling on it. Laws of reflection of light:
- – The angle of incidence is equal to the angle of reflection, and
- – The incident ray, the normal to the mirror at the point of incidence and the reflected ray, all lie in the same plane.
- These laws of reflection are applicable to all types of reflecting surfaces including spherical surface
- Image formed by a plane mirror is always virtual and erect. The size of the image is equal to that of the object. The image formed is as far behind the mirror as the object is in front of it. Further, the image is laterally inverted.

Spherical Mirrors

- The mirrors whose reflecting surfaces are spherical, are called spherical mirrors. The reflecting surface of a spherical mirror may be curved inwards or outwards. A spherical mirror, whose reflecting surface is curved inwards, that is, faces towards the centre of the sphere, is called a concave mirror. A spherical mirror whose reflecting surface is curved outwards, is called a convex mirror.
- The reflecting surface of a spherical mirror forms a part of a sphere. This sphere has a centre. This point is called the centre of curvature of the spherical mirror. It is not part of the mirror. The centre of curvature of a concave mirror lies in front of it. However, it lies behind the mirror in case of a convex mirror.

Uses of concave mirrors

- Concave mirrors are commonly used in torches, search-lights and vehicles headlights to get powerful parallel beams of light. They are often used as shaving mirrors to see a larger image of the face. The dentists use concave mirrors to see large images of the teeth of patients. Large concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.

Uses of convex mirrors

- Convex mirrors are commonly used as rear-view (wing) mirrors in vehicles. These mirrors are fitted on the sides of the vehicle, enabling the driver to see traffic behind him/her to facilitate safe driving. Convex mirrors are preferred because they always give an erect, though diminished, image. Also, they have a wider field of view as they are curved outwards. Thus, convex mirrors enable the driver to view much larger area than would be possible with a plane mirror.

Mirror Formula and Magnification

- In a spherical mirror, the distance of the object from its pole is called the object distance(u). The distance of the image from the pole of the mirror is called the image distance (v). The distance of the principal focus from the pole is called the focal length (f). There is a relationship between these three quantities given by the mirror formula which is $1/v + 1/u = 1/f$
- This formula is valid in all situations for all spherical mirrors for all positions of the object.
- Magnification produced by a spherical mirror gives the relative extent to which the image of an object is magnified with respect to the object size. It is expressed as the ratio of the height of the image to the height of the object. It is usually represented by the letter m.
- A negative sign in the value of the magnification indicates that the image is real. A positive sign in the value of the magnification indicates that the image is virtual.

Refraction of Light

- When travelling obliquely from one medium to another, the direction of propagation of light in the second medium changes. This phenomenon is known as refraction of light.
- A coin, kept in a bowl full of water, appears slightly raised above its actual position due to refraction of light.
- The following are the laws of refraction of light.

1. The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
2. The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of refraction

- If i is the angle of incidence and r is the angle of refraction, then,
- Sin i/Sin r = constant.
- This constant is called the refractive index of the second medium with respect to the first.

Refractive Index

- The extent of the change in direction that takes place in a given pair of media may be expressed in terms of the refractive index
- The refractive index can be linked to an important physical quantity, the relative speed of propagation of light in different media. It turns out that light propagates with different speeds in different media. Light travels fastest in vacuum with speed of 3×108 m s–1. In air, the speed of light is only marginally less, compared to that in vacuum. It reduces considerably in glass or water. The value of the refractive index for a given pair of media depends upon the speed of light.
- The refractive index of medium 2 with respect to medium 1 is given by the ratio of the speed of light in medium 1 and the speed of light in medium 2. This is usually represented by the symbol n21. This can be expressed in an equation form as n21=speed of light in medium 1/speed of light in medium 2
- An optically denser medium may not possess greater mass density. For example, kerosene having higher refractive index, is optically denser than water, although its mass density is less than water.
- The speed of light is higher in a rarer medium than a denser medium. Thus, a ray of light travelling from a rarer medium to a denser medium slows down and bends towards the normal. When it travels from a denser medium to a rarer medium, it speeds up and bends away from the normal.

Refraction by Spherical Lenses

- When several rays of light parallel to the principal axis fall on a convex lens, they converge to a point on the principal axis, after refraction from the lens. This point on the principal axis is called the principal focus of the lens.
- When several rays of light parallel to the principal axis fall on a concave lens, they appear to diverge from a point on the principal axis, after refraction from the lens. This point on the principal axis is called the principal focus of the concave lens.
- A lens has two principal foci. They are represented by F1 and F2. The distance of the principal focus from the optical centre of a lens is called its focal length.
- A concave lens will always give a virtual, erect and diminished image, irrespective of the position of the object.

Power Of A Lens

- The power of a lens is defined as the reciprocal of its focal length. It is represented by the letter P. The power P of a lens of focal length f is given by $P = (1/f)$
- The SI unit of power of a lens is 'dioptre'. It is denoted by the letter D. If f is expressed in metres, then, power is expressed in dioptres. Thus, 1 dioptre is the power of a lens whose focal length is 1 metre. The power of a convex lens is positive and that of a concave lens is negative.
- Many optical instruments consist of a number of lenses. They are combined to increase the magnification and sharpness of the image. The net power (P) of the lenses placed in contact is given by the algebraic sum of the individual powers P1, P2, P3, ... as $P = P1 + P2 + P3 + \ldots$

THE HUMAN EYE AND THE COLOURFUL WORLD

The Human Eye

- The human eye is like a camera. Its lens system forms an image on a light-sensitive screen called the retina. Light enters the eye through a thin membrane called the cornea. It forms the transparent bulge on the front surface of the eyeball.
- Most of the refraction for the light rays entering the eye occurs at the outer surface of the cornea. The crystalline lens merely provides the finer adjustment of focal length required to focus objects at different distances on the retina.
- Iris is a dark muscular diaphragm that controls the size of the pupil. The pupil regulates and controls the amount of light entering the eye. It acts like a variable aperture whose size can be varied with the help of the iris. When the light is very bright, the iris contracts the pupil to allow less light to enter the eye. However, in dim light the iris expands the pupil to allow more light to enter the eye. Thus, the pupil opens completely through the relaxation of the iris.
- The eye lens forms an inverted real image of the object on the retina. The retina is a delicate membrane having enormous number of light-sensitive cells. The light-sensitive cells get activated upon illumination and generate electrical signals. These signals are sent to the brain via the optic nerves. The brain interprets these signals, and finally, processes the information so that we perceive objects as they are.

Power of Accommodation

- The ability of the eye lens to adjust its focal length is called accommodation. This happens when the curvature is modified using the ciliary muscles. While seeing the distant object, the muscles are relaxed and lens becomes thin. Thus, its focal length increases. This enables us to see distant objects clearly.
- While looking at objects closer to the eye, the ciliary muscles contract. This increases the curvature of the eye lens. The eye lens then becomes thicker. Consequently, the focal length of the eye lens decreases. This enables us to see nearby objects clearly.
- However, the focal length of the eye lens cannot be decreased below a certain minimum limit. The minimum distance, at which objects can be seen most distinctly without strain, is called the least distance of distinct vision. It is also called the near point of the eye. For a young adult with normal vision, the near point is about 25 cm. The farthest point upto which the eye can see objects clearly is called the far point of the eye. It is infinity for a normal eye.

- Sometimes, the crystalline lens of people at old age becomes milky and cloudy. This condition is called cataract. This causes partial or complete loss of vision. It is possible to restore vision through a cataract surgery.
- The need for two eyes: Having two eyes gives a wider field of view. A human being has a horizontal field of view of about 150° with one eye and of about 180° with two eyes. The ability to detect faint objects is, of course, enhanced with two detectors instead of one.
- With one eye shut, we only get a flat two dimensional view. The third dimension of depth is added when both the eyes are open.

DEFECTS OF VISION AND THEIR CORRECTION

(a) Myopia:

- Myopia is also known as near-sightedness. A person with myopia can see nearby objects clearly but cannot see distant objects distinctly. A person with this defect has the far point nearer than infinity.
- In a myopic eye, the image of a distant object is formed in front of the retina and not at the retina itself. This defect may arise due to (i) excessive curvature of the eye lens, or (ii) elongation of the eyeball. This defect can be corrected by using a concave lens of suitable power.

(b) Hypermetropia:

- Hypermetropia is also known as far-sightedness. A person with hypermetropia can see distant objects clearly but cannot see nearby objects distinctly. The near point, for the person, is farther away from the normal near point (25 cm).
- This is because the light rays from a closeby object are focussed at a point behind the retina. This defect arises either because (i) the focal length of the eye lens is too long, or (ii) the eyeball has become too small. This defect can be corrected by using a convex lens of appropriate power.

(c) Presbyopia:

- The power of accommodation of the eye usually decreases with ageing. For most people, the near point gradually recedes away. This defect is called Presbyopia. It arises due to the gradual weakening of the ciliary muscles and diminishing flexibility of the eye lens.

Dispersion of white light by prism

- The prism has probably split the incident white light into a band of colours which is known with the spectrum VIBGYOR (Violet, Indigo, Blue, Green, Yellow, Orange, Red). The band of the coloured components of a light beam is called its spectrum. The splitting of light into its component colours is called dispersion.
- Different colours of light bend through different angles with respect to the incident ray, as they pass through a prism. The red light bends the least while the violet the most. Thus the rays of each colour emerge along different paths and thus become distinct. It is the band of distinct colours that we see in a spectrum.
- Isaac Newton was the first to use a glass prism to obtain the spectrum of sunlight. He tried to split the colours of the spectrum of white light further by using another similar prism.
- When a second identical prism is placed in an inverted position with respect to the first prism and all the colours of the spectrum are allowed to pass through the second prism, a beam of white light emerges from the other side of the second prism.It was this experiment that gave Newton the idea that the sunlight is made up of seven colours.
- Any light that gives a spectrum similar to that of sunlight is often referred to as white light. A rainbow is a natural spectrum appearing in the sky after a rain shower. It is caused by dispersion of sunlight by tiny water droplets, present in the atmosphere. A rainbow is always formed in a direction opposite to that of the Sun. The water droplets act like small prisms. They refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop

ATMOSPHERIC REFRACTION

Twinkling of stars

The twinkling of a star is due to atmospheric refraction of starlight. The atmospheric refraction occurs in a medium of gradually changing refractive index. Since the atmosphere bends starlight towards the normal, the apparent position of the star is slightly different from its actual position. The star appears slightly higher (above) than its actual position when viewed near the horizon. Further, this apparent position of the star is not stationary, but keeps on changing slightly, since the physical conditions of the earth's atmosphere are not stationary.

- As the path of rays of light coming from the star goes on varying slightly, the apparent position of the star fluctuates and the amount of starlight entering the eye flickers – the star sometimes appears brighter, and at some other time, fainter, which is the twinkling effect.
- The planets are much closer to the earth, and are thus seen as extended sources. It can be considered as a collection of a large number of point-sized sources of light, which average out to zero thus nullifying the twinkling effect. Thus planets do not twinkle.

Advance sunrise and delayed sunset

- The Sun is visible to us about 2 minutes before the actual sunrise, and about 2 minutes after the actual sunset because of atmospheric refraction. The apparent flattening of the Sun's disc at sunrise and sunset is also due to the same phenomenon.

SCATTERING OF LIGHT

Tyndall Effect

- The earth's atmosphere is a heterogeneous mixture of minute particles. These particles include smoke, tiny water droplets, suspended particles of dust and molecules of air. When a beam of light strikes such fine particles, the path of the beam becomes visible. The light reaches us, after being reflected diffusely by these particles. The phenomenon of scattering of light by the colloidal particles gives rise to Tyndall effect.
- The colour of the scattered light depends on the size of the scattering particles. Very fine particles scatter mainly blue light while particles of larger size scatter light of longer wavelengths. If the size of the scattering particles is large enough, then, the scattered light may even appear white.

Why is the colour of sky blue

- The molecules of air and other fine particles in the atmosphere have size smaller than the wavelength of visible light. These are more effective in scattering light of shorter wavelengths at the blue end than light of longer wavelengths at the red end.
- The red light has a wavelength about 1.8 times greater than blue light. Thus, when sunlight passes through the atmosphere, the fine particles in air scatter the blue colour (shorter wavelengths) more strongly than red. The scattered blue light enters our eyes.
- If the earth had no atmosphere, there would not have been any scattering. Then, the sky would have looked dark. The sky appears dark to passengers flying at very high altitudes, as scattering is not prominent at such heights.

Colour of the Sun at Sunrise and Sunset

- Light from the Sun near the horizon passes through thicker layers of air and larger distance in the earth's atmosphere before reaching our eyes
- However, light from the Sun overhead would travel relatively shorter distance. At noon, the Sun appears white as only a little of the blue and violet colours are scattered. Near the horizon, most of the blue light and shorter wavelengths are scattered away by the particles. Therefore, the light that reaches our eyes is of longer wavelengths. This gives rise to the reddish appearance of the Sun.

ELECTRICITY

Electric Current and circuit

- Electric current is expressed by the amount of charge flowing through a particular area in unit time. In other words, it is the rate of flow of electric charges. In circuits using metallic wires, electrons constitute the flow of charges.
- Conventionally, in an electric circuit the direction of electric current is taken as opposite to the direction of the flow of electrons, which are negative charges.
- If a net charge Q, flows across any cross-section of a conductor in time t, then the current I, through the cross-section is I=Q/t. The SI unit of electric charge is coulomb (C), which is equivalent to the charge contained in nearly 6×10^{18} electrons.
- The electric current is expressed by a unit called ampere (A), named after the French scientist, Andre-Marie Ampere (1775–1836). One ampere is constituted by the flow of one coulomb of charge per second, that is, 1 A = 1 C/1 s.
- An instrument called ammeter measures electric current in a circuit. It is always connected in series in a circuit through which the current is to be measured.

Electric Potential and Potential Difference

- For flow of charges in a conductor, a difference of electric pressure called potential difference, is required. This difference of potential may be produced by a battery, consisting of one or more electric cells.
- The electric potential difference between two points in an electric circuit carrying some current is defined as the work done to move a unit charge from one point to the other.
- Potential difference (V) between two points = Work done (W)/Charge (Q) V = W/Q. The SI unit of electric potential difference is volt (V), named after Alessandro Volta. One Volt is the potential difference between two points in a current carrying conductor when 1 joule of work is done to move a charge of 1 coulomb from one point to the other.
- The potential difference is measured by means of an instrument called the voltmeter. The voltmeter is always connected in parallel across the points between which the potential difference is to be measured.

OHM's Law

- German physicist Georg Simon Ohm (1787–1854) found out the relationship between the current I, flowing in a metallic wire and the potential difference across its terminals. The potential difference, V, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. This is called Ohm's law. In other words –
- V=I*R
- R is a constant for the given metallic wire at a given temperature and is called its resistance. It's SI unit is ohm.
- Resistance of the conductor depends (i) on its length, (ii) on its area of cross-section, and (iii) on the nature of its material. Precise measurements have shown that resistance of a uniform metallic conductor is directly proportional to its length (l) and inversely proportional to the area of cross-section (A).

Resistance of a system of resistors

- In a series combination of resistors the current is the same in every part of the circuit or the same current through each resistor.
- The total potential difference across a combination of resistors in series is equal to the sum of potential difference across the individual resistors. That is, v =V1+v2+v2+…
- We can conclude that when several resistors are joined in series, the resistance of the combination Rs equals the sum of their individual resistances, R1, R2, R3, and is thus greater than any individual resistance.
- When the resistors are connected in parallel, the total current I, is equal to the sum of the separate currents through each branch of the combination. The reciprocal of the equivalent resistance of a group of resistances joined in parallel is equal to the sum of the reciprocals of the individual resistances.

- As the current is constant throughout the electric circuit connected in series, it is obviously impracticable to connect an electric bulb and an electric heater in series, because they need currents of widely different values to operate properly.
- Another major disadvantage of a series circuit is that when one component fails the circuit is broken and none of the components works.
- On the other hand, a parallel circuit divides the current through the electrical gadgets. This is helpful particularly when each gadget has different resistance and requires different current to operate properly.

Heating Effect of electric current

- If the electric circuit is purely resistive, that is, a configuration of resistors only connected to a battery; the source energy continually gets dissipated entirely in the form of heat. This is known as the heating effect of electric current. This effect is utilised in devices such as electric heater, electric iron etc.
- The Joule's Law of Heating implies that heat produced in a resistor is (i) directly proportional to the square of current for a given resistance, (ii) directly proportional to resistance for a given current, and (iii) directly proportional to the time for which the current flows through the resistor.
- The electric heating is also used to produce light, as in an electric bulb. Here, the filament must retain as much of the heat generated as is possible, so that it gets very hot and emits light. It must not melt at such high temperature. A strong metal with high melting point such as tungsten (melting point 3380°C) is used for making bulb filaments. The bulbs are usually filled with chemically inactive nitrogen and argon gases to prolong the life of filament. Most of the power consumed by the filament appears as heat, but a small part of it is in the form of light radiated.
- Another common application of Joule's heating is the fuse used in electric circuits. It protects circuits and appliances by stopping the flow of any unduly high electric current. The fuse is placed in series with the device. It consists of a piece of wire made of a metal or an alloy of appropriate melting point. If a current larger than the specified value flows through the circuit, the temperature of the fuse wire increases. This melts the fuse wire and breaks the circuit.

Electric Power

- The rate at which electric energy is dissipated or consumed in an electric circuit is termed as electric power. The SI unit of electric power is watt (W). It is the power consumed by a device that carries 1 A of current when operated at a potential difference of 1 V. Thus,
- $P=VI$;
- $P= I*I*R$; $P=(V*V)/R$
- The commercial unit of electric energy is kilowatt hour (kW h), commonly known as 'unit'.
- 1 kW h = 1000 watt × 3600 second = 3.6×10^6 watt second = 3.6×10^6 joule (J)

Magnetic Effects of Electric Current

Magnetic Field And Field Lines

- The region surrounding a magnet, in which the force of the magnet can be detected, is said to have a magnetic field. The lines along which the iron filings align themselves represent magnetic field lines.
- Magnetic field is a quantity that has both direction and magnitude. The direction of the magnetic field is taken to be the direction in which a north pole of the compass needle moves inside it. Therefore it is taken by convention that the field lines emerge from north pole and merge at the south pole. Inside the magnet, the direction of field lines is from its south pole to its north pole. Thus the magnetic field lines are closed curves.
- The relative strength of the magnetic field is shown by the degree of closeness of the field lines. The field is stronger, that is, the force acting on the pole of another magnet placed is greater where the field lines are crowded.
- No two field-lines are found to cross each other. If they did, it would mean that at the point of intersection, the compass needle would point towards two directions, which is not possible.

MAGNETIC FIELD DUE TO CURRENT CARRYING CONDUCTOR

Magnetic Field Due to current through a Straight conductor

- If the current is increased, the deflection also increases. It indicates that the magnitude of the magnetic field produced at a given point increases as the current through the wire increases.
- The magnetic field produced by a given current in the conductor decreases as the distance from it increases. The concentric circles representing the magnetic field around a current-carrying straight wire become larger and larger as we move away from it.

Right Hand Thumb Rule

- This rule is used in finding the direction of magnetic field associated with a current-carrying conductor.
- If one is holding a current-carrying straight conductor in his right hand such that the thumb points towards the direction of current. Then the fingers will wrap around the conductor in the direction of the field lines of the magnetic field.

Magnetic Field Due to current through a Circular Loop

- At every point of a current-carrying circular loop, the concentric circles representing the magnetic field around it would become larger and larger as we move away from the wire. By the time we reach at the centre of the circular loop, the arcs of these big circles would appear as straight lines.
- As the magnetic field produced by a current-carrying wire at a given point depends directly on the current passing through it. Therefore, if there is a circular coil having n turns, the field produced is n times as large as that produced by a single turn. This is because the current in each circular turn has the same direction, and the field due to each turn then just adds up.

Magnetic Field Due to Current Carrying Solenoid

- A coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder is called a solenoid. The pattern of the magnetic field lines around a current-carrying solenoid is similar to the pattern of magnetic field around a bar magnet
- The field lines inside the solenoid are in the form of parallel straight lines. This indicates that the magnetic field is the same at all points inside the solenoid. That is, the field is uniform inside the solenoid.
- A strong magnetic field produced inside a solenoid can be used to magnetise a piece of magnetic material, like soft iron, when placed inside the coil. The magnet so formed is called an electromagnet. Force on current carrying conductor in a magnetic field
- It is known that the field produced by the current flowing through a conductor exerts a force on a magnet placed in the vicinity of the conductor. French scientist Andre Marie Ampere (1775–1836) suggested that the magnet must also exert an equal and opposite force on the current-carrying conductor.
- The direction of the force on the conductor depends upon the direction of current andthe direction of the magnetic field. Experiments have shown that the displacement of the rod is largest (or the magnitude of the force is the highest) when the direction of current is at right angles to the direction of the magnetic field.
- The three directions can be illustrated through a simple rule, called Fleming's left-hand rule. According to this rule, stretch the thumb, forefinger and middle finger of your left hand such that they are mutually perpendicular. If the first finger points in the direction of magnetic field and the second finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor.
- Devices that use current-carrying conductors and magnetic fields include electric motor, electric generator, loudspeakers, microphones and measuring instruments.

Electric Motor

- An electric motor is a rotating device that converts electrical energy to mechanical energy. Electric motor is used as an important component in electric fans, refrigerators, mixers, washing machines, computers etc.
- A device that reverses the direction of flow of current through a circuit is called a commutator. In electric motors, the split ring acts as a commutator. The reversal of current also reverses the direction of force on the conducting wire.
- The commercial motors use (i) an electromagnet in place of permanent magnet; (ii) large number of turns of the conducting wire in the current-carrying coil; and (iii) a soft iron core on which the coil is wound. The soft iron core, on which the coil is wound, plus the coils, is called an armature. This enhances the power of the motor.

Electromagnetic Induction

- Faraday made an important breakthrough by discovering how a moving magnet can be used to generate electric currents. When the coil and the magnet are both stationary, there is no deflection in the galvanometer. It is, thus, clear from this activity that motion of a magnet with respect to the coil produces an induced potential difference, which sets up an induced electric current in the circuit.
- The process, by which a changing magnetic field in a conductor induces a current in another conductor, is called electromagnetic induction. In practice we can induce current in a coil either by moving it in a magnetic field or by changing the magnetic field around it. It is convenient in most situations to move the coil in a magnetic field.
- The induced current is found to be the highest when the direction of motion of the coil is at right angles to the magnetic field. In this situation, Fleming's Right Hand Rule can be used to know the direction of the induced current. Stretch the thumb, forefinger and middle finger of right hand so that they are perpendicular to each other. If the forefinger indicates the direction of the magnetic field and the thumb shows the direction of motion of conductor, then the middle finger will show the direction of induced current.

Electric Generator

- Electric Generator is based on the phenomenon of electromagnetic Induction. In an electric generator, mechanical energy is used to rotate a conductor in a magnetic field to produce electricity.
- Here, after every half rotation the polarity of the current changes. Such a current, which changes direction after equal intervals of time, is called an alternating current (abbreviated as AC). This device is called an AC generator. To get a direct current (DC, which does not change its direction with time), a split-ring type commutator must be used.
- The difference between the direct and alternating currents is that the direct current always flows in one direction, whereas the alternating current reverses its direction periodically. Most power stations constructed these days produce AC. In India, the AC changes direction after every 1/100 second, that is, the frequency of AC is 50 Hz. An important advantage of AC over DC is that electric power can be transmitted over long distances without much loss of energy.

Domestic Electric Circuit

- In our homes, we receive supply of electric power through a main supply (also called mains). One of the wires in this supply, usually with red insulation cover, is called live wire (or positive). Another wire, with black insulation, is called neutral wire (or negative). In our country, the potential difference between the two is 220 V.
- At the meter-board in the house, these wires pass into an electricity meter through a main fuse. Through the main switch they are connected to the line wires in the house.
- Often, two separate circuits are used, one of 15 A current rating for appliances with higher power ratings such as geysers, air coolers, etc. The other circuit is of 5 A current rating for bulbs, fans, etc.

- The earth wire, which has insulation of green colour, is usually connected to a metal plate deep in the earth near the house. This is used as a safety measure, especially for those appliances that have a metallic body. The metallic body is connected to the earth wire, which provides a low-resistance conducting path for the current. Thus, it ensures that any leakage of current to the metallic body of the appliance keeps its potential to that of the earth, and the user may not get a severe electric shock.
- A fuse in a circuit prevents damage to the appliances and the circuit due to overloading. Overloading can occur when the live wire and the neutral wire come into direct contact. (This occurs when the insulation of wires is damaged or there is a fault in the appliance.) In such a situation, the current in the circuit abruptly increases. This is called short-circuiting.
- The electric fuse prevents the electric circuit and the appliance from a possible damage by stopping the flow of unduly high electric current. The Joule heating that takes place in the fuse melts it to break the electric circuit.

PART - B

CHEMISTRY

CHEMISTRY

ATOM

- An atom is the smallest particle of the element that cannot usually exist independently and retain all its chemical properties.
- Atom are very small they are smaller than anything that we can imagine or compare with more than millions of atoms when stacked would make a Layer barely as thick as this sheet of paper. Atomic radius is measured in nanometres
- Our entire world is made up of atoms. We may not be able to see them, but they are there, and constantly affecting whatever we do.

Atomic Mass

- The most remarkable concept that Dalton's atomic theory proposed was that of the atomic mass. According to him, each element had a characteristic atomic mass. The theory could explain the law of constant proportions so well that scientists were prompted to measure the atomic mass of an atom.
- Since determining the mass of an individual atom was a relatively difficult task, relative atomic masses were determined using the laws of chemical combinations and the compounds formed.
- While searching for various atomic mass units, scientists initially took 1/16 of the mass of an atom of naturally occurring oxygen as the unit. This was considered relevant de to two reasons

1. Oxygen reacted with a large number of elements and form compounds
2. This atomic mass unit gave masses of most of the elements as whole numbers

- However, in 1961 for a universally accepted atomic mass unit, carbon-12 isotopes was chosen as the standard reference for measuring atomic masses
- One atomic mass unit is a mass unit equal to exactly one-twelfth (1/12th the mass of one atom of carbon-12. The relative atomic masses of all elements have been found with respect to an atom of carbon-12
- Atoms of most elements are not able to exist independently. Atoms form molecules and ions. These molecules or ions aggregate a large numbers to form the matter that we can see, feel or touch

MOLECULE

- A molecule is the smallest particle of an element or a compound capable of independent existence under ordinary conditions. It shows all the properties of the substance. Atoms of the same element or of different elements can join together to form molecules.

Molecules of Elements

- The molecules of an element are constituted by the same type of atoms. Molecules of many elements, such as Argon (Ar), Helium (He) etc. are made up of only one atom of that element. But this is not the case with most of the non-metals. For example, a molecule of oxygen consists of two atoms of oxygen and hence it is known as a diatomic molecule.
- If 3 atoms of oxygen unite into a molecule. Instead of the usual 2, we get one.
- The number of atoms constituting a molecule is known as its atomicity
- Metals and some other elements, such as carbon, do not have a simple structure but consist of a very large and indefinite number of atoms bonded together

Elements

- Element is a basic form of matter that cannot be broken down into simpler substances by chemical reactions
- Elements can be normally divided into metals, non-metals and metalloids Metal usually show some or all of the following properties

a) They have a lustre (shine)
b) They have silvery-grey or golden-yellow colour
c) They conduct heat and electricity

d) They are ductile (can be drawn into wie)
e) They are malleable can be hammered into thin sheets)
f) They are sonorous (make a ringing sound when it) eg gold, silver, copper etc. Mercury is the only metal that quid at room Temperature

Non-metals usually show some or all of the following property

a) They display a variety of colours
b) They are poor conductors of heat and electricity

- Some elements have intermediate properties between those of metals and non-metals, they are called metalloids: examples are boron silicon, germanium etc

What is an lon?

- Compounds composed of metals and non-metals contain charged species. The charged species are now as ions. Ions may consist of a single charged atom of a group of atoms that have a ne charge on them
- An ion can be negatively or positively charged. A negatively charged lon is called an union and the positively charged ion, a cation

Molecular Mass and Mole Concept

- The concept of atomic mass can be extended to calculate molecular masses. The molecular mass of a substance is the um of the atomic masses of all the atoms in molecule of the substance It is therefore the relative mass of a molecule expressed in atomic mass units (U)

Formula Unit Mass

- The formula mass of a substance is sum of the atomic masses of all atoms in a formula unit of a compound Formula unit mass is calculated in the same manner as we calculate the molecular mass. The only difference is that we use the word formula unit for those substances whose constituent particles are ions

Mole Concept

- The word mole was introduced around 1896 by Wilhelm Ostwald who derived the term from the Latin word moles meaning a heap or pile. A substance may be considered as a heap of atoms or molecules. The unit mole was accepted in 1967 to provide a simple way of reporting a large number the massive heap of atoms and molecules in a sample Mass of 1 mole of a substance is called its molar mass

Structure of the Atom

- A major challenge before the scientists at the end of the 19th century was to reveal the structure of the atom as well as to explain its important properties. The elucidation of the structure of atoms is based on a series of experiments
- One of the first indications that atoms are not indivisible, comes from studying static electricity and the condition under which electricity is conducted by different substances

FIBRE – Natural and Synthetic Fibre

- Fabrics are made up of yarns and yarns are further made up of fibres
- The fibres of some fabrics such as cotton, jute, silk and wool are obtained from plants and animals. These are called natural fibres
- Flax Is also a plant that gives natural fibres. Cotton and jute are examples of fibres obtained from plants
- Wool and silk fibres are obtained from animals. Wool is obtained from the fleece of sheep or goat.
- Fibres are also made from chemical substances which are not obtained from plant or animal sources. These are called synthetic fibres. Some examples of synthetic fibres are polyester, nylon and acrylic

PLANT FIBRES

- Cotton plants are usually grown in places having black soil and warm climate.
- The process of separating fibres from seeds by combing is called ginning of cotton
- The process of making yarn from fibres is called spinning

- The process of arranging two sets of yarns together to make a fabric is called weaving
- Jute fibre obtained from the stem of the jute plant.
- It is cultivated during the rainy season in India, jute is mainly grown in West Bengal Bihar and Assam

FIBRE TO FABRIC

Wool

- Wool comes from sheep, goat yak and some other animals. These animals bear hair on their body. Hair trap a lot of air
- Air is a poor conductor of heat So, hair keeps these animals warm Wool is derived from these hairy fibres
- The fine soft under fair close to the skin of the sheep provide the fibres for making wool Some breeds of sheep possess only fine under-hair
- Their parents are specially chosen to give birth to sheep which have only soft under-hair. This process of selecting parents for obtaining special characters in their offspring, such as soft under hair in sheep, is termed selective breeding
- Yak wool is common in Tibet and Ladakh Mohair Is obtained from angora goats found in hilly regions such as Jammu and Kashmir. Wool is also obtained from goat hair The under fur of Kashmiri goat is soft. It is woven into fine shawls called Pashmina shawls.
- Silkworms spin the &;silk fibres rearing of silkworms for obtaining silk is called sericulture
- The female silk moth lays eggs, from which hatch larvae which are called caterpillars of silkworms
- The caterpillar secretes fibre made of protein which hardens on exposure to air and becomes silk fibre. Soon the caterpillar completely covers itself by silk fibres and turns into pupa. This covering is known as cocoon The further development of the pupa into moth continues inside the cocoon
- Tassar, Mooga, kosa, Erl Mulberry silk etc, are obtained from cocoons Spun by different types of moths
- The process of taking out threads from the cocoon for use as silk is called reeling the silk

SYNTHETIC FIBLES AND PLASTIC

- A synthetic fibre is also a chain of small units joined together. Each small unit is actually a chemical substance. Many such small units combine to forma large single unit called a polymer.
- The word polymer comes from two Greek words: Poly meaning many and mer meaning part/unit. So, a polymer is made of many repeating units.
- Polymers occur in nature also. Cotton, for example, is a polymer called cellulose. Cellulose is made up of a large number of glucose units.

Types of Synthetic Fibres

- <u>Rayon</u>: Towards the end of the 19h century, scientists were successful in obtaining a fibre having properties similar to that of silk such a fibre was obtained by chemical treatment of wood pulp. This fibre was called rayon or artificial silk.
- <u>Nylon</u>: In 1931, it was made without using any natural raw material (from plant or animal) it was prepared from coal, water and air it was the first fully synthetic fibre.
- Nylon fibre was strong, elastic and light. It was lustrous and easy to wash. So, It became very popular for making clothes.
- A nylon thread is actually stronger than a steel wire.
- <u>Polyester and Acrylic</u>:
- Fabric made from this fibre does not get wrinkled easily. Terylene is popular polyester.
- PET is a very familiar form of polyester. It is used for making bottles utensils, films, wires and many other useful products.
- Polyester (Poly+ester) is actually made up of the repeating units of a chemical called an ester. Esters are the chemicals which give fruits their smell.
- Fabrics are sold by names like polycot, polywool, terrycot etc. As the name suggests, these are made by mixing two types of fibres

- Sweaters, shawls or blankets etc are actually not made from natural wool though they appear to resemble wool. This type of synthetic fibre called acrylic.
- All the synthetic fibres are prepared by a number of processes using raw materials of petroleum origin, called petrochemicals.

Characteristics of Synthetic Fibres

- They possess unique characteristics which make them popular dress materials.
- They dry up quickly, are durable, less expensive, readily available and easy to maintain.

Plastics

- It is also a polymer like the synthetic fibre. It is easily polythene (polyethylene) is an example of a plastic it is used for making commonly used polythene bags.
- Plastic which gets deformed easily on heating and can be bent easily are known as thermoplastics. Eg. Polythene and PVC.
- There are some plastics which when moulded once, cannot be softened by heating. These are called thermo setting plastics e.g Bakelite and melamine.
- Plastics do not react with water and air. They are not corroded easily Plastic is light, strong and durable. These are poor conductors of heat and electricity Special plastic cookware is used in microwave ovens for cooking food. In microwave ovens, the heat cooks the food but does not affect the plastic vessel
- Teflon is a special plastic on which oil and water do not stick. It is used for non-stick coating on cookwares.

Plastics and the Environment:

- A material which gets decomposed through natural processes, such as action by bacteria, Is called biodegradable. A material which is not easily decomposed by natural processes is termed non-biodegradable.
- Since plastic takes several years to decompose, it is not environment friendly. It causes environmental pollution.
- Besides, the burning process in the synthetic material is quite slow and it does not get completely burnt easily. In the process it releases lots of poisonous fumes into the atmosphere causing air pollution.

ACIDS, BASES AND SALTS

- Acids (Curd, lemon juice, orange juice and vinegar) are sour in taste Generally, buses Baking Soda) are bitter in taste and soapy to touch
- Substances which are used to test whether a substance is acidic or basic are known as indicators
- The indicators change their colour when added to a solution containing an acidic or a basic substance. Turmeric, litmus, China rose petals (Gudhal), etc are some of the naturally occurring indicators
- The most commonly used natural indicator is litmus It extracted from lichens, it has a mauve (purple) colour in distilled water. Acid Turns blue litmus red. Bases turn red litmus blue
- The solutions which do not change the colour of either or or blue litmus are known as neutral solutions. These substances neither acidic nor basic

Acid Rain

- The rain containing excess of acids is called an acid rain The rain becomes acidic because carbon dioxide sulphur dioxide and nitrogen oxide (which are released into the air as pollutants) dissolve in rain drops to form carbonic acid, sulphuric acid and nitric acid respectively

Neutralisation

- The reaction between an acid and a base is known as neutralisation Salt and water are produced in this process with the evolution of heat
- Acid+Base '! Salt+Water (Heat is evolved)
- Hydrochloric acid (HCI) + Sodium Hydroxide (NaOH) Sodium chloride gives (NaCl)+Water (H20)
- The stomach contains hydrochloric acid, which helps in the digestion of food However, when this acids produced in excess, it causes indigestion, which is painful. An antacid such as milk of magnesia neutralises the excessive acid in the stomach, and provides relief from the pain due to indigestion

PHYSICAL AND CHEMICAL CHANGES

- Physical changes are changes in the physical properties of substances include shape, size, colour and state of matter
- No new substances are formed in these changes Forms of energy such as heat, light and electricity, are neither emitted nor absorbed in a physical change These changes may be reversible A Physical change is temporary
- Chemical changes are changes in which one or more new substances are formed, it is also called a chemical reaction
- A chemical change is permanent. Forms of energy, such as heat, light or electricity, may be emitted or absorbed during a chemical reaction, A chemical change is generally irreversible

Galvanisation

- Rusting of Iron is a chemical reaction. For rusting, the presence of both oxygen and water (or water vapour) is essential
- A way to avoid rusting is to deposit a layer of a metal like chromium or zinc on iron. Paint and grease can also be used. This process of depositing a layer of zinc on iron is called galvanisation

Crystallisation

- Some substances can be obtained in pure state from their solutions by crystallisation, it is the solidification of atom or molecules into a highly structured form called a crystal

Combustion and Flame

- A chemical process in which a substance reacts with oxygen to give off heat is called combustion. The substance that undergoes combustion is said to be combustible. It is also called a fuel.
- In the sun, heat and light are produce by nuclear reactions. The lowest temperature at which a substance catches fire is called its ignition temperature.

Types of Combustion

- The gas burns rapidly and produces heat and light such combustion is known as rapid combustion.
- There are substances like phosphorus which burn in air at room temperature.
- The type of combustion in which a material suddenly bursts into flames without the application of any apparent cause is called spontaneous combustion. Such combustion of coal dust has resulted in many disastrous fires in coal mines.
- When a cracker is ignited, a sudden reaction takes place with the evolution of heat, light and sound. A large amount of gas formed in the reaction is liberated. Such a reaction is called explosion.

Fuel

- The sources of heat energy for domestic and industrial purposes are mainly wood, charcoal, petrol, kerosene etc. These substances are called fuels.
- A good fuel is one which is readily available, it is cheap, it burns easily in air at a moderate rate. It produces a large amount of heat, it does not leave behind any undesirable substances.

Coal and Petroleum

- In the light of the availability of various resources in nature, natural resources can be broadly classified into two kinds

(1) Inexhaustible Natural Resources: These resources are present in unlimited quantity in nature and are not likely to be exhausted by human activities. E.g. sunlight, air.

(2) Exhaustible Natural Resources: The amount of these resources in nature is limited. They can be exhausted by human activities, E.g. forests, coal etc

- Coal, petroleum and natural gas etc were formed from the dead remains of living organisms (fossils), So these are all known as fossil fuel.

Coal

- About 300 MYA the earth had dense forests in low lying wetlands areas
- Due to natural processes, like flooding, these forests got buried under the soil. As more soil deposited over them, they were compressed
- The temperature also rose as they sank deeper and deeper. Under high pressure and high temperature, dead plants got slowly converted to coal.
- As coal contains mainly carbon, the slow process of conversion of dead vegetation into coal is called carbonization Coal is processed in industry to get some useful products such as coke. coal tar and coal gas.
- Coke: It is a tough, porous and black substance it is an almost pure form of carbon. It is used in the manufacture of steel and in the extraction of many metals.
- Coal Tar: It is a black, thick liquid with an unpleasant smell. It is a mixture of about 200 substances. Products obtained from coal tar are used as starting material for manufacturing various substances used in everyday life and in industry, like synthetic dyes, drugs, explosives etc.
- Coal Gas-Is obtained during the processing of coal to get coke. It is used as a fuel in many industries situated near the coal processing plants.

Petroleum:

- Petrol and diesel are obtained from a natural resource called petroleum
- Petroleum was formed from organisms living in the sea. As these organisms died, their bodies settled at the bottom of the se and got covered with layers of sand clay.
- Over millions of years, absence of at, high temperature and high pressure transformed the dead organisms into petroleum and natural gas.
- The process of separating the various constituents/fractions of petroleum is known as refining. It is carried out in a petroleum refiner.
- Many useful substances are obtained from petroleum and natural gas. These are termed as Petrochemicals. These are used in the manufacture of detergents, fibres, polythene etc. Hydrogen gas, obtained from natural gas, is used in the production of fertilizers (urea). Due to its great commercial importance, petroleum is also called black gold.

Natural Gas

- It is a very important fossil fuel because it is easy to transport through pipes. Natural gas is stored under high pressure as compressed natural gas (CNG). CNG is used for power generation
- It is now being used as a fuel for transport vehicles because it is less polluting. It is a cleaner fuel.

Materials: Metals and Non-Metals

Physical Properties of Metals and Non-Metals

- The property of metals by which they can be beaten into thin sheets is called malleability. This is a characteristic property of metals.
- The property of metal by which it can be drawn into wires is called ductility
- Since metals produce ringing sounds, they are said to be sonorous. The materials other than metals are not sonorous.
- Thus, metals possess properties such as hard, lustrous, malleable, ductile, sonorous and good conductors of heat and electricity are metals. E.g. iron copper, aluminium etc.
- In contrast, materials like coal and sulphur are soft and dull in appearance.
- They break down into a powdery mass on tapping with a hammer. They are not sonorous and are poor conductors of heat and electricity. These materials are called non-metals. E.g. sulphur, carbon, etc.
- Metals like sodium and potassium are soft and can be cut with a knife. Mercury Is the only metal which is found in liquid state at room temperature. These are exceptions.

Chemical Properties of Metals and Non-Metals

- Reaction with oxygen: when a copper vessel is exposed to moist air for long. It acquires a dull green coating. The green material is a mixture of copper hydroxide and copper carbonate.
- The name of the product formed in the reaction of sulphur and oxygen is sulphur dioxide gas. When sulphur dioxide is dissolved in water, sulphurous acid formed.

Reaction with water:

- Sodium metal is very reactive. It reacts vigorously with oxygen and water. A lot of heat is generated in the reaction. It is, therefore stored in kerosene.
- Generally, non-metals do not react with water though they may be very reactive in air. Such non-metals are stored in water, eg phosphorus.
- Reactions with Acids: Metals react with sodium hydroxide to produce hydrogen gas. Reactions of non-metals with bases are complex.
- Displacement Reactions: A more reactive metal can replace a less reactive metal, but a less reactive one cannot replace a more reactive metal.

Uses of Metal and Non-Metals

- Metals are used in making machinery, automobiles, aeroplanes, trains, satellites, industrial gadgets, cooking utensils etc.
- Non- Metals are essential for breathing, in fertilizers, used as antiseptics, in water purification process and also in crackers

CHEMICAL REACTIONS AND EQUATIONS

Our daily life is surrounded by many chemical reaction happening around us. This includes milk getting spoilt during summer seasons, grapes getting fermented, food getting cooked, food getting digested in human body and many more. From these examples, one can induce that a chemical reaction is said to have taken place if it involves one of the following observations- n

- change in state
- change in colour
- evolution of a gas
- change in temperature.

CHEMICAL REACTIONS

- When a chemical reaction is written in the form of word-equation, instead of a long sentence, it is called chemical equation. The reactants are written on the left-hand side (LHS) with a plus sign (+) between them. Similarly, products are written on the right-hand side (RHS) with a plus sign (+) between them. The arrowhead points towards the products, and shows the direction of the reaction.

Combination Reaction

- When two or more substances (elements or compounds) combine to form a single product, the reactions are called combination reactions. In such reactions, a large amount of heat is evolved. This makes the reaction mixture warm. Reactions in which heat is released along with the formation of products are called exothermic chemical reactions.
- Examples of combination reaction includes burning of natural gas and the process of respiration when glucose combined with the oxygen of our body cells and release energy.

Decomposition Reaction

- In this reaction, a single reactant breaks down to give simpler products. Decomposition of calcium carbonate to calcium oxide and carbon dioxide on heating is an important decomposition reaction used in various industries. Calcium oxide is called lime or quick lime. It has many uses – one is in the manufacture of cement. When a decomposition reaction is carried out by heating, it is called thermal decomposition.
- The decomposition reactions require energy either in the form of heat, light or electricity for breaking down the reactants. Reactions in which energy is absorbed are known as endothermic reactions.

Displacement Reaction

- A displacement reaction is a chemical reaction in which one element replaces an/other element in a compound. This happens when A is more reactive than B, thus giving a more stable product.
- For example, when iron nails are placed in copper sulphate solution, it acquires brownish colour and the blue colour of the copper sulphate solution fades. This happens because iron, being more reactive than copper, replaces copper from it compound.
- A double displacement reaction is a type of chemical reaction in which the reactant ions exchange places to form new products. Usually, a double displacement reaction results in precipitate formation.

Oxidation and Reduction Reaction

- If a substance gains oxygen or loses hydrogen during a reaction, it is oxidised. If a substance loses oxygen or gains hydrogen during a reaction, it is reduced.
- For example, The surface of copper powder becomes coated with black copper(II) oxide as it mixes with oxygen. If hydrogen gas is passed over this copper oxide, the black coating on the surface turns brown as the reverse reaction takes place. When one reactant gets oxidised while the other gets reduced during a reaction, such reactions are called oxidation-reduction reactions or redox reactions.

Corrosion

- When a metal is attacked by substances around it such as moisture, acids, etc., it is said to corrode and this process is called corrosion. The black coating on silver and the green coating on copper are other examples of corrosion.
- Corrosion causes damage to car bodies, bridges, iron railings, ships and to all objects made of metals, specially those of iron. Corrosion of iron is a serious problem. Every year an enormous amount of money is spent to replace damaged iron.

Rancidity

- When fats and oils are oxidised, they become rancid and their smell and taste change. Usually substances which prevent oxidation (antioxidants) are added to foods containing fats and oil. Keeping food in air tight containers helps to slow down oxidation. Chips manufacturers usually flush bags of chips with gas such as nitrogen to prevent the chips from getting oxidised

ACIDS, BASES AND SALTS.

- Acids are sour in taste and change the colour of blue litmus to red, whereas, bases are bitter and change the colour of the red litmus to blue. Litmus is a natural indicator. Turmeric is another such indicator. A stain of curry on a white cloth becomes reddish-brown when soap, which is basic in nature, is scrubbed on it. It turns yellow again when the cloth is washed with plenty of water.
- Litmus solution is a purple dye, which is extracted from lichen, a plant belonging to the division Thallophyta, and is commonly used as an indicator. When the litmus solution is neither acidic nor basic, its colour is purple.

Chemical Properties of Acids and Bases

- Red Litmus, Phenolphthalein and Methyl Orange are the substances that tell us whether a substance is acidic or basic by change in colour.
- There are some substances whose odour changes in acidic or basic media. These are called olfactory indicators. Dilute vanilla and clove oil are some of the examples of olfactory indicators. Reaction of acids and bases with metal
- Metal displaces hydrogen atoms from the acids as hydrogen gas and forms a compound called a salt. Thus, the reaction of a metal with an acid can be summarised as –
- Acid + Metal '! Salt + Hydrogen gas
- However, reaction of bases is not possible with all the metals.

Reaction of Metal Carbonates and Metal Hydrogencarbonates with acids

- Limestone, chalk and marble are different forms of calcium carbonate. All metal carbonates and hydrogencarbonates react with acids to give a corresponding salt, carbon dioxide and water.
- Thus, the reaction can be summarised as –
- Metal carbonate/Metal hydrogencarbonate + Acid ’! Salt + Carbon dioxide + Water

Reaction and acids and bases with each other

- The reaction between an acid and a base to give a salt and water is known as a neutralisation reaction. It is called neutralisation because the the effect of a base is nullified by an acid and vice-versa. In general, a neutralisation reaction can be written as –
- Base + Acid ’! Salt + Water

Reaction of metallic oxides with acids

- Metallic oxides react with acids to give salts and water. Since this reaction is similar to the reaction of a base with an acid, metallic oxides are said to be basic oxides.
- The general reaction between a metal oxide and an acid can be written as –
- Metal oxide + Acid ’! Salt + Water

Reaction of Non Metallic Oxides with base

- Non metallic oxides react with bases to produce a salt and water. Since this is similar to the reaction between a base and an acid, we can conclude that non- metallic oxides are acidic in nature.

Common Properties of All Acids and All Bases

- Acids contain H+ ion as cation and anion such as Cl– in HCl, NO3– in
- HNO , SO2– in H SO , CH COO– in CH COOH. Since the cation present in acids is H+, this suggests that acids produce hydrogen ions, H+(aq), in solution, which are responsible for their acidic properties. What Happens to Acid or Base in water solution
- The hydrogen ions from an acid is produced in the presence of water. The separation of H+ ion from HCl molecules cannot occur in the absence of water. Hydrogen ions cannot exist alone, but they exist after combining with water molecules. Thus hydrogen ions must always be shown as H+(aq) or hydronium ion (H3O+). Thus acids give H3O+ or H+(aq) ion in water. Bases generate hydroxide (OH–) ions in water. Bases which are soluble in water are called alkalis.
- The process of dissolving an acid or a base in water is a highly exothermic one. The acid must always be added slowly to water with constant stirring. If water is added to a concentrated acid, the heat generated may cause the mixture to splash out and cause burns. The glass container may also break due to excessive local heating.
- Mixing an acid or base with water results in decrease in the concentration of ions (H3O+/OH–) per unit volume. Such a process is called dilution and the acid or the base is said to be diluted.

Strength of acid and base

- A scale for measuring hydrogen ion concentration in a solution, called pH scale has been developed. The p in pH stands for ‘potenz’ in German, meaning power. On the pH scale we can measure pH generally from 0 (very acidic) to 14 (very alkaline). pH should be thought of simply as a number which indicates the acidic or basic nature of a solution. Higher the hydronium ion concentration, lower is the pH value.
- The pH of a neutral solution is 7. Values less than 7 on the pH scale represent an acidic solution. As the pH value increases from 7 to 14, it represents an increase in OH– ion concentration in the solution, that is, increase in the strength of alkali (Fig. 2.6). Generally paper impregnated with the universal indicator is used for measuring pH.
- The strength of acids and bases depends on the number of H+ ions and OH– ions produced, respectively. Acids that give rise to more H+ ions are said to be strong acids, and acids that give less H+ ions are said to be weak acids.

  Similarly, bases that give rise to more OH– ions are said to be strong bases, and acids that give less OH– ions are said to be weak bases.

Importance of PH in everyday life

- Our body works within the pH range of 7.0 to 7.8. Living organisms can survive only in a narrow range of pH change. When pH of rain water is less than 5.6, it is called acid rain. When acid rain flows into the rivers, it lowers the pH of the river water. The survival of aquatic life in such rivers becomes difficult.
- Our stomach produces hydrochloric acid. It helps in the digestion of food without harming the stomach. During indigestion the stomach produces too much acid and this causes pain and irritation. To get rid of this pain, people use bases called antacids. These antacids neutralise the excess acid. Magnesium hydroxide (Milk of magnesia), a mild base, is often used for this purpose.
- Tooth decay starts when the pH of the mouth is lower than 5.5. Tooth enamel, made up of calcium hydroxyapatite (a crystalline form of calcium phosphate) is the hardest substance in the body. It does not dissolve in water, but is corroded when the pH in the mouth is below 5.5. Bacteria present in the mouth produce acids by degradation of sugar and food particles remaining in the mouth after eating. Using toothpastes, which are generally basic, for cleaning the teeth can neutralise the excess acid and prevent tooth decay.
- Bee-sting leaves an acid which causes pain and irritation. Use of a mild base like baking soda on the stung area gives relief. Stinging hair of nettle leaves inject methanoic acid causing burning pain. A traditional remedy to nettle leaves sting is rubbing the area with the leaf of the dock plant, which often grows beside the nettle in the wild and is basic in nature.

Some naturally occurring acids

Natural acid	Source	Natural acid	Source
Vinegar	Acetic acid	Curd	Lactic acid
Orange	Citric acid	Lemon	Citric acid
Tamarind	Tartaric acid	Ant sting	Methanoic acid
Tomato	Oxalic acid	Nettle sting	Methanoic acid

Family of salts

- Salts having the same positive or negative radicals are said to belong to a family. For example, NaCl and Na2SO4 belong to the family of sodium salts. Similarly, NaCl and KCl belong to the family of chloride salts.

pH of salts

- Salts of a strong acid and a strong base are neutral with pH value of 7.
- On the other hand, salts of a strong acid and weak base are acidic with pH value less than 7 and those of a strong base and weak acid are basic in nature, with pH value more than 7.

CHEMICALS FROM SALT

- Seawater contains many salts dissolved in it. Sodium chloride is separated from these salts. Deposits of solid salt are also found in several parts of the world. These large crystals are often brown due to impurities. This is called rock salt. Beds of rock salt were formed when seas of bygone ages dried up. Rock salt is mined like coal.

Common salt — A raw material for chemicals

- The common salt thus obtained is an important raw material for various materials of daily use, such as sodium hydroxide, baking soda, washing soda, bleaching powder and many more.

Sodium hydroxide

- When electricity is passed through an aqueous solution of sodium chloride (called brine), it decomposes to form sodium hydroxide. The process is called the chlor-alkali process because of the products formed–chlor for chlorine and alkali for sodium hydroxide.

Bleaching powder

- Bleaching powder is produced by the action of chlorine gas on dry slaked lime [$Ca(OH)_2$]. Bleaching powder is represented as $CaOCl_2$.

Bleaching powder is used –

- for bleaching cotton and linen in the textile industry, for bleaching wood pulp in paper factories and for bleaching washed clothes in laundry;
  (ii) as an oxidising agent in many chemical industries; and
  (iii) to make drinking water free from germs.
- Baking soda is used for cooking purposes. Sometimes it is added for faster cooking. The chemical name of the compound is sodium hydrogencarbonate ($NaHCO_3$). It is produced using sodium chloride as one of the raw materials.

Uses of Baking soda

- For making baking powder, which is a mixture of baking soda (sodium hydrogencarbonate) and a mild edible acid such as tartaric acid. When baking powder is heated or mixed in water, Carbon dioxide produced during the reaction can cause bread or cake to rise making them soft and spongy.
- Sodium hydrogencarbonate is also an ingredient in antacids. Being alkaline, it neutralises excess acid in the stomach and provides relief.
- It is also used in soda-acid fire extinguishers.

Washing soda

Sodium carbonate and sodium hydrogencarbonate are useful chemicals for many industrial processes as well.

Uses of washing soda

1. Sodium carbonate (washing soda) is used in glass, soap and paper industries.
2. It is used in the manufacture of sodium compounds such as borax.
3. Sodium carbonate can be used as a cleaning agent for domestic purposes.
4. It is used for removing permanent hardness of water.

Are the crystals of salt really dry?

- Water of crystallisation is the fixed number of water molecules present in one formula unit of a salt. Five water molecules are present in one formula unit of copper sulphate. Chemical formula for hydrated copper sulphate is $Cu\ SO_4 . 5H_2O$.
- When we heat the crystals, this water is removed and the salt turns white from blue. If the crystals are moistened again with water, blue colour of the crystals reappears.
- One other salt, which possesses water of crystallisation is gypsum. It has two water molecules as water of cyrstallisation. It has the chemical formula $CaSO_4.2H_2O$.

On heating gypsum at 373 K, it loses water molecules and becomes calcium sulphate hemihydrate ($CaSO_4 .1\ H_2O$). This is called Plaster of Paris, the substance which doctors use as plaster for supporting fractured bones in the right position. Plaster of Paris is a white powder and on mixing with water, it changes to gypsum once again giving a hard solid mass.

METALS AND NON METALS

Physical Properties

Metals

- Metals, in their pure state, have a shining surface. This property is called metallic lustre.
- Metals are generally hard. Hardness varies from metal to metal.
- It can be beaten into thin sheets. This property is called malleability. Gold and silver are the most malleable metals. It is because of their malleability and ductility that metals can be given different shapes according to our needs.

- Metals are good conductors of heat and have high melting points. The best conductors of heat are silver and copper. Lead and mercury are comparatively poor conductors of heat. Metals are also good conductors of electricity.
- The metals that produce a sound on striking a hard surface are said to be sonorous.

Non Metals

- There are very few non-metals as compared to metals. Some of the examples of non-metals are carbon, sulphur, iodine, oxygen, hydrogen, etc. The non- metals are either solids or gases except bromine which is a liquid.
- The physical properties of non metals are completely opposite to that of non mental.
- However, we cannot group elements according to their physical properties alone, as there are many exceptions. For example –
- All metals except mercury exist as solids at room temperature.
- Metals have high melting points but gallium and caesium have very low melting points. These two metals will melt if you keep them on your palm.
- Iodine is a non-metal but it is lustrous.
- Carbon is a non-metal that can exist in different forms. Each form is called an allotrope. Diamond, an allotrope of carbon, is the hardest natural substance known and has a very high melting and boiling point.
- Graphite, another allotrope of carbon, is a conductor of electricity.
- Alkali metals (lithium, sodium, potassium) are so soft that they can be cut with a knife. They have low densities and low melting points.
- Elements can be more clearly classified as metals and non-metals on the basis of their chemical properties.

Reaction of metals with oxygen

- Almost all metals combine with oxygen to form metal oxides. For example, when copper is heated in air, it combines with oxygen to form copper(II) oxide, a black oxide.
- Most metal oxides are insoluble in water but some of these dissolve in water to form alkalis. Sodium oxide and potassium oxide dissolve in water to produce alkalis
- We have learnt that metal oxides are basic in nature. But some metal oxides, such as aluminium oxide, zinc oxide show both acidic as well as basic behaviour. Such metal oxides which react with both acids as well as bases to produce salts and water are known as amphoteric oxides.
- Different metals show different reactivities towards oxygen. Metals such as potassium and sodium react so vigorously that they catch fire if kept in the open. Hence, to protect them and to prevent accidental fires, they are kept immersed in kerosene oil. At ordinary temperature, the surfaces of metals such as magnesium, aluminium, zinc, lead, etc., are covered with a thin layer of oxide. The protective oxide layer prevents the metal from further oxidation. Iron does not burn on heating but iron filings burn vigorously when sprinkled in the flame of the burner. Copper does not burn, but the hot metal is coated with a black coloured layer of copper(II) oxide. Silver and gold do not react with oxygen even at high temperatures.
- Anodising is a process of forming a thick oxide layer of aluminium. Aluminium develops a thin oxide layer when exposed to air. This aluminium oxide coat makes it resistant to further corrosion. The resistance can be improved further by making the oxide layer thicker. During anodising, a clean aluminium article is made the anode and is electrolysed with dilute sulphuric acid. The oxygen gas evolved at the anode reacts with aluminium to make a thicker protective oxide layer.

Reaction of metals with water

- Metals react with water and produce a metal oxide and hydrogen gas. Metal oxides that are soluble in water dissolve in it to further form metal hydroxide. But all metals do not react with water.
- Metals like potassium and sodium react violently with cold water. In case of sodium and potassium, the reaction is so violent and exothermic that the evolved hydrogen immediately catches fire.
- The reaction of calcium with water is less violent. The heat evolved is not sufficient for the hydrogen to catch fire.

- Calcium starts floating because the bubbles of hydrogen gas formed stick to the surface of the metal.
- Magnesium does not react with cold water. It reacts with hot water to form magnesium hydroxide and hydrogen. It also starts floating due to the bubbles of hydrogen gas sticking to its surface.
- Metals like aluminium, iron and zinc do not react either with cold or hot water. But they react with steam to form the metal oxide and hydrogen.
- Metals such as lead, copper, silver and gold do not react with water at all. Reaction of metals with acids
- It has already been learnt that metals react with acids to give a salt and hydrogen gas.
- Metal + Dilute acid -> Salt + Hydrogen
- But not all the metals react in the similar manner. Hydrogen gas is not evolved when a metal reacts with nitric acid. It is because HNO3 is a strong oxidising agent. It oxidises the H2 produced to water and itself gets reduced to any of the nitrogen oxides (N2O, NO, NO2). But magnesium (Mg) and manganese (Mn) react with very dilute HNO3 to evolve H2 gas. Copper does not react with dilute HCl.
- Aqua regia, (Latin for 'royal water') is a freshly prepared mixture of concentrated hydrochloric acid and concentrated nitric acid in the ratio of 3:1. Aqua regia is a highly corrosive, fuming liquid. It is one of the few reagents that is able to dissolve gold and platinum.

Reaction of metals with other metal salts

- Reactive metals can displace less reactive metals from their compounds in solution or molten form. metal A displaces metal B from its solution, it is more reactive than B.

The reactivity series

The reactivity series is a list of metals arranged in the order of their decreasing activities. After performing displacement experiments , the following series, known as the reactivity or activity series, has been developed.

K	Potassium	Most reactive
Na	Sodium	
Ca	Calcium	
Mg	Magnesium	
Al	Aluminium	
Zn	Zinc	Reactivity decreases
Fe	Iron	
Pb	Lead	
H	Hydrogen	
Cu	Copper	
Hg	Mercury	
Ag	Silver	
Au	Gold	Least reactive

How do metals and non metals react?

- Reactivity of elements can be understood in terms of the tendency to attain a completely filled valence shell. Sodium and chloride ions, being oppositely charged, attract each other and are held by strong electrostatic forces of attraction to exist as sodium chloride (NaCl). It should be noted that sodium chloride does not exist as molecules but aggregates of oppositely charged ions.
- The compounds formed in this manner by the transfer of electrons from a metal to a non-metal are known as ionic compounds or electrovalent compounds.

The general properties of ionic compound can be summarised as follows

- Physical nature: Ionic compounds are solids and are somewhat hard because of the strong force of attraction between the positive and negative ions. These compounds are generally brittle and break into pieces when pressure is applied.
- Melting and Boiling points: Ionic compounds have high melting and boiling points (see Table 3.4). This is because a considerable amount of energy is required to break the strong inter-ionic attraction.
- Solubility: Electrovalent compounds are generally soluble in water and insoluble in solvents such as kerosene, petrol, etc.

- Conduction of Electricity: The conduction of electricity through a solution involves the movement of charged particles. A solution of an ionic compound in water contains ions, which move to the opposite electrodes when electricity is passed through the solution. Ionic compounds in the solid state do not conduct electricity because movement of ions in the solid is not possible due to their rigid structure. But ionic compounds conduct electricity in the molten state. This is possible in the molten state since the elecrostatic forces of attraction between the oppositely charged ions are overcome due to the heat. Thus, the ions move freely and conduct electricity.

Occurrence of metals

- The elements or compounds, which occur naturally in the earth's crust, are known as minerals. At some places, minerals contain a very high percentage of a particular metal and the metal can be profitably extracted from it. These minerals are called ores.

Extraction of metals

- The metals at the bottom of the activity series are the least reactive. They are often found in a free state. For example, gold, silver, platinum and copper are found in the free state. Copper and silver are also found in the combined state as their sulphide or oxide ores. The metals at the top of the activity series (K, Na, Ca, Mg and Al) are so reactive that they are never found in nature as free elements. The metals in the middle of the activity series (Zn, Fe, Pb, etc.) are moderately reactive. They are found in the earth's crust mainly as oxides, sulphides or carbonates.
- Thus on the basis of reactivity, we can group the metals into the following three categories. Metals of low reactivity; (ii) Metals of medium reactivity; (iii) Metals of high reactivity. Different techniques are to be used for obtaining the metals falling in each category.

Enrichment of Ores

- Ores mined from the earth are usually contaminated with large amounts of impurities such as soil, sand, etc., called gangue. The impurities must be removed from the ore prior to the extraction of the metal.
- The processes used for removing the gangue from the ore are based on the differences between the physical or chemical properties of the gangue and the ore. Different separation techniques are accordingly employed.

Extracting metals low in the activity series

- Metals low in the activity series are very unreactive. The oxides of these metals can be reduced to metals by heating alone. For example, cinnabar (HgS) is an ore of mercury. When it is heated in air, it is first converted into mercuric oxide (HgO). Mercuric oxide is then reduced to mercury on further heating.

Extracting Metals in the Middle of Activity Series

- The metals in the middle of the activity series such as iron, zinc, lead, copper, are moderately reactive. These are usually present as sulphides or carbonates in nature. Prior to reduction, the metal sulphides and carbonates must be converted into metal oxides.
- The sulphide ores are converted into oxides by heating strongly in the presence of excess air. This process is known as roasting. The carbonate ores are changed into oxides by heating strongly in limited air. This process is known as calcination.
- Obtaining metals from their compounds is also a reduction process. Besides using carbon (coke) to reduce metal oxides to metals, sometimes displacement reactions can also be used. The highly reactive metals are used as reducing agents because they can displace metals of lower reactivity from their compounds.
- These displacement reactions are highly exothermic. The amount of heat evolved is so large that the metals are produced in the molten state.

Extracting Metals Towards the top of the activity series

- The metals high up in the reactivity series are very reactive. They cannot be obtained from their compounds by heating with carbon. For example, carbon cannot reduce the oxides of sodium, magnesium, calcium, aluminium, etc., to the respective metals. This is because these metals have more affinity for oxygen than carbon. These metals are obtained by electrolytic reduction. For example, sodium, magnesium and calcium are obtained by the electrolysis of their molten chlorides. The metals are deposited at the cathode (the negatively charged electrode), whereas, chlorine is liberated at the anode (the positively charged electrode). Similarly, aluminium is obtained by the electrolytic reduction of aluminium oxide.

Refining of Metals

- The metals produced by various reduction processes described so far contain impurities, which must be removed to obtain pure metals. The most widely used method for refining impure metals is electrolytic refining.
- Electrolytic Refining: Many metals, such as copper, zinc, tin, nickel, silver, gold, etc., are refined electrolytically. In this process, the impure metal is made the anode and a thin strip of pure metal is made the cathode. A solution of the metal salt is used as an electrolyte.
- On passing the current through the electrolyte, the pure metal from the anode dissolves into the electrolyte. An equivalent amount of pure metal from the electrolyte is deposited on the cathode. The soluble impurities go into the solution, whereas, the insoluble impurities settle down at the bottom of the anode and are known as anode mud.

Corrosion

Instances of corrosion is visible in following cases:

I. Silver articles become black after some time when exposed to air. This is because it reacts with sulphur in the air to form a coating of silver sulphide.

II. Copper reacts with moist carbon dioxide in the air and slowly loses its shiny brown surface and gains a green coat. This green substance is basic copper carbonate.

III. Iron, when exposed to moist air for a long time, acquires a coating of a browny flaky substance called rust.

Prevention of Corrosion

- The rusting of iron can be prevented by painting, oiling, greasing, galvanising, chrome plating, anodising or making alloys.
- Galvanisation is a method of protecting steel and iron from rusting by coating them with a thin layer of zinc. The galvanised article is protected against rusting even if the zinc coating is broken.
- Alloying is a very good method of improving the properties of a metal. We can get the desired properties by this method. For example, iron is the most widely used metal. But it is never used in its pure state. This is because pure iron is very soft and stretches easily when hot. But, if it is mixed with a small amount of carbon (about 0.05 %), it becomes hard and strong. When iron is mixed with nickel and chromium, we get stainless steel, which is hard and does not rust. Thus, if iron is mixed with some other substance, its properties change. In fact, the properties of any metal can be changed if it is mixed with some other substance. The substance added may be a metal or a non-metal. An alloy is a homogeneous mixture of two or more metals, or a metal and a non- metal. It is prepared by first melting the primary metal, and then, dissolving the other elements in it in definite proportions. It is then cooled to room temperature.
- If one of the metals is mercury, then the alloy is known as an amalgam. The electrical conductivity and melting point of an alloy is less than that of pure metals.
- Pure gold, known as 24 carat gold, is very soft. It is, therefore, not suitable for making jewellery. It is alloyed with either silver or copper to make it hard. Generally, in India, 22 carat gold is used for making ornaments. It means that 22 parts of pure gold is alloyed with 2 parts of either copper or silver.

CARBON AND ITS COMPOUNDS

- All living structures are carbon based. The earth's crust has only 0.02% carbon in the form of minerals (like carbonates, hydrogen- carbonates, coal and petroleum) and the atmosphere has 0.03% of carbon dioxide. In spite of this small amount of carbon available in nature, the importance of carbon seems to be immense.

Bonding in carbon - The Covalent Bond

- Bonds which are formed by the sharing of an electron pair between two atoms are known as covalent bonds. Covalently bonded molecules are seen to have strong bonds within the molecule, but inter- molecular forces are weak. This gives rise to the low melting and boiling points of these compounds. Since the electrons are shared between atoms and no charged particles are formed, such covalent compounds are generally poor conductors of electricity.
- The reactivity of elements is explained as their tendency to attain a completely filled outer shell, that is, attain noble gas configuration. Elements forming ionic compounds achieve this by either gaining or losing electrons from the outermost shell. In the case of carbon, it has four electrons in its outermost shell and needs to gain or lose four electrons to attain noble gas configuration.
- Carbon overcomes this problem by sharing its valence electrons with other atoms of carbon or with atoms of other elements. Not just carbon, but many other elements, including water, nitrogen, methane, form molecules by sharing electrons in this manner. Thus these molecules form the carbon bond.
- Allotropes of Carbon: The element carbon occurs in different forms in nature with widely varying physical properties. Both diamond and graphite are formed by carbon atoms, the difference lies in the manner in which the carbon atoms are bonded to one another.
- In diamond, each carbon atom is bonded to four other carbon atoms forming a rigid three-dimensional structure. In graphite, each carbon atom is bonded to three other carbon atoms in the same plane giving a hexagonal array. One of these bonds is a double-bond, and thus the valency of carbon is satisfied. Graphite structure is formed by the hexagonal arrays being placed in layers one above the other.
- These two different structures result in diamond and graphite having very different physical properties even though their chemical properties are the same. Diamond is the hardest substance known while graphite is smooth and slippery. Graphite is also a very good conductor of electricity unlike other non-metals that you studied in the previous Chapter.
- Diamonds can be synthesised by subjecting pure carbon to very high pressure and temperature. These synthetic diamonds are small but are otherwise indistinguishable from natural diamonds.
- Fullerenes form another class of carbon allotropes. The first one to be identified was C-60 which has carbon atoms arranged in the shape of a football. Since this looked like the geodesic dome designed by the US architect Buckminster Fuller, the molecule was named fullerene.

Versatile Nature of Carbon

- Carbon has the unique ability to form bonds with other atoms of carbon, giving rise to large molecules. This property is called catenation. These compounds may have long chains of carbon, branched chains of carbon or even carbon atoms arranged in rings. In addition, carbon atoms may be linked by single, double or triple bonds. Compounds of carbon, which are linked by only single bonds between the carbon atoms are called saturated compounds. Compounds of carbon having double or triple bonds between their carbon atoms are called unsaturated compounds. No other element exhibits the property of catenation to the extent seen in carbon compounds. The carbon-carbon bond is very strong and hence stable.
- Since carbon has a valency of four, it is capable of bonding with four other atoms of carbon or atoms of some other mono-valent element. Compounds of carbon are formed with oxygen, hydrogen, nitrogen, sulphur, chlorine and many other elements giving rise to compounds with specific properties One reason for the formation of strong bonds by carbon is its small size. This enables the nucleus to hold on to the shared pairs of electrons strongly. Saturated and unsaturated carbon compounds
- The Carbon compound with valencies of all the atoms are satisfied by single bonds between them, are called saturated compounds. These saturated compounds are not very reactive. The compounds of carbon having double or triple bonds between the carbon atoms are known as unsaturated carbon compounds and they are more reactive than the saturated carbon compounds.
- The compounds with identical molecular formula but different structures are called structural isomers.
- All the carbon compounds which contain only carbon and hydrogen are called hydrocarbons. Among these, the saturated hydrocarbons are called alkanes. The unsaturated hydrocarbons which contain one or more double bonds are called alkenes. Those containing one or more triple bonds are called alkynes.

Friendly Nature of Carbon

- Carbon is a friendly element in terms of forming bond. Besides Hydrogen, Carbon also forms bonds with other elements such as halogens, oxygen, nitrogen and sulphur. In a hydrocarbon chain, one or more hydrogens can be replaced by these elements, such that the valency of carbon remains satisfied. In such compounds, the element replacing hydrogen is referred to as a heteroatom.
- These heteroatoms and the group containing these confer specific properties to the compound, regardless of the length and nature of the carbon chain and hence are called functional groups.

Homologous Series

- The presence of a functional group such as alcohol decides the properties of the carbon compound, regardless of the length of the carbon chain. For example, the chemical properties of CH3OH, C2H5OH, C3H7OH and C4H9OH are all very similar. Hence, such a series of compounds in which the same functional group substitutes for hydrogen in a carbon chain is called a homologous series.
- The general formula for alkenes can be written as CnH2n, where n = 2, 3, 4. The general formula for alkanes can be written as CnH2n+2, where n = 1,2, 3, 4. The general formula for alkynes can be written as CnH2n-2, where n = 2, 3, 4.
- As the molecular mass increases in any homologous series, a gradation in physical properties is seen. This is because the melting and boiling points increase with increasing molecular mass. Other physical properties such as solubility in a particular solvent also show a similar gradation. But the chemical properties, which are determined solely by the functional group, remain similar in a homologous series.

Chemical Properties of Carbon Compounds

- Carbon, in all its allotropic forms, burns in oxygen to give carbon dioxide along with the release of heat and light.
- Saturated hydrocarbons will generally give a clean flame while unsaturated carbon compounds will give a yellow flame with lots of black smoke. However, limiting the supply of air results in incomplete combustion of even saturated hydrocarbons giving a sooty flame. The gas/kerosene stove used at home has inlets for air so that a sufficiently oxygen-rich mixture is burnt to give a clean blue flame.
- Fuels such as coal and petroleum have some amount of nitrogen and sulphur in them. Their combustion results in the formation of oxides of sulphur and nitrogen which are major pollutants in the environment.
- Flame is only produced when gaseous substances burn. When wood or charcoal is ignited, the volatile substances present vapourise and burn with a flame in the beginning. While a candle or LPG burns with a flame, coal and charcoal just glows red and gives out heat without flame. A luminous flame is seen when the atoms of the gaseous substance are heated and start to glow. The colour produced by each element is a characteristic property of that element.

Oxidation

- Carbon compounds can be easily oxidised on combustion. In addition to this complete oxidation, we have reactions in which alcohols are converted to carboxylic acids

Addition Reaction

- Unsaturated hydrocarbons add hydrogen in the presence of catalysts such as palladium or nickel to give saturated hydrocarbons. Catalysts are substances that cause a reaction to occur or proceed at a different rate without the reaction itself being affected. This reaction is commonly used in the hydrogenation of vegetable oils using a nickel catalyst.
- Oils containing unsaturated fatty acids are more healthy than the saturated ones.

Properties of Ethanol

- Ethanol is a liquid at room temperature. Ethanol is commonly called alcohol and is the active ingredient of all alcoholic drinks. In addition, because it is a good solvent, it is also used in medicines such as tincture iodine, cough syrups, and many tonics. Ethanol is also soluble in water in all proportions.
- Consumption of small quantities of dilute ethanol causes drunkenness. However, intake of even a small quantity of pure ethanol (called absolute alcohol) can be lethal.

- When large quantities of ethanol are consumed, it tends to slow metabolic processes and to depress the central nervous system. This results in lack of coordination, mental confusion, drowsiness, lowering of the normal inhibitions, and finally stupor.
- Unlike ethanol, intake of methanol in very small quantities can cause death. Methanol is oxidised to methanal in the liver. Methanal reacts rapidly with the components of cells. It coagulates the protoplasm, in much the same way an egg is coagulated by cooking. Methanol also affects the optic nerve, causing blindness.
- Ethanol is an important industrial solvent. To prevent the misuse of ethanol produced for industrial use, it is made unfit for drinking by adding poisonous substances like methanol to it. Dyes are also added to colour the alcohol blue so that it can be identified easily. This is called denatured alcohol.
- Some countries now use alcohol as an additive in petrol since it is a cleaner fuel which gives rise to only carbon dioxide and water on burning in sufficient air (oxygen).
- Sugarcane plants are one of the most efficient convertors of sunlight into chemical energy. Sugarcane juice can be used to prepare molasses which is fermented to give alcohol (ethanol).

Properties of Ethnic Acid

- Ethanoic acid is commonly called acetic acid and belongs to a group of acids called carboxylic acids (weak acids). 5-8% solution of acetic acid in water is called vinegar and is used widely as a preservative in pickles. The melting point of pure ethanoic acid is 290 K and hence it often freezes during winter in cold climates. This gave rise to its name glacial acetic acid.
- Ethanoic acid reacts with absolute ethanol in the presence of an acid catalyst to give an ester which are sweet smelling substances used in making perfumes and flavouring agents.
- On treating with sodium hydroxide, which is an alkali, the ester is converted back to alcohol and sodium salt of carboxylic acid. This reaction is known as saponification because it is used in the preparation of soap. Soaps are sodium or potassium salts of long chain carboxylic acid.

Soaps and Detergents

- Most dirt is oily in nature. The molecules of soap are sodium or potassium salts of long-chain carboxylic acids. The ionic-end of soap interacts with water while the carbon chain interacts with oil. The soap molecules, thus form structures called micelles where one end of the molecules is towards the oil droplet while the ionic-end faces outside. This forms an emulsion in water. The soap micelle thus helps in pulling out the dirt in water and we can wash our clothes clean.
- When washing in hard water, it becomes difficult to form foam and an insoluble substance (scum) remains after washing. This happens due to the reaction of soap with the calcium and magnesium salts which is present in hard water. Hence one needs to use a larger amount of soap.
- This problem is overcome by using another class of compounds called detergents as cleansing agents. Detergents are generally sodium salts of sulphonic acids or ammonium salts with chlorides or bromides ions, etc. Both have long hydrocarbon chain. The charged ends of these compounds do not form insoluble precipitates with the calcium and magnesium ions in hard water. Thus, they remain effective in hard water.

PERIODIC CLASSIFICATION OF ELEMENTS

Dobereiner's Triad

- He identified some groups having three elements each. So he called these groups 'triads'. Döbereiner showed that when the three elements in a triad were written in the order of increasing atomic masses; the atomic mass of the middle element was roughly the average of the atomic masses of the other two elements.
- Döbereiner could identify only three triads from the elements known at that time. Hence, this system of classification into triads was not found to be useful.

Newland's Law of Octaves

- John Newlands arranged the then known elements in the order of increasing atomic masses. He started with the element having the lowest atomic mass (hydrogen) and ended at thorium which was the 56th element. He found that every eighth element had properties similar to that of the first. He called it the "Law of Octaves".

Drawbacks:

- It was applicable only upto Calcium.
- It assumed only 56 elements to be existing in nature without having space for any element to be discovered in future.
- To fit elements into his table, he even put two unlike elements under the same note.
- Thus, Newlands' Law of Octaves worked well with lighter elements only.

Mendeleev's Periodic Table

- Mendeléev formulated a Periodic Law, which states that 'the properties of elements are the periodic function of their atomic masses'. Mendeléev's Periodic Table contains vertical columns called 'groups' and horizontal rows called 'periods'.
- While developing the Periodic Table, there were a few instances where Mendeléev had to place an element with a slightly greater atomic mass before an element with a slightly lower atomic mass. This was done to group the similar elements together.
- Mendeléev left some gaps in his Periodic Table. Instead of looking upon these gaps as defects, Mendeléev boldly predicted the existence of some elements that had not been discovered at that time.
- One of the strengths of Mendeléev's Periodic Table was that, when these gases were discovered, they could be placed in a new group without disturbing the existing order.

Defects of Mendeleev's Periodic Table

- No fixed position for Hydrogen which resemble both alkali metal and Halogen group
- Isotopes of an element have similar chemical properties, but different atomic masses. Thus, isotopes of all elements posed a challenge to Mendeleev's Periodic Law.
- Another problem was that the atomic masses do not increase in a regular manner in going from one element to the next.

Modern Periodic Table

- In 1913, Henry Moseley showed that the atomic number (symbolised as Z) of an element is a more fundamental property than its atomic mass. Accordingly, Mendeléev's Periodic Law was modified and atomic number was adopted as the basis of Modern Periodic Table and the Modern Periodic Law can be stated as follows: 'Properties of elements are a periodic function of their atomic number.'
- Modern Periodic Table takes care of three limitations of Mendléev's Periodic Table.

Position of Elements in the Modern Periodic Table

- The Modern Periodic Table has 18 vertical columns known as 'groups' and 7 horizontal rows known as 'periods'. Elements present in any one group have the same number of valence electrons.
- Hence, we can say that groups in the Periodic Table signify an identical outer- shell electronic configuration. On the other hand, the number of shells increases as we go down the group.
- The number of valence shell electrons increases by one unit, as the atomic number increases by one unit on moving from left to right in a period. Thus atoms of different elements with the same number of occupied shells are placed in the same period.
- The position of an element in the Periodic Table tells us about its chemical reactivity as the valence electrons determine the kind and number of bonds formed by an element.

Trends in modern periodic table

- The atomic radius decreases in moving from left to right along a period. This is due to an increase in nuclear charge which tends to pull the electrons closer to the nucleus and reduces the size of the atom.
- The atomic size increases down the group. This is because new shells are being added as we go down the group. This increases the distance between the outermost electrons and the nucleus so that the atomic size increases in spite of the increase in nuclear charge.
- In the Modern Periodic Table, a zig-zag line separates metals from non- metals. The borderline elements – boron, silicon, germanium, arsenic, antimony, tellurium and polonium – are intermediate in properties and are called metalloids or semi-metals.
- As the effective nuclear charge acting on the valence shell electrons increases across a period, the tendency to lose electrons will decrease. Down the group, the effective nuclear charge experienced by valence electrons is decreasing because the outermost electrons are farther away from the nucleus. Therefore, these can be lost easily. Hence metallic character decreases across a period and increases down a group.
- Non-metals, on the other hand, are electronegative. They tend to form bonds by gaining electrons. Let us learn about the variation of this property. As the trends in the electronegativity show, non-metals are found on the right-hand side of the Periodic Table towards the top.
- These trends also help us to predict the nature of oxides formed by the elements because it is known that the oxides of metals are basic and that of non-metals are acidic in general.

PART - C

BIOLOGY

CHANGES AROUND US

- Every day, we see different types changes around us like day turning into night, the season changing from winter to summer, melting of ice to water, cooking of food, and so on
- Changes take place around us all the time However, all changes are the same We get back the original substance in some, and can't get them back in others
- A Reversible change is a change that can be undone or reversed Melting is an example of a reversible change. Some other examples of reversible changes are the folding a paper and blowing a balloon,
- An irreversible change is a permanent change that cannot be undone. In an irreversible change, new substances are formed Cake batter is made from eggs flour, sugar and butter. Once the cake has been baked, you cannot get the ingredients back

WATER

- Our Earth is covered by two-thirds of water, but most of the water is not potable and contains salt
- Water is used for various activities such as agriculture, industries, cooking, cleaning utensils, bathing, washing clothes, and most importantly, for drinking
- Ponds wells, streams lakes and rivers are the different sources of drinking water. They are supplied water by the oceans and seas through the water cycle.

WATER CYCLE

- The circulation of water from the oceans and the surface of the earth, to the air as water vapour, and its return to the ocean as rain, hail or snow is called the water cycle
- The water present on the surface of the ocean evaporates by the sun's heat This process of conversion of water from liquid state to vapour state is called evaporation
- The evaporated water is carried away by warm air As the warm air moves higher from the surface of the Earth, it starts to cool down.
- It is because the water vapour present stats to condense to form tiny water droplets These droplets float in the air and form cloud and fog The process is called condensation
- All these droplets collect to form bigger drops of water. Some of them may become too heavy to remain in the sky and fall down as rain.
- This process is known as precipitation if the air is too cold, the water drops can become snow or hail and may settle on the top of a mountain.
- When these snow or hail melts, they can become part of a river or a stream Thus, the water that is evaporated from the oceans or seas is again condensed to form water and fills up the rivers and seas. Rain water also seeps into the ground to form ground water
- Plants release the water in air through the process of Transpiration They retain the water they need and release the excess water into the air as water vapour through the stomata of the leaves and the stem

DROUGHT

- Droughts occur when there are no rains for a longer period of time The soil continues to lose water by evaporation and transpiration Since it is not being brought back by rain, the soil becomes dry. The level of water in ponds and wells of the region goes down and some of them may even dry up. The ground water may also become scarce. Droughts results in drying up of the crops and vegetation

FLOODS

- Due to heavy rainfall the water levels in ponds, lakes rise to a greater extend and the rise in the water level of these water bodies causes the excess water to spread across causing floods
- Floods wash out the living beings such as fish and other animals etc. and they create great havoc to the mankind Once the rains stop the flood water receded, fish, cattle and other animals were left dead Floods cause lot of harm to the living beings and there will be loss in property also

RAINWATER HARVESTING

- Harvesting is a method to collect and store the rain water
- Constant use of ground water results in scarcity of groundwater So, rain harvesting clears the problem of depleting the ground water

FOOD: WHERE DOES IT COME FROM?

- The main sources of our food are plants and animals.
- Animals which eat only plants are called herbivores. Animals which eat only animals are called carnivores. Animals which eat both plants as well as other animals are called omnivores

COMPONENTS OF FOOD

- The major nutrients in our food are carbohydrates, proteins, fats, vitamins and minerals. In addition, food also contains dietary fibres and water
- Carbohydrates and fats mainly provide energy to our body. Foods containing fats and carbohydrates are also called 'energy giving foods
- The main carbohydrates found in our food are in the form of starch and sugars.
- Proteins and minerals are needed for the growth and the maintenance of our body. Foods containing proteins are often called body building foods
- Vitamins help in protecting our body against diseases. Vitamins also help in keeping our eyes, bones, teeth and gums healthy.
- Roughage is mainly provided by plant products in our foods. Whole grains and pulses, potatoes, fresh fruits and vegetables are main sources of roughage. Roughage does not provide any nutrient to our body, but is an essential component of our food and adds to its bulk. This helps our body get rid of undigested food.
- Water helps our body to absorb nutrients from food. It also helps in throwing out some wastes from body as urine and sweat.

THE LIVING ORGANISMS AND THEIR SURROUNDINGS

HABITAT AND ADAPTATION

- The presence of specific features or certain habits, which enable an organism to live naturally in a place is called adaptation.
- The place where organisms live is called habitat. Habitat means a dwelling place (a home). The habitat provides food, water, air, shelter and other needs to organisms. Several kinds of plants and animals Live in the same habitat
- The plants and animals that live on land are said to live in terrestrial habitats.
- The habitats of plants and animals that live in water are called aquatic habitats.
- The organisms, both plants and animals, living in a habitat are its biotic components.
- The non-living things such as rocks, soil, air and water in the habitat constitute its abiotic components. Sunlight and heat also form abiotic components of the habitat.

TERRESTRIAL HABITATS

Deserts

- Desert plants lose very little water through transpiration. The leaves in desert plants are either absent, very small or they are in the form of spines. This helps in reducing loss of water from the leaves through transpiration
- The leaf-like structure you see in a cactus is, in fact, its stem Photosynthesis in these plants is usually carried out by the stems. The stem is also covered with a thick waxy layer, which helps to retain water in the tissues of cacti. Most desert plants have roots that go very deep into the soil for absorbing water
- The body structure of a camel helps it to survive in desert conditions. Camels have long legs which help to keep their bodies away from the heat of the sand. They excrete small amount of urine, their dung is dry and they do not sweat. Since camels lose very little water from their bodies, they can live for many days without water

Mountain Regions

- Trees are normally cone shaped and have sloping branches. The leaves of some of these trees are needle-like. This helps the rainwater and snow to slide off easily. There could be trees with shapes very different from these that are also present on mountains

Aquatic Habitat

- All the fresh water and marine water bodies, has come under terrestrial habitat
- Fish have special features that help them to live in water. They have streamlined bodies, which reduce friction and allow them to move freely in water
- Sea animals like the octopus and the squid do not have streamlined body as they stay deep inside the ocean on the ocean bed, but make their body streamlined when they move in the water. Sea animals, like fish, octopus and squid have gills that help them to absorb the dissolved oxygen from the water they drink
- Dolphins and whales have blowholes to breathe in air when they swim close to the surface of the water and there by stay inside the water for a long time without breathing
- In general, the aquatic plants have much smaller roots and helps the plant in holding on the surface. Stems are long and light
- A frog can live both in water and on land. Frogs have strong hind legs to hop on land and webbed feet to swim in water. Frogs also have a membrane called the nictitating membrane on their eyes. This membrane helps protect their eyes inside water.

GETTING TO KNOW PLANTS

- Plants can be classified into three categories: herbs, shrubs and trees
- Plants with green and tender stems are called herbs.
- Some plants develop branches near the base of stem. The stem is hard but not very thick. Such plants are called shrubs.
- Some plants are very tall and have hard and thick stem. The stems have branches in the upper part, much above the ground. Such plants are called trees.
- Plants with weak stems that cannot stand upright but spread on the ground are called creepers, while those that take support and climb up are called climbers. These are different from the herbs, shrubs and trees.

LEAF

- The part of leaf by which it is attached to the stem is called petiole. The broad, green part of the leaf is called lamina. The thick vein in the middle of the leaf is called Midrib.
- The design made by veins in a leaf is called the leaf venation. If this design is net-like on both sides of midrib, the venation is reticulate. In the leaves of grass, the veins are parallel to one another. This is parallel venation.
- Water comes out of leaves in the form of vapour by a process called transpiration.
- Leaves prepare their food in the presence of sunlight and a green coloured substance present in them. For this, they also use water and carbon dioxide. This process is called photosynthesis. Oxygen is given out in this process. The food prepared by leaves ultimately gets stored in different parts of plant

ROOTS

- Roots absorb water and minerals from the soil and anchor the plant firmly in the soil.
- Roots are mainly of two types: Tap Roots and fibrous roots. Carrot, radish, sweet potato, turnip and tapioca are roots.
- Plants having leaves with reticulate venation have tap roots while plants having leaves with parallel venation have fibrous roots.
- The stem conducts water from roots to the leaves and other parts) and food from leaves other parts of the plant.

FLOWER

- The parts of a flower are sepals, petals, stamens and pistil.
- Pistil is the female reproductive part of a flower. The pistil, centrally located, typically consists of a swollen base, the ovary, which contains the potential seeds, or ovules; a stalk, or style, arising from the ovary and a pollen- receptive tip, the stigma, variously shaped and often sticky
- Small bead like structures inside the ovary are called ovules.
- The stamen is a male reproductive organ of a flower. It produces the pollen. The stamen has two parts: anther and stalk. The stalk is also called a filament

BODY MOVEMENTS

- The human skeleton comprises the skull, the back bone, ribs and the breast bone, shoulder and hip bones, and the bones of hands and legs.
- Bones and cartilage form the skeleton of the human body. It gives the frame and shape to the body and helps in movement. It protects the inner organs.
- The bones are moved by alternate contractions and relaxations of two sets of muscles

Joints and their Types

- The point at which two separate bones meet called joint. There are four types of joints in the human body

Ball and socket joint

- One end of a bone is rounded and ball-like, and fits into a cup like depression of the other bone. This joint provides movement in any direction. Shoulder joints and hip joints are examples in the shoulder Joint, the head of the humerus fits into a socket of the shoulder girdle. in the hip joint, the large ball- like head of the femur fits into the deep socket of the hip girdle.

Hinge joint

- This joint moves like a hinge in one plane only, just like the hinge of a door. The elbow joint between the humerus and the ulna. The joints between the bones of the fingers and toes, and less perfectly, the knee joint. Hinge joints usually gives sufficient power, because there is less danger of twisting at the joint.

Pivot joint

- The joint where our neck joins the head is a pivotal joint. It allows us to bend our head forward and backward and turn the head to our right or left

Fixed Joint

- Joints where bones dont move are known as Fixed joints.
- Backbone is made of many small bones. The rib cage is joined to these bones
- Pelvic bones enclosed the portion of your body below the stomach
- The skull is made up of many bones joined together. It encloses and protects a very important part of the body, the brain
- Cartilage are not as hard as the bones and can be bent.

Other Living Organisms

Earthworm

- The body of an earthworm is made up of many rings joined end to end
- An earthworm does not have bones it has muscles which help to extend and shorten the body.
- Earthworms move by alternate extension and contraction of the body using muscles. Tiny bristles on the underside of the body help in gripping the ground.

Snail

- The outer skeleton of the snail, the shell, is made of calcium carbonate.

- The under surface of the muscular foot is lubricated with mucus. Waves of muscular contractions along this surface help a snail move. The mucus also reduces the risk of injury from sharp objects. That is why snails can walk over sharp objects like blades without getting hurt.

Cockroach

- The cockroach has three pairs of legs that help it to walk, and two pairs of wings that help it to fly. A cockroach moves its legs with the help of muscles near the limbs
- The body and legs of cockroaches have hard coverings forming an outer skeleton. The muscles of the breast connected with three pairs of legs and two pairs of wings help the cockroach to walk and fly.

Birds

- A bird has a body best suited for flying. Its wings are actually modified forelimbs. Birds can fly easily with the help of these bony forelimbs.
- Birds have very strong shoulder bones. They don't have the urinary bladder, which helps them to fly easily. They can walk and perch on trees with the help of their hind limbs

Gait of Snakes

- Snakes move in S-shaped loops and in a zigzag manner. They cannot move in a straight line. They have difficulty in moving on very smooth surfaces
- Snakes have a long back bone and many interconnected muscles that help them to slither. They have muscles connecting the backbone, ribs and skin. Snakes move in grass, sand and water. Snakes do not have arms or legs, but even then, they can climb trees.

Gait of fish

- Fish have a streamlined body, which helps them move fast in water, Fish swim with the help of their fins. The tail moves from side to side, and helps the fish swim in the right direction. Some fish, however, move by bending their bodies from one side to another in quick succession, which produces a thrust that helps it move forward. Fish swim by forming loops alternately on two sides of the body

CHARACTERISTICS OF THE LIVING BEINGS

Respiration

- The process of breathing and out. Living things take oxygen into the body as they breathe in and release carbon dioxide as they breathe out.
- The oxygen that enters the body during respiration helps the body to create energy from the food consumed. Some animals have special organs that help them in the process of respiration
- The gills of fish help them to absorb oxygen dissolved in water. Earthworms breathe through their skin.
- Plants have tiny pores on the leaves that help them to breathe. Plants respire day and night, but breathe out oxygen during the day. Plants release more oxygen while producing their food than they release during respiration

Excrete

- The process of eliminating wastes from the body is called excretion.
- Livings things need food, but they only absorb some amount of it for various processes, while the remaining food needs to be eliminated from the body. For example, plants eliminate harmful waste substances in the form of secretions such as resins and gums, whereas some plants store the harmful substances without any difficulty

Reproduce

- All livings things reproduce. Some animals lay eggs, while others
- reproduce by giving birth to young ones. Plants produce seeds that can germinate into a new plant, but there are some, such as potato and rose plants, which reproduce through other parts.

GARBAGE IN, GARBAGE OUT

- Landfill is an area where the garbage collected from a city or town is dumped. The area is later converted into a park
- Converting plant and animal waste including that from kitchen into manure, is called composting
- The method of preparing compost with the help of redworms is called composting

VERMICOMPOSTING

- Vermicomposting. The red worm is a type of earthworm that lives in the soil rich in organic matter, which is a combination of nitrogen-rich and carbon-rich material with plenty of moisture and microbes

SOIL

- The mixture of rock particles and humus is called the soil. It provides anchorage to the plants and supplies water and nutrients.
- Living organisms such as bacteria, plant roots and earthworm are important parts of any soil

Soil Profile

- Soil is composed of distinct layers and is formed by the breaking down of rocks by the action of wind, water and climate This process is called weathering
- The nature of any soil depends upon the rocks from has been formed and the type of vegetation that grows in it
- A vertical section through different layers of the soil called the soil profile
- Each layer differs in steel (texture), colour depth and chemical composition. These layers are referred to as horizons.
- The uppermost horizon is generally dark in colour as it is rich in humus and minerals. The humus makes the soil fertile and provides nutrients to growing plants This layer is generally soft, porous and can retain more water It is called the topsoil or the A-horizon.
- This provides shelter for many living organisms such as worms, rodents, moles and beetles. The roots of small plants are embedded entirely in the topsoil
- The next layer has a lesser amount of humus but more of minerals This layer is generally harder and more compact and is called the B-horizon or the middle layer. The third layer is the C- Horizon, which is made up of small lumps of rocks with cracks and crevices
- Below this layer is the bedrock which is hard and difficult to dig with a spade Soil Types
- The soil is classified on the basis of the proportion of particles of various sizes
- If soil contains greater proportion of big particles it is called sandy soil Sand particles are quite large They cannot fit close together, so there are large spaces between them. These spaces are filled with air. We say that the sand is well aerated Water can drain quickly through the spaces between the sand particles So, sandy soils tend to be light well aerated and rather dry
- If the proportion of fine particles is relatively higher, then it is called clayey soil Clay particles, being much smaller, pack tightly together, leaving little space for air. Unlike sandy soil, water can be held in the tiny gaps between the particles of clay So clayey soils have less air but they are heavy as they hold more water than the sandy soils
- If the amount of large and fine particles is about the same, then the soil is called loam The best topsoil for growing plants is loam. Loamy soil is a mixture of sand, clay and another type of soil particle known as silt. Silt occurs as a deposit in riverbeds The size of the silt particles is between those of sand and clay. The loamy soil also has humus in it It has the night water holding capacity for the growth of plants.

Soil and Crops

- Soil is affected by Wind, rainfall, temperature, light and humidity. The climatic factors, as well as the components of soil, determine the various types of vegetation and crops that might grow in any region.
- Clayey and loamy soils are both suitable for growing cereals like wheat and gram
- For paddy, soils rich in clay and organic matter and having a good capacity to retain water are ideal

- For lentils (masoor and other pulses, loamy soils, which drain water easily, are required
- For cotton sandy-loam or loam, which drain water easily and can hold plenty of air are more suitable
- Percolation - The phenomenon of absorption of water by soil
- The removal of land surface by water, wind or ice is known as erosion Plant roots firmly bind soil. In the absence of plants, soil becomes loose
- Wind and flowing water move the loose soil away Soil erosion is severe in areas of little or no surface vegetation, such as deserts and barren lands. Therefore, cutting of trees and deforestation should be prevented, and efforts should be made to increase greenery

NUTRITION IN PLANTS

- Nutrition is the mode of taking food by an organism and its utilisation by the body
- The mode of nutrition in which organisms make food themselves from simple substances is called autotrophic, plants are called Autotrophs
- Animals and most other organisms take in food prepared by plants They are called Heterotrophs

Cells

- The bodies of living organisms are made of tiny units called cells
- The cell is enclosed by a thin outer boundary called the cell membrane
- Most cells have a distinct, centrally located spherical structure called the nucleus
- The nucleus is surrounded by a jelly-like substance called cytoplasm

Photosynthesis

- Leaves are the food factories of plants. Plants prepare food by using water, carbon dioxide and minerals.
- Water and minerals present in the soil are absorbed by the roots and transported to the leaves
- Carbon dioxide from air is taken in through the tiny pores present on the surface of leaves These pores are surrounded by guard cells Such pores are called stomata
- The leaves have a green pigment called chlorophyll which helps leaves to capture the energy of the sunlight to synthesise (prepare) food from carbon dioxide and water, called photosynthesis
- Oxygen is produced during photosynthesis
- The presence of starch in leaves indicates the occurrence of photosynthesis. Starch is also a carbohydrate.
- The leaves other than green also have chlorophyll Slimy green patches in ponds or stagnant water bodies are generally formed by the growth of organisms called algae. Algae can also prepare their own food by photosynthesis
- Carbohydrates are made of carbon, hydrogen and oxygen while Proteins are nitrogenous substances which contain nitrogen
- Soil has certain bacteria that convert gaseous nitrogen into a usable form and release it into the soil and absorbed by the plants along with water

Other Modes of Nutrition in Plants

- Heterotrophs do not contain chlorophyll, for eg Cuscuta (Amarbel). It takes readymade food from the plant(host)on which it is climbing Since it deprives the host of valuable nutrient, Cuscuta is called the parasite Insectivorous plants are the insect eating plants

Saprotrophs

- Fungi Have a different mode of nutrition. They secrete digestive juices on the dead and decaying matter and convert it into a solution. Then they observe the nutrients from it. This mode of nutrition in which organisms take in nutrients in solution form from dead and decaying matter is called

Nutrients in the Soil

- Usually crop plants absorb a lot of nitrogen and the soil becomes deficient in nitrogen, Through nitrogen gas is available in plenty in the air, plants cannot use it in the manner they can use carbon dioxide. They need nitrogen in a soluble form.

- The bacteria called Rhizobium can take atmospheric nitrogen and convert it into a usable form. But Rhizobium cannot make its own food.
- So, it often lives in the roots of gram, peas, mung beans and other legumes and provides them with nitrogen. In return, the plants provide food and shelter to the bacteria. They, thus have a symbiotic relationship.

NUTRITION IN ANIMALS

- Animal nutrition includes nutrient requirement mode of intake of food and its utilisation in the body
- The components of food such as carbohydrates are complex substances
- These complex substances cannot be utilised as such. So, they are broken down into simpler substances The breakdown of complex components of food into simpler substances is called digestion

Digestive System of Human

- Nutrition is a complex process involving: i) ingestion, ii)digestion iii) absorption, (iv) assimilation and v) egestion.
- The human digestive system consists of the alimentary canal and secretory glands
- It consists of the i) buccal cavity. ii) oesophagus, iii) stomach, (iv) small intestine, v) large intestine ending in rectum and (vi) anus
- The main digestive glands which secrete digestive juices are i) the Salivary glands, (ii) the liver and () the pancreas The stomach wall and the wall of the small intestine also secrete digestive juices
- The digestive juices convert complex substances of food into simpler ones
- The process of taking food into the body is called ingestion
- Our mouth has the salivary glands which secrete saliva. The saliva breaks down the starch into sugars
- The stomach is a thick-walled flattened shaped bag and it is the widest part of the alimentary canal. It receives food from the food pipe at one end and opens into the small intestine at the other
- The inner lining of the stomach secretes mucous, hydrochloric acid and digestive juices. The mucous protects the lining of the stomach The digestive juices break down the proteins into simpler substances
- The small intestines highly coiled and is about 7.5 metres long It receives secretions from the liver and the pancreas Besides, its wall also secretes Juices
- The liver is a reddish brown gland, situated in the upper part of the abdomen on the right side, It is the largest gland in the body. It secretes bile juice that is stored in a sac called the gall bladder. The bile plays an important role in the digestion of fats
- The pancreas is a large cream coloured gland located just below the stomach The pancreatic juice acts on carbohydrates, fats and proteins and changes them into simpler forms
- The digested food can pass into the blood vessels in the wall of the intestine. This process is called absorption
- The inner walls of the small intestine have thousands of finger like outgrowths. These are called villi (singular villus. Each villus has a network of thin and small blood vessels close to its surface. The surface of the villi absorbs the digested food materials. The absorbed substances are transported via the blood vessels to different organs of the body where they are used to build complex substances such as the proteins required by the body. This is called assimilation.
- In the cells, glucose breaks down with the help of oxygen into carbon dioxide and water, and energy is released The food that remains undigested and unabsorbed enters into the large intestine.
- The large intestine is wider and shorter than small intestine. It is about 15 metre in length. Its function is to absorb water and some salts from the undigested food material The remaining waste passes into the rectum and remains there as semi-solid faeces. The faecal matter is removed through the anus from time-to-time. This is called egestion Digestion in Ruminants
- Cows, buffaloes and other grass-eating animal quickly swallow the grass and store it in a part of the stomach called rumen Here the food gets partially digested and is called cud But later the cud returns to the mouth in small lumos and the animal chews it. This process is called rumination and these animals are called ruminants.

- The grass is rich in cellulose a type of carbohydrate. In ruminants like cattle, deer, etc, bacteria present in rumen helps in digestion of cellulose
- Many animals, including humans cannot digest cellulose Animals like horses, rabbit, etc, have a large sac-like structure called Caecum between the oesophagus and the small intestine The cellulose of the food is digested here by the action of certain bacteria which are not present in humans

Amoeba

- Amoeba is a microscopic single-celled organism found in pond water
- Amoeba has a cell membrane, a rounded, dense nucleus and many small bubble-like vacuoles in its cytoplasm
- Amoeba constantly changes its shape and position. It pushes out one, or more finger-like projections called pseudopodia or false feet for movement and culture of food. Amoeba feeds on some microscopic organisms.
- When it senses food, it pushes out pseudopodia around the food particle and engulfs it. The food becomes trapped in a food vacuole

RESPIRATION IN ORGANISM

- Respiration is essential for survival of living organisms releases energy from the food.
- All organisms are made of small microscopic units called cells A cells the smallest structural and functional unit of an organism
- Each cell of an organism performs certain functions such as nutrition transport, excretion and reproduction. To perform these functions, the cell needs energy The food has stored energy, which is released during respiration. All living organisms respire to get energy from food
- The air we breathe in is transported to all parts of the body and ultimately to each cell in the cells, oxygen in the air helps in the breakdown of food.
- The process of breakdown of food in the cell with the release of energy called cellular respiration Cellular respiration takes place in the cells of all organisms in the cell, the food (glucose) is broken down into carbon dioxide and water using oxygen. When breakdown of glucose occurs with the use of oxygen it is called aerobic respiration
- Food can also be broken down, without using oxygen. This is called anaerobic respiration Breakdown of food releases energy
- There are some organisms such as yeast that can survive in the absence of air. They are called anaerobes They get energy through anaerobic respiration. In the absence of oxygen, glucose breaks down into alcohol and carbon dioxide.
- Yeasts are single-celled organisms They respire anaerobically and during this process yield alcohol They are, therefore, used to make wine and beer

Breathing

- The taking in of air rich in oxygen into the body is called inhalation and giving out of air rich in carbon dioxide is known as exhalation The number of times a person breathes in a minutes termed as the breathing rate. On an average, an adult human being at rest breathes in and out 15-18 times in a minute.
- During heavy exercise, the breathing rate can increase upto 25 times per minute
- Air passes through the tiny hair in the nasal cavity, and then through the pharynx larynx and windpipe before reaching the lungs
- The hairs in the nasal cavity prevent the entry of dust particles and pollen
- Lungs are situated inside the chest cavity, and they rest on a large Muscular sheet called the diaphragm, which forms the floor of the chest cavity When you breathe in your diaphragm and rib cage get into action

Breathing in other Animals

- A cockroach has small openings on the sides of its body. These openings are called spiracles

- Insects have a network of air tubes called tracheae for gas exchange Oxygen rich air rushes through spiracles into the tracheal tubes, diffuses into the body tissue, and reaches every cell of the body.
- Similarly, carbon dioxide from the cells goes into the tracheal tubes and moves out through spiracles. These air tubes or tracheae are found only in insects and not in any other group of animals
- Earthworms breathe through their skins. The skin of an earthworm feels moist and slimy on touching Gases can easily pass through them. Though frogs have a pair of lungs in human beings they can also breathe through their skin, which is moist and slippery
- Gills in fish help them to use oxygen dissolved in water. Gills are projections of the skin. Gills are well supplied with blood vessels for exchange of gases

Circulatory System

- This is also known as the cardiovascular system. It consists of the heart blood vessels and blood

Blood

- Blood is the fluid which tows in blood vessels. It transports substances like digested food from the small intestine to the other parts of the body. It carries oxygen from the lungs to the cells of the body. It also transports waste for removal from the body Blood is composed of a fluid, called plasma in which different types of cells are suspended
- One type of cell is the red blood cells (RBC) which contain a red pigment called haemoglobin Haemoglobin binds with oxygen and transports it to all the parts of the body and ultimately to all the cells. It will be difficult to provide oxygen efficiently to all the cells of the body without haemoglobin. The presence of haemoglobin makes blood appear red
- The blood also has white blood cells (WBC) which fight against germs that may enter our body
- The clot is formed after injury because of the presence of another type ofcells in the blood, called platelets

Blood Vessels

- Blood flows through narrow pipe-like structures in the body, known as blood vessels. These blood vessels transport food, oxygen and waste within the body
- Arteries transport oxygen-rich blood from the heart to the other parts of the body. The blood in the arteries is bright red in colour Blood flows through the arteries at high pressure, because of which the arteries have thick elastic walls When an artery is cut, blood rushes out immediately
- The arteries divide into smaller vessels when they enter an organ, and further divide into thin tubes called capillaries. These capillaries supply oxygen and nutrients to the tissues and also collect waste and carbon dioxide.
- Veins carry blood low in oxygen content Veins have valves that allow blood to flow in one direction towards the heart - only. Veins have thin walls That is why when a vein is cut blood comes out slowly and continuously. A number of capillaries together form a vein

Heart

- The heart is an organ which beats continuously to act as a pump for the transport of blood, which carries other substances with it
- The heart is located in the chest cavity with its lower tip slightly tilted towards the left. The heart has four chambers The two upper chambers are called the atria (singular atrium) and the two lower chambers are called the ventricles. The partition between the chambers helps to avoid mixing up of blood rich in Oxygen with the blood rich in carbon dioxide

Heartbeat

- The walls of the chambers of the heart are made up of muscles These muscles contract and relax rhythmically. This rhythmic contraction followed by its relaxation constitute a heartbeat Each heart beat generate one pulse in the arteries and the pulse rate per minute indicates the rate of heart beat
- Animals such as sponges and Hydra do not possess any circulatory system. The water in which they live brines food and oxygen as it enters their bodies The water carries away waste materials and carbon dioxide as it moves out. Thus, these animals do not need a way not need a circulatory fluid like the blood

Excretory System

- The process of removal of wastes produced in the cells of the Living organisms is called excretion The parts involved in excretion form the excretory system
- A mechanism to filter the blood is required. This is done by the blood capillaries in the kidneys. When the blood reaches the two kidneys, it contains both useful and harmful substances.
- The useful substances are absorbed back Into the blood. The wastes dissolved in water are removed as urine From the kidneys, the urine goes into the urinary bladder through tube-like ureters it is stored in the bladder and is passed out through the urinary opening at the end of a muscular tube called urethra The kidneys, ureters, bladder and urethra form the excretory system
- Aquatic animals like fishes, excrete cell waste as ammonia which directly dissolves in water Some land animals like birds, lizards, snakes excrete a semi-solid, white coloured compound (uric acid. The major excretory product in humans is urea
- The functioning of the kidneys stops when there is an infection. This is known as kidney failure. As a result, waste products remain in the blood. When blood is not filtered, survival becomes difficult, so it is filtered through an artificial kidney. The process is called dialysis

Transportation in Plants

- Plants make their own food by taking in carbon dioxide from the air, minerals and water from the soil. They release oxygen and water vapour, and the process is termed photosynthesis Plants get energy from the food to perform the vital activities. Food and water are transported to various cells in the body

Root hair

- Plants take in water through their roots. All roots have a root cap to protect the tender root tip from getting damaged by the soil particles When the plants grow, the roots branch and branch and get fixed in the soil
- At the root tips there are a large number of cells that absorb water and nutrients from the soil. The amount of water absorbed is proportionate to the number of root hairs. As the number of root hair increases the surface area also increases, and the plant absorbs more water and minerals
- There are pipe-like vessels in plants through which water and minerals enter. Each vessel is made up of thick walls and elongated cells
- A tissue is a group of cells that performs a specialised function in organisms. These are commonly known as conducting tissue The conducting tissues are of two types They are xylem and phloem. These tissues form a continuous network within the plants, and spread across the roots, stem branches and leaves

Xylem and phloem

- The xylem carries water and nutrient minerals from the roots to the leaves. The phloem carries food from the leaves to various parts of the plant Transportation
- Plants absorb mineral nutrients and water from the soil Not all the water absorbed is utilised by the plant. The water evaporates through the stomata present on the surface of the leaves by the process of transpiration

REPRODUCTION IN PLANTS

- The production of new individuals from their parents is known as reproduction. All organisms multiply or reproduce their own kind
- Most plants have roots, stems and leaves These are called the vegetative parts of plant
- Plants reproduce either sexually or asexually Plants reproduce sexually by the most attractive part, called the flower Flowers are the reproductive parts
- In asexual reproduction plants can give rise to new plants without seeds whereas in sexual reproduction, new plants are obtained from seeds
- Since reproduction is through the vegetative parts of the plant, it is known as vegetative propagation Plants produced by vegetative propagation take less time to grow and bear flowers and fruits earlier than those produced from seeds

Sexual Reproduction

- Flowers are the reproductive parts of a plant. Stamens are the male reproductive part and pistil is the female reproductive part
- Flowers which contain either only pistil or only stamens are called unisexual flowers
- Flowers which contain botth stamens and pistil are called bisexual flowers. Com, papaya and cucumber produce unisexual
- Flowers, whereas mustard, rose and petunia have bisexual flowers
- Anther Contains pollen grains which produce male gametes
- A pistil consists of stigma, style and ovary. Ovary contains one or more ovules
- The female gamete is formed in an ovule in sexual reproduction a male and a female gamete fuse to form a zygote

Pollination

- The transfer of pollen grains from one flower to another is called pollination Pollen grains transfer from one flower to another by pollinating agents
- The transfer of pollen grains from the anther of one flower, to the stigma of another flower on another plant of the same type, is known as cross pollination
- The transfer of pollen grains from the anther to the stigma of the same flower or to the stigma of another flower on the same plant, it is termed self-pollination

Reproduction in Animals

- Reproduction is essential for the continuation of a species. There are two modes by which animals reproduce. These are:

(1) Sexual reproduction, and
(2) Asexual reproduction

- The reproductive parts in animals produce gametes that fuse to form a zygote. It is the zygote which develops into a new individual This type of reproduction beginning from the fusion of male and female gametes is called sexual reproduction.
- Male reproductive organs Include a pair of testes (singular, testis), two sperm duets and penis. The testes produce the male gametes called sperms
- Millions of sperms are produced by the testes. Though sperms are very small in size, each has a head, a middle piece and a tail. Each sperm is a single cell with all the usual cell components.
- Female reproductive organs: are a pair of ovaries, oviducts (fallopian tubes) and the uterus. The ovary produces female gametes called Ova (eggs). In human beings a single matured egg is released into the oviduct by one of the ovaries every month. Uterus is the part where development of the baby takes place. Like the sperm, an egg is also a single cell
- Fertilization: The first step in the process of reproduction is the fusion of a sperm and an ovum. When sperms come in contact with an egg, one of the sperms may fuse with the egg. Such fusion of the egg and the sperm is called fertilization.
- During fertilization, the nuclei of the sperm and the egg fuse to form a single nucleus. This results in the formation of a fertilized egg or zygote.
- The process of fertilization is the meeting of an egg cell from the mother and a sperm cell from the father. So, the new individual inherits some characteristics from the mother and some from the father.
- Fertilization which takes place inside the female body is called internal fertilization. It occurs in many animals including humans, cows, dogs and hens.
- Development of Embryo: Fertilization results in the formation of zygote which begins to develop into an embryo. The zygote divides repeatedly to give rise to a ball of cells. The cells then begin to form group that develop into different tissues and organs of the body
- This developing structure is termed an embryo. The embryo gets embedded in the wall of the uterus for further development.

- The embryo continues to develop in the uterus. It gradually develops body parts such as hands, legs, head, eyes, ears etc. The stage of the embryo in which all the body parts can be identified is called a foetus.
- When the development of the foetus is complete, the mother gives birth to the baby In animals which undergo external fertilization, development of the embryo takes place outside the female body.
- The embryo continue to grow within their egg coverings. After the embryos develop, the eggs hatch
- Viviparous and oviparous animals: The animals which give birth to young ones are called viviparous animals. Those animals which lay eggs are called oviparous animals. The transformation of the larva into adult through drastic changes is called metamorphosis.
- The type of reproduction in which only a single parent is involved is called asexual reproduction
- In hydra, new individuals develop from buds. This method of asexual reproduction is called budding
- Amoeba reproduces by dividing itself into two. This asexual reproduction is called binary fission.

FOREST: OUR LIFELINE

- Forest is a system comprising various plants animals and micro organisms We get various products from the forests surrounding us In a forest, trees form the uppermost layer, followed by shrubs The herbs form the lowest layer of vegetation
- Different layers of vegetation provide food and shelter for animals, birds and insects
- The various components of the forest are interdependent on one another
- The forest keeps on growing and changing and can regenerate organisms
- In the forest, there is Interaction between soil, water, air and living
- Forests protect the soil from erosion. Soil helps forests to grow and

regenerate.

- Forests are the lifeline for the forest-dwelling communities
- Forests influence climate water cycle and air quality
- The branchy part of a tree above the stem is known as the crown
- The dead plant and animal tissues are called humus
- The micro-organisms which convert the dead plants and animals to humus are known as decomposers

Conservation of Forest and Wildlife

- The plants and animals found in a particular area are termed flora and fauna of that area. To protect our flora and fauna and their habitats, protected areas called sanctuaries, national parks and biosphere reserves have been earmarked
- Sanctuary: Areas where animals are protected from any disturbance to them and their habitat
- National Park: Areas reserved for wild life where they can freely use the habitats and natural resources.
- Biosphere Reserve: large areas of protected land for conservation of wild life, plant and animal resources and traditional life of the tribals living in the area
- Endemic species: are those species of plants and animals which are found exclusively in a particular area. They are not naturally found anywhere else. A particular type of animal or plant may be endemic to a zone, a state or a country.
- Wildlife Sanctuary: Provide protection and suitable living conditions to wild animals. Some of the threatened wild animals like black buck, white eyed, buck elephant, golden cat, pink headed duck, gharial, Marsh crocodile
- Animals whose numbers are diminishing to a level that they might face extinction are known as the endangered animals.
- An ecosystem is made of all the plants, animals and microorganisms in an area along with non-living components such as climate, soil, river deltas etc.
- Red Data Book: is the source book which keeps a record of all the endangered animals and plants. There are different Red data books for plants, animals and other species.

Deforestation

- Due to the rise in the population, trees are being cut down to obtain and for agriculture Industry and housing. This is known deforestation. Due to this, many species become homeless
- Forests are also lost due to forest fires and floods. If trees are cut down, then the carbon dioxide level increases This leads to an increase in the
- temperature of the earth's surface, resulting in global warming If forests disappear, then the soil becomes very loose, resulting in soil erosion. The fertility of the soil is maintained when the roots hold the trees and prevent soil erosion by wind and water

Consequences of Deforestation:

- Deforestation increases the temperature and pollution level on the earth. It increases the level of carbon dioxide in the atmosphere. Ground water level also gets lowered. It disturbs the balance in nature.
- If cutting of trees continues, rainfall and fertility of the soil will decrease. Moreover, there will be increased chances of natural calamities such as floods and droughts.
- The Increase In temperature on the earth disturbs the water cycle and may reduce rainfall. This could cause droughts.
- Fewer trees result in more soil erosion. Removal of the top layer of the soil exposes the lower, hard and rocky layers. This soil has less humus and is less fertile. Gradually the fertile land gets converted into deserts, it is called desertification.
- Deforestation also leads to a decrease in the water holding capacity of the soil. The movement of water from into the ground (infiltration rate) is reduces. So, there are floods.

Crop Production and Management

- When plants of the same kind are cultivated at one place on a large scale, it is called a crop
- India is a vast country. The climatic conditions like temperature, humidity and rainfall vary from one region to another. Despite this diversity, two broad cropping patterns can be identified.
  These are

1. Kharif Crops:

- The crops which are sown in the rainy season are called Kharif crops. The rainy season in India is generally from June to September. Paddy, Maize, Soyabean, groundnut cotton etc. are kharif crops.

2. Rabi Crops:

- The crops grown in the winter season are called rabi crops. Their time period is generally from October to March. Eg. wheat, gram, pea, mustard and linseed.
- Basic practices of crop production: Cultivation of crops involves several activities undertaken by farmers over a period of time. These activities or tasks are referred to as agricultural practices.

These activities are listed below

- Preparation of soil
- Sowing
- Adding manures and fertilizers
- Irriigration
- Protecting from weeds
- Harvesting
- Storage

Irrigation:

- Water is important for proper growth and development of flowers, fruits and seeds of plant. The supply of water to crops at different intervals is called irrigation.
- Sources of irrigation: are wells, tube-wells, ponds, lakes, rivers, dams and canals

Modern methods of irrigation

- Sprinkler System: This system is more useful on the uneven land where sufficient water is not available.

The perpendicular pipes, having rotating nozzles on top, are joined to the main pipeline at regular intervals. Sprinkler is very useful for sandy soil.

- Drip System: In this system, the water falls drop by drop first at the position of the roots. So it is called drip system. It is the best technique for watering fruit plants, gardens and trees.
- The system provides water to plants drop by drop. Water is not wasted at all. It is a boon in regions where availability of water is poor.

Protection from Weeds:

- In a field many other undesirable plants may grow naturally along with the crops. These undesirable plants are called weeds. The removal of weeds is called weeding.
- Weeding is necessary since weeds compete with the crop plants for water, nutrients, space and light.
- Tilling before sowing of crops helps uprooting and killing of weeds, which may then dry up and get mixed with the soil.
- Weeds are also controlled by using certain chemicals, called weedicides, like 2,4-D. These are sprayed in the fields to kill the weeds. They do not damage the crops.

Harvesting:

- The cutting of crop after it is mature is called harvesting. In our country it is either done manually by sickle or by a machine called harvester
- In the harvested crops, the grain seeds need to be separated from the chaff. This process is called threshing. This is carried out with the help of a machine called combine which is in fact a combined harvester and thresher
- Farmers with small holdings of land do the separation of grain and chaff by winnowing.

Storage:

- If the crop grains are to be kept for longer time, they should be safe from moisture, insects, rats and micro-organisms. Before storing, the grains are properly dried in the sun to reduce the moisture in them.
- Farmers store grains in jute bags or metallic bins. However, large scale storage of grains is done in silos and granaries to protect them from rests like rats and insects

Micro organisms

- There are living organisms around us which we normally cannot see. These are called micro organisms or microbes.
- Micro organisms are classified into four major groups. These groups are bacteria, fungi, protozoa and some algae.
- Viruses are also microscopic. They, however, reproduce only inside the cells of the host organism, which may be a bacterium, plant or animal. Common ailments like cold, influenza (flu) and most coughs are caused by viruses serious diseases like polio and chicken pox are also caused by viruses
- Diseases like dysentery and malaria are caused by protozoa (Protozoan) whereas typhoid and tuberculosis (TB) are bacterial diseases.
- Microorganisms may be single-celled like bacteria, some algae and protozoa, or multi cellular, such as algae and fungi. They can survive under all types of environment, ranging from ice cold climate to hot springs and deserts to marshy lands.
- They are also found inside the bodies of animals including humans. Some live alone and others live in colonies

CELLS- STRUCTURE AND FUNCTIONS

- The basic structural unit of an organ is called the cell. Cells are assembled to make the body of every organism
- Cells were first observed in cork by Robert Hooke in 1665. Cells of living organisms could be observed only after the discovery of improved microscopes.
- There are millions of living organisms. They are of different shapes and sizes.

- Their organs also very in shape, size and number of cells.
- Organisms made of more than one cell are called multi-cellular organisms.
- The number of cells being less in smaller organisms does not, in any way, affect the functioning of the organisms.
- The single-celled organisms are called unicellular organisms like amoeba, captures and digests food, respires, excretes, grows and reproduces. Similar functions in multi-cellular organisms are carried out by group of specialised cells forming different tissues. Tissues, in turn, form organs Shape of Cells: Amoeba has no definite shape, unlike other organisms. It keeps on changing its shape. These are called Pseudopodia (Pseudo: false; podia: feet)
- A WBC in human blood is another example of a single cell which can change its shape. But while WBC is a cell, amoeba is a full fledged organism capable of independent existence.
- Generally, cells are round, spherical or elongated. Some cells are long and pointed at both ends. They exhibit a spindle shape. Cells sometimes are quite long.
- Some are branched like the nerve cell or a neuron. The nerve cell receives and transfers messages, thereby helping to control and coordinate the working of different parts of the body.

Size of cells:

- The size of cells in living organisms may be as small as a millionth of a metre (micrometre or micron) or may be as large as a few centimetres. However, most of the cells are microscopic in size and are not visible to the unaided eye.
- The size of the cell is related to its function. For e.. nerve cells, both in the elephant and rat, are long and branched. They perform the same function that of transferring messages
- Each organ is made up of smaller parts called tissues. A tissue is a group of similar cells performing a specific function.

Parts of the Cell

Cell Membrane:

- The basic components of a cell are cell membrane, cytoplasm and nucleus. The cytoplasm and nucleus are enclosed within the cell membrane, also called the plasma membrane.
- The membrane separates cells from one another and also the cell from the surrounding medium The plasma membrane is porous and allows the movement of substances or materials both inward and outward.
- There is an outer thick layer in cells of plants called cell wall. This additional layer surrounding the cell membrane is required by plants for protection. Plants cells need protection against variations in temperature high wind speed, atmospheric moisture etc. They are exposed to these variations because they cannot move. Cells can be observed in the leaf peel of Tradescantia Elodea or Rhoco.

Cytoplasm:

- It is the Jelly-like substance present between the cell membrane and the nucleus. Various other components, or organelles, of cells are present in the cytoplasm. These are Mitochondria, Golgi bodies, Ribosomes, etc.

Nucleus:

- It is an important component of the living cell. It is generally spherical and located in the centre of the cell. Nucleus is separated from the cytoplasm by a membrane called the nuclear membrane. This membrane is also porous and allows the movement of materials between the cytoplasm and the inside of the nucleus.
- Nucleus contains thread like structures called chromosomes. These carry genes and help in inheritance or transfer of characters from parents to the offspring. The chromosomes can be seen only when the cell divides.

LIFE PROCESSES

- Molecular movement for the necessity of life. Living creatures must keep repairing and maintaining their structures. Since all these structures are made up of molecules, they must move molecules around all the time. Life Processes
- The maintenance functions of living organisms must go on even when they are not doing anything particular. The processes which together perform this maintenance job are life processes.
- Energy needed for these maintenance process is obtained from outside the body in the form of food. It is transferred inside our body and is called nutrition. The process of acquiring oxygen from outside the body, and to use it in the process of break-down of food sources for cellular needs, is what we call respiration.
- In a single celled organism, since the entire body is in contact with the environment, simple diffusion meets the requirement of all the cells without the need of separate organs.
- In multi-cellular organisms, all the cells may not be in direct contact with the surrounding environment. Thus there exists various body parts with specialised body parts. They also need transportation system for carrying food and oxygen from one place to another in the body.
- The waste by- products produced as part of the chemical reactions within the body are discarded outside by a process called excretion. Here, again a transportation system is needed to transport waste away from cells to this excretory tissue.

NUTRITION

- The general requirement for energy and materials is common in all organisms, but it is fulfilled in different ways.

Autotrophic Nutrition

- Carbon and energy requirements of the autotrophic organism are fulfilled by photosynthesis. It is the process by which autotrophs take in substances like Carbon dioxide and water from the outside and convert them into stored forms of energy (Carbohydrate) in the presence of sunlight and chlorophyll.
- Carbohydrates are utilised for providing energy to the plant. The carbohydrates which are not used immediately are stored in the form of starch, which serves as the internal energy reserve to be used as and when required by the plant.
- The green dots on a leaf, are cell organelles called chloroplasts which contain chlorophyll. Massive amounts of gaseous exchange takes place in the leaves through small pores called stomata. Though exchange of gases occurs across the surface of stems, roots and leaves as well. Since large amounts of water can also be lost through these stomata, the plant closes these pores when it does not need carbon dioxide for photosynthesis. The opening and closing of the pore is a function of the guard cells.
- Water used in photosynthesis is taken up from the soil by the roots in terrestrial plants. Other materials like nitrogen, phosphorus, iron and magnesium are taken up from the soil. Nitrogen is an essential element used in the synthesis of proteins and other compounds. This is taken up in the form of inorganic nitrates or nitrites. Or it is taken up as organic compounds which have been prepared by bacteria from atmospheric nitrogen.

Heterotrophic Nutrition

- There is a range of strategies by which the food is taken in and used by the organism. Some organisms break-down the food material outside the body and then absorb it. Examples are fungi like bread moulds, yeast and mushrooms. Others take in whole material and break it down inside their bodies. What can be taken in and broken down depends on the body design and functioning. Some other organisms derive nutrition from plants or animals without killing them. This parasitic nutritive strategy is used by a wide variety of organisms like cuscuta (amar-bel), ticks, lice, leeches and tape-worms.
- The complexity of the organism increases, different parts become specialised to perform different functions. For example, Amoeba takes in food using temporary finger-like extensions of the cell surface which fuse over the food particle forming a food-vacuole. In Paramoecium, which is also a unicellular organism, the cell has a definite shape and food is taken in at a specific spot. Food is moved to this spot by the movement of cilia which cover the entire surface of the cell.

Nutrition in Human Beings

- The food taken from outside is crushed into small and similar texture with the help of teeth. It is then wetted by a fluid called saliva secreted by the salivary glands. Another aspect of the food we ingest is its complex nature. If it is to be absorbed from the alimentary canal, it has to be broken into smaller molecules.
- This is done with the help of biological catalysts called enzymes. The saliva contains an enzyme called salivary amylase that breaks down starch which is a complex molecule to give simple sugar.
- The lining of canal has muscles that contract rhythmically in order to push the food forward. These peristaltic movements occur all along the gut.
- From the mouth, the food is taken to the stomach through the food-pipe or oesophagus. The digestion in stomach is taken care of by the gastric glands present in the wall of the stomach. These release hydrochloric acid, a protein digesting enzyme called pepsin, and mucus. The hydrochloric acid creates an acidic medium which facilitates the action of the enzyme pepsin. The mucus protects the inner lining of the stomach from the action of the acid under normal conditions.
- The exit of food from the stomach is regulated by a sphincter muscle which releases it in small amounts into the small intestine. This is the longest part of the alimentary canal which is fitted into a compact space because of extensive coiling. The length of the small intestine differs in various animals depending on the food they eat. Herbivores eating grass need a longer small intestine to allow the cellulose to be digested. Meat is easier to digest, hence carnivores like tigers have a shorter small intestine.
- The small intestine receives the secretions of the liver and pancreas that facilitates the complete digestion of carbohydrates, proteins and fats. The food coming from the stomach is acidic and has to be made alkaline for the pancreatic enzymes to act. Bile juice from the liver accomplishes this in addition to acting on fats. Fats are present in the intestine in the form of large globules which makes it difficult for enzymes to act on them. Bile salts break them down into smaller globules increasing the efficiency of enzyme action.
- The pancreas secretes pancreatic juice which contains enzymes like trypsin for digesting proteins and lipase for breaking down emulsified fats. The walls of the small intestine contain glands which secrete intestinal juice. The enzymes present in it finally convert the proteins to amino acids, complex carbohydrates into glucose and fats into fatty acids and glycerol.
- Digested food is taken up by the walls of the intestine. The inner lining of the small intestine has numerous finger-like projections called villi which increase the surface area for absorption. The villi are richly supplied with blood vessels which take the absorbed food to each and every cell of the body, where it is utilised for obtaining energy, building up new tissues and the repair of old tissues.
- The unabsorbed food is sent into the large intestine where its wall absorb more water from this material. The rest of the material is removed from the body via the anus. The exit of this waste material is regulated by the anal sphincter.

Respiration

- The food taken during the process of nutrition is used in cells to provide energy for various life processes. Diverse organisms do this in different ways. In all cases, the first step is the break-down of glucose, a six-carbon molecule, into a three-carbon molecule called pyruvate. This process takes place in the cytoplasm. Further, the pyruvate may be converted into ethanol and carbon dioxide. This process takes place in yeast during fermentation. Since this process takes place in the absence of air (oxygen), it is called anaerobic respiration.
- Break- down of pyruvate using oxygen takes place in the mitochondria. This process breaks up the three-carbon pyruvate molecule to give three molecules of carbon dioxide. The other product is water. Since this process takes place in the presence of air (oxygen), it is called aerobic respiration. The release of energy in this aerobic process is a lot greater than in the anaerobic process.
- Sometimes, when there is a lack of oxygen in our muscle cells, another pathway for the break-down of pyruvate is taken. Here the pyruvate is converted into lactic acid which is also a three-carbon molecule. This build-up of lactic acid in our muscles during sudden activity causes cramps.

- The energy released during cellular respiration is immediately used to synthesise a molecule called ATP which is used to fuel all other activities in the cell. In these processes, ATP is broken down giving rise to a fixed amount of energy which can drive the endothermic reactions taking place in the cell.
- Animals have evolved different organs for the uptake of oxygen from the environment and for getting rid of the carbon dioxide produced. Terrestrial animals can breathe the oxygen atmosphere, but animals that live in water need to use the dissolved in water.
- Since the amount of dissolved oxygen is fairly low compared to the amount of oxygen in the air, the rate of breathing in aquatic organisms is much faster than that seen in terrestrial organisms.
- In human beings, air is taken into the body through the nostrils. The air passing through the nostrils is filtered by fine hairs that line the passage. The passage is also lined with mucus which helps in this process. From here, the air passes through the throat and into the lungs. Rings of cartilage are present in the throat. These ensure that the air-passage does not collapse.
- Within the lungs, the passage divides into smaller and smaller tubes which finally terminate in balloon-like structures which are called alveoli. It provides a surface where the exchange of gases can take place. The walls of the alveoli contain an extensive network of blood-vessels.
- The blood brings carbon dioxide from the rest of the body for release into the alveoli, and the oxygen in the alveolar air is taken up by blood in the alveolar blood vessels to be transported to all the cells in the body. During the breathing cycle, when air is taken in and let out, the lungs always contain a residual volume of air so that there is sufficient time for oxygen to be absorbed and for the carbon dioxide to be released.
- When the body size of animals is large, the diffusion pressure alone cannot take care of oxygen delivery to all parts of the body. Instead, respiratory pigments take up oxygen from the air in the lungs and carry it to tissues which are deficient in oxygen before releasing it. In human beings, the respiratory pigment is haemoglobin which has a very high affinity for oxygen. This pigment is present in the red blood corpuscles. Carbon dioxide is more soluble in water than oxygen is and hence is mostly transported in the dissolved form in our blood.

TRANSPORTATION

Transportation in Human Beings

- Blood consists of a fluid medium called plasma in which the cells are suspended. Plasma transports food, carbon dioxide and nitrogenous wastes in dissolved form. Oxygen is carried by the red blood corpuscles. Many other substances like salts, are also transported by the blood.

Our pump — the heart

- The carbon dioxide-rich blood has to reach the lungs for the carbon dioxide to be removed, and the oxygenated blood from the lungs has to be brought back to the heart. This oxygen-rich blood is then pumped to the rest of the body.
- The separation of the right side and the left side of the heart is useful to keep oxygenated and de-oxygenated blood from mixing. This is useful in animals that have high energy needs, such as birds and mammals, which constantly use energy to maintain their body temperature. In animals that do not use energy for this purpose, the body temperature depends on the temperature in the environment. Such animals, like amphibians or many reptiles have three- chambered hearts, and tolerate some mixing of the oxygenated and de- oxygenated blood streams.
- Fishes, on the other hand, have only two chambers to their hearts Thus, blood goes only once through the heart in the fish during one cycle of passage through the body. On the other hand, it goes through the heart twice during each cycle in other vertebrates. This is known as double circulation.
- Blood Pressure: The force that blood exerts against the wall of a vessel is called blood pressure. This pressure is much greater in arteries than in veins. The pressure of blood inside the artery during ventricular systole (contraction) is called systolic pressure and pressure in artery during ventricular diastole (relaxation) is called diastolic pressure. The normal systolic pressure is about 120 mm of Hg and diastolic pressure is 80 mm of Hg.

- Arteries are the vessels which carry blood away from the heart to various organs of the body. Since the blood emerges from the heart under high pressure, the arteries have thick, elastic walls. Veins collect the blood from different organs and bring it back to the heart. They do not need thick walls because the blood is no longer under pressure, instead they have valves that ensure that the blood flows only in one direction.
- On reaching an organ or tissue, the artery divides into smaller and smaller vessels to bring the blood in contact with all the individual cells. The smallest vessels have walls which are one-cell thick and are called capillaries. Exchange of material between the blood and surrounding cells takes place across this thin wall. The capillaries then join together to form veins that convey the blood away from the organ or tissue.
- Platelet cells circulate around the cells and help to clot the blood at the point of journey.
- Lymph: Through the pores present in the walls of capillaries some amount of plasma, proteins and blood cells escape into intercellular spaces in the tissues to form the tissue fluid or lymph. Lymph carries digested and absorbed fat from intestine and drains excess fluid from extra cellular space back into the blood.

Transportation in Plants

- Plants do not move, and plant bodies have a large proportion of dead cells in many tissues. As a result, plants have low energy needs, and can use relatively slow transport systems. The distances over which transport systems have to operate, however, can be very large in plants such as very tall trees.
- Plant transport systems will move energy stores from leaves and raw materials from roots. These two pathways are constructed as independently organised conducting tubes. One, the xylem moves water and minerals obtained from the soil. The other, phloem transports products of photosynthesis from the leaves where they are synthesised to other parts of the plant.

Transport of water

- In xylem tissue, vessels and tracheids of the roots, stems and leaves are interconnected to form a continuous system of water-conducting channels reaching all parts of the plant. At the roots, cells in contact with the soil actively take up ions. This creates a difference in the concentration of these ions between the root and the soil. Water, therefore, moves into the root from the soil to eliminate this difference.
- However, this pressure by itself is insufficient to move water over the entire height of the plant. Thus besides this pressure, the evaporation of water molecules from the cells of a leaf creates a suction which pulls water from the xylem cells of roots. The loss of water in the form of vapour from the aerial parts of the plant is known as transpiration.
- Thus, transpiration helps in the absorption and upward movement of water and minerals dissolved in it from roots to the leaves. It also helps in temperature regulation. The effect of root pressure in transport of water is more important at night. During the day when the stomata are open, the transpiration pull becomes the major driving force in the movement of water in the xylem.

Transport of food and other substances

- The transport of soluble products of photosynthesis is called translocation and it occurs in the part of the vascular tissue known as phloem. Besides the products of photosynthesis, the phloem transports amino acids and other substances. These substances are especially delivered to the storage organs of roots, fruits and seeds and to growing organs. The translocation of food and other substances takes place in the sieve tubes with the help of adjacent companion cells both in upward and downward directions.
- Material like sucrose is transferred into phloem tissue using energy from ATP. This increases the osmotic pressure of the tissue causing water to move into it. This pressure moves the material in the phloem to tissues which have less pressure. This allows the phloem to move material according to the plant's needs.

Excretion

- The biological process involved in the removal of the harmful metabolic wastes from the body is called excretion. While the unicellular organisms simply use the process of diffusion, complex multi-cellular organisms use specialised organs to perform the same function.

Excretion in Human Beings

- Just as CO2 is removed from the blood in the lungs, nitrogenous waste such as urea or uric acid are removed from blood in the kidneys. Thus kidneys are the basic filtration units.
- The kidneys have a cluster of very thin-walled blood capillaries. Each capillary cluster in the kidney is associated with the cup-shaped end of a coiled tube called Bowman's capsule that collects the filtrate
- Each kidney has large numbers of these filtration units called nephrons packed close together. Some substances in the initial filtrate, such as glucose, amino acids, salts and a major amount of water, are selectively re-absorbed as the urine flows along the tube.
- In case of kidney failure, an artificial kidney can be used. An artificial kidney is a device to remove nitrogenous waste products from the blood through dialysis.

Excretion in Plants

- Plants use completely different strategies for excretion than those of animals. Oxygen itself can be thought of as a waste product generated during photosynthesis!
- They can get rid of excess water by transpiration. For other wastes, plants use the fact that many of their tissues consist of dead cells, and that they can even lose some parts such as leaves. Many plant waste products are stored in cellular vacuoles. Waste products may be stored in leaves that fall off. Other waste products are stored as resins and gums, especially in old xylem. Plants also excrete some waste substances into the soil around them.

Control And Coordination

- All the movements in response to the environment are carefully controlled. In keeping with the general principles of body organisation in multicellular organisms, specialised tissues are used to provide these control and coordination activities.

Animals - Nervous System

- All information from our environment is detected by the specialised tips of some nerve cells. These receptors are usually located in our sense organs, such as the inner ear, the nose, the tongue, and so on. So gustatory receptors will detect taste while olfactory receptors will detect smell.
- This information, acquired at the end of the dendritic tip of a nerve cell , sets off a chemical reaction that creates an electrical impulse. This impulse travels from the dendrite to the cell body, and then along the axon to its end. At the end of the axon, the electrical impulse sets off the release of some chemicals. These chemicals cross the gap, or synapse, and start a similar electrical impulse in a dendrite of the next neuron.
- Thus the nervous tissue is made up of an organised network of nerve cells or neurons, and is specialised for conducting information via electrical impulses from one part of the body to another.

Reflex Actions

- 'Reflex' is a word we use very commonly when we talk about some sudden action in response to something in the environment. Such reflexes are made possible through 'Reflex Arc' which can be understood as the connection between input and output nerves.
- Nerves from all over the body meet in a bundle in the spinal cord on their way to the brain. Reflex arcs are formed in this spinal cord itself, although the information input also goes on to reach the brain. Even after the complex Huron networks in in existence due to evolution, reflex arcs continue to be more efficient for quick responses.

Human Brain

- Spinal cord is made up of nerves which supply information to think about. These are concentrated in the brain, which is the main coordinating centre of the body. The brain and spinal cord constitute the central nervous system. They receive information from all parts of the body and integrate it.
- The communication between the central nervous system and the other parts of the body is facilitated by the peripheral nervous system consisting of cranial nerves arising from the brain and spinal nerves arising from the spinal cord. The brain thus allows us to think and take actions based on that thinking.

- The brain has three such major parts or regions, namely the fore-brain, mid-brain and hind-brain.
- The fore-brain is the main thinking part of the brain. Separate areas of the fore-brain are specialised for hearing, smell, sight and so on. There are separate areas of association where this sensory information is interpreted by putting it together with information from other receptors as well as with information that is already stored in the brain. Based on all this, a decision is made about how to respond and the information is passed on to the motor areas which control the movement of voluntary muscles
- In between the simple reflex actions like change in the size of the pupil, and the thought out actions such as moving a chair, there is another set of muscle movements over which we do not have any thinking control. Many of these involuntary actions are controlled by the mid-brain and hind-brain. All these involuntary actions including blood pressure, salivation and vomiting are controlled by the medulla in the hind-brain.
- Cerebellum, part of the Hind Brain is responsible for precision of voluntary actions and maintaining the posture and balance of the body. This includes activities like walking in a straight line, riding a bicycle, picking up a pencil.

Protection of The Brain

- The brain sits inside a bony box. Inside the box, the brain is contained in a fluid-filled balloon which provides further shock absorption. How does the nervous tissue cause action
- In case of animals, the simplest notion of movement at the cellular level is that muscle cells will move by changing their shape so that they shorten. Muscle cells have special proteins that change both their shape and their arrangement in the cell in response to nervous electrical impulses. When this happens, new arrangements of these proteins give the muscle cells a shorter form.

Coordination In Plants

- Plants neither have the nervous system nor the muscles. Plants show two different types of movement – one dependent on growth and the other independent of growth.

Immediate Response to Stimulus

- The plants also use electrical-chemical means to convey information of the 'touch' or other immediate stimulus, from cell to cell, but unlike in animals, there is no specialised tissue in plants for the conduction of information.
- Finally, again as in animals, some cells must change shape in order for movement to happen. Instead of the specialised proteins found in animal muscle cells, plant cells change shape by changing the amount of water in them, resulting in swelling or shrinking, and therefore in changing shapes.

Movement Due To Growth

- Some plants like the pea plant climb up other plants or fences by means of tendrils. These tendrils are sensitive to touch. When they come in contact with any support, the part of the tendril in contact with the object does not grow as rapidly as the part of the tendril away from the object. This causes the tendril to circle around the object and thus cling to it.
- More commonly, plants respond to stimuli slowly by growing in a particular direction. Environmental triggers such as light, or gravity will change the directions that plant parts grow in. These directional, or tropic, movements can be either towards the stimulus, or away from it. So, in two different kinds of phototropic movement, shoots respond by bending towards light while roots respond by bending away from it.
- The upward and downward growth of shoots and roots, respectively, in response to the pull of earth or gravity is, obviously, geotropism. In a similar manner, plants also exhibit hydrotropism and chemotropism. One example of chemotropism is the growth of pollen tubes towards ovules.
- The movement of sunflowers in response to day or night, on the other hand, is quite slow. Growth-related movement of plants will be even slower. Even in animal bodies, there are carefully controlled directions to growth.
- There are limitations to the use of electrical impulses for the purpose of coordination. They will reach only those cells that are connected by nervous tissue, not each and every cell in the animal body. In

other words, cells cannot continually create and transmit electrical impulses. Thus most multicellular organisms use another means of communication between cells, namely, chemical communication.

- Different plant hormones help to coordinate growth, development and responses to the environment. They are synthesised at places away from where they act and simply diffuse to the area of action.
- When growing plants detect light, a hormone called auxin, synthesised at the shoot tip, helps the cells to grow longer. When light is coming from one side of the plant, auxin diffuses towards the shady side of the shoot. This concentration of auxin stimulates the cells to grow longer on the side of the shoot which is away from light. Thus, the plant appears to bend towards light.
- Another example of plant hormones are gibberellins which, like auxins, help in the growth of the stem. Cytokinins promote cell division, and it is natural then that they are present in greater concentration in areas of rapid cell division, such as in fruits and seeds. These are examples of plant hormones that help in promoting growth. But plants also need signals to stop growing. Abscisic acid is one example of a hormone which inhibits growth. Its effects include wilting of leaves.

Hormones In Animals

- Animals too do not only rely on the electrical impulses, but also make use of chemical signals using hormones. Adrenaline is secreted directly into the blood and carried to different parts of the body. The target organs or the specific tissues on which it acts include the heart. As a result, the heart beats faster, resulting in supply of more oxygen to our muscles.
- The blood to the digestive system and skin is reduced due to contraction of muscles around small arteries in these organs. This diverts the blood to our skeletal muscles. The breathing rate also increases because of the contractions of the diaphragm and the rib muscles. All these responses together enable the animal body to be ready to deal with the situation. Such animal hormones are part of the endocrine system which constitutes a second way of control and coordination in our body.
- Iodine is necessary for the thyroid gland to make thyroxin hormone. Thyroxin regulates carbohydrate, protein and fat metabolism in the body so as to provide the best balance for growth. In case iodine is deficient in our diet, there is a possibility that we might suffer from goitre.
- Growth hormone is one of the hormones secreted by the pituitary. As its name indicates, growth hormone regulates growth and development of the body. If there is a deficiency of this hormone in childhood, it leads to dwarfism.
- Hypothalamus plays an important role in the release of many hormones. For example, when the level of growth hormone is low, the hypothalamus releases growth hormone releasing factor which stimulates the pituitary gland to release growth hormone.
- The changes associated with puberty are because of the secretion of testosterone in males and oestrogen in females.
- Insulin is a hormone which is produced by the pancreas and helps in regulating blood sugar levels. If it is not secreted in proper amounts, the sugar level in the blood rises causing many harmful effects.
- The timing and amount of hormone released are regulated by feedback mechanisms. For example, if the sugar levels in blood rise, they are detected by the cells of the pancreas which respond by producing more insulin. As the blood sugar level falls, insulin secretion is reduced.

How Do Organisms Reproduce

- A basic event in reproduction is the creation of a DNA copy. Cells use chemical reactions to build copies of their DNA. DNA copying is accompanied by the creation of an additional cellular apparatus, and then the DNA copies separate, each with its own cellular apparatus. Effectively, a cell divides to give rise to two cells.
- No bio-chemical reaction is absolutely reliable. Therefore, it is only to be expected that the process of copying the DNA will have some variations each time. As a result, the DNA copies generated will be similar, but may not be identical to the original. Some of these variations might be so drastic that the new DNA copy cannot work with the cellular apparatus it inherits. Thus, the surviving cells are similar to, but subtly different from each other. This inbuilt tendency for variation during reproduction is the basis for evolution

Importance of Variation

- Reproduction is linked to the stability of populations of species. However, niches can change because of reasons beyond the control of the organisms. This may include change in the temperature, variation in water level or even a meteorite hit. Thus, if some variations were to be present in a few individuals in these populations, there would be some chance for them to survive. If not, then the entire population may wipe out. Variation is thus useful for the survival of species over long time.

Modes of Reproduction Used by Single Organisms

- All the modes of production that involves single individual is called the asexual mode of production.

Fission

- For unicellular organisms, cell division, or fission, leads to the creation of new individuals. While bacteria and protozoa simply split into two equal halves during cell division, amoeba splits in any plane. Leishmania (which cause kala-azar), shows more organised splitting, with binary fission occurring in a definite orientation in relation to a whip-like structure at one end of the cell. Plasmodium, divide into many daughter cells simultaneously by multiple fission.

Fragmentation

- This is most common among the multi-cellular organisms with relatively simple body organisation. Spirogyra, for example, simply breaks up into smaller pieces upon maturation. These pieces or fragments grow into new individuals. However not all the multi cellular organisms can undergo a cell by cell division.
- This is because in many such organisms, specialised cells are organised as tissues, and tissues are organised into organs, which then have to be placed at definite positions in the body. Following this general pattern, reproduction in such organisms is also the function of a specific cell type. This cell type is capable of growing, proliferating and making other cell types under the right circumstance

Regeneration

- In this mode of reproduction, if the individual is somehow cut or broken up into many pieces, many of these pieces grow into separate individuals. This is shown in simple animals like Hydra and Planaria.
- Regeneration is carried out by specialised cells. These cells proliferate and make large numbers of cells. From this mass of cells, different cells undergo changes to become various cell types and tissues. These changes take place in an organised sequence referred to as development.
- However, regeneration is not the same as reproduction, since most organisms would not normally depend on being cut up to be able to reproduce.

Budding

- In this method, organisms use regenerative cells for reproduction in the process of budding. For example, in Hydra, a bud develops as an outgrowth due to repeated cell division at one specific site. These buds develop into tiny individuals and when fully mature, detach from the parent body and become new independent individuals.

Vegetative Propagation

- There are many plants in which parts like the root, stem and leaves develop into new plants under appropriate conditions. This property of vegetative propagation is used in methods such as layering or grafting to grow many plants like sugarcane, roses, or grapes. Such methods also make possible the propagation of plants such as banana, orange, rose and jasmine that have lost the capacity to produce seeds. Another advantage of vegetative propagation is that all plants produced are genetically similar enough to the parent plant to have all its characteristics. Similarly buds produced in the notches along the leaf margin of Bryophyllum fall on the soil and develop into new plants
- Tissue Culture: In tissue culture, new plants are grown by removing tissue or separating cells from the growing tip of a plant. The cells are then placed in an artificial medium where they divide rapidly to form a small group of cells or callus. The callus is transferred to another medium containing hormones for growth and differentiation. The plantlets are then placed in the soil so that they can grow into mature plants.

Sexual Reproduction

- In this mode of reproduction, both sexes, males and females, are needed to produce new generations.

Why The Sexual Mode of Reproduction

- While DNA-copying mechanisms are not absolutely accurate, they are precise enough to make the generation of variation a fairly slow process. The sexual mode of reproduction incorporates such a process of combining DNA from two different individuals during reproduction. Combining variations from two or more individuals would thus create new combinations of variants.
- Through the process of meiosis when these germ-cells from two individuals combine during sexual reproduction to form a new individual, it results in re-establishment of the number of chromosomes and the DNA content in the new generation.
- As the body designs become more complex, the germ-cells also specialise. One germ-cell is large and contains the food-stores while the other is smaller and likely to be motile. Conventionally, the motile germ- cell is called the male gamete and the germ-cell containing the stored food is called the female gamete.

Sexual Reproduction is from Flowering Plants

- The reproductive parts of angiosperms are located in the flower. Stamens and pistil are the reproductive parts of a flower which contain the germ-cells.
- The flower may be unisexual (papaya, watermelon) when it contains either stamens or pistil or bisexual (Hibiscus, mustard) when it contains both stamens and pistil.
- Stamen is the male reproductive part and it produces pollen grains that are yellowish in colour. Pistil is present in the centre of a flower and is the female reproductive part. It is made of three parts. swollen bottom part is the ovary, middle elongated part is the style and the terminal part which may be sticky is the stigma. The ovary contains ovules and each ovule has an egg cell. The male germ-cell produced by pollen grain fuses with the female gamete present in the ovule. This fusion of the germ-cells or fertilisation gives us the zygote which is capable of growing into a new plant.
- Thus the pollen needs to be transferred from the stamen to the stigma. If this transfer of pollen occurs in the same flower, it is referred to as self-pollination. On the other hand, if the pollen is transferred from one flower to another, it is known as cross- pollination. This transfer of pollen from one flower to another is achieved by agents like wind, water or animals.
- After fertilisation, the zygote divides several times to form an embryo within the ovule. The ovule develops a tough coat and is gradually converted into a seed. The ovary grows rapidly and ripens to form a fruit. Meanwhile, the petals, sepals, stamens, style and stigma may shrivel and fall off.
- The seed contains the future plant or embryo which develops into a seedling under appropriate conditions. This process is known as germination. Reproduction in Human Beings
- At the age of early teenage, the body enters the age of sexual maturity. The creation of germ-cells to participate in sexual reproduction is another specialised function. Both plants and human beings develop special cell and tissue types to create them. As the rate of general body growth begins to slow down, reproductive tissues begin to mature. This period during adolescence is called puberty.

Male Reproductive System

- The formation of germ-cells or sperms takes place in the testes. These are located outside the abdominal cavity in scrotum because sperm formation requires a lower temperature than the normal body temperature
- In addition to regulating the formation of sperms, testosterone brings about changes in appearance seen in boys at the time of puberty.
- The sperms formed are delivered through the vas deferens which unites with a tube coming from the urinary bladder. Along the path of the vas deferens, glands like the prostate and the seminal vesicles add their secretions so that the sperms are now in a fluid which makes their transport easier and this fluid also provides nutrition.

Female Reproductive Organ

- The female germ-cells or eggs are made in the ovaries. When a girl is born, the ovaries already contain thousands of immature eggs. On reaching puberty, some of these start maturing. One egg is produced every month by one of the ovaries. The egg is carried from the ovary to the womb through a thin oviduct or fallopian tube.
- The sperms enter through the vaginal passage during sexual intercourse. They travel upwards and reach the oviduct where they may encounter the egg. The fertilised egg (zygote) starts dividing and form a ball of cells or embryo. The embryo is implanted in the lining of the uterus where they continue to grow and develop organs to become foetus.
- The embryo gets nutrition from the mother's blood with the help of a special tissue called placenta. This is a disc which is embedded in the uterine wall. It contains villi on the embryo's side of the tissue. On the mother's side are blood spaces, which surround the villi. This provides a large surface area for glucose and oxygen to pass from the mother to the embryo. The developing embryo will also generate waste substances which can be removed by transferring them into the mother's blood through the placenta.
- Since the ovary releases one egg every month, the uterus also prepares itself every month to receive a fertilised egg. Thus its lining becomes thick and spongy. Now, however, this lining is not needed any longer. So, the lining slowly breaks and comes out through the vagina as blood and mucous. This is called the menstruation cycle.

Heredity And Evolution

Accumulation of Variation during Reproduction

- In asexual reproduction, there would be only very minor differences between them, generated due to small inaccuracies in DNA copying. However, if sexual reproduction is involved, even greater diversity will be generated. Depending on the nature of variations, different individuals would have different kinds of advantages.

Heredity

- The most obvious outcome of the reproductive process still remains the generation of individuals of similar design. The rules of heredity determine the process by which traits and characteristics are reliably inherited.

Inherited Traits

- Though a child bears all the basic features of human beings, he does not look exactly like his parents. Rules of Inheritance of Traits - Mendel's Contribution
- The rules for inheritance of such traits in human beings are related to the fact that both the father and the mother contribute practically equal amounts of genetic material to the child.
- Mendel proposed that two copies of factor (now called genes) controlling traits are present in sexually reproducing organism. These two may be identical, or may be different, depending on the parentage.
- A single copy of 'T' (tall plant) is enough to make the plant tall, while both copies have to be 't' (short plant) for the plant to be short. Traits like 'T' are called dominant traits, while those that behave like 't' are called recessive traits. Tallness and round seeds are thus dominant traits.

How are traits expressed

- Cellular DNA is the information source for making proteins in the cell. A section of DNA that provides information for one protein is called the gene for that protein.
- Each gene set is present, not as a single long thread of DNA, but as separate independent pieces, each called a chromosome. Thus, each cell will have two copies of each chromosome, one each from the male and female parents. Every germ- cell will take one chromosome from each pair and these may be of either maternal or paternal origin. When two germ cells combine, they will restore the normal number of chromosomes in the progeny, ensuring the stability of the DNA of the species. Such a mechanism of inheritance explains the results of the Mendel experiments, and is used by all sexually reproducing organisms.

Sex Determination

- All human chromosomes are not paired. Most human chromosomes have a maternal and a paternal copy, and we have 22 such pairs. But one pair, called the sex chromosomes, is odd in not always being a perfect pair. Women have a perfect pair of sex chromosomes, both called X. But men have a mismatched pair in which one is a normal-sized X while the other is a short one called Y. So women are XX, while men are XY.
- All children will inherit an X chromosome from their mother regardless of whether they are boys or girls. Thus, the sex of the children will be determined by what they inherit from their father. A child who inherits an X chromosome from her father will be a girl, and one who inherits a Y chromosome from him will be a boy.

Evolution

- Natural selection often directs the evolution process in population. It results in adaptations population to fit their environment better. Accidents in small populations can change the frequency of some genes in a population, even if they give no survival advantage. This is the notion of genetic drift, which provides diversity without any adaptations.

Acquired and Inherited Traits

- Change in non-reproductive tissues cannot be passed on to the DNA of the germ cells. Therefore the experiences of an individual during its lifetime cannot be passed on to its progeny, and cannot direct evolution. These are only the acquired traits and not the Inherited Traits.
- Darwin's theory of evolution tells us how life evolved from simple to more complex forms and Mendel's experiments give us the mechanism for the inheritance of traits from one generation to the next. But neither tells us anything about how life began on earth in the first place.

Speciation

- Over generations, genetic drift accumulates different changes in each sub-population. Also, natural selection may also operate differently in different geographic locations. Together, the processes of genetic drift and natural selection make the isolated sub-populations more and more different from each other. Eventually, members of these two groups will be incapable of reproducing with each other even if they happen to meet.
- There can be a number of ways by which this can happen. If the DNA changes are severe enough, such as a change in the number of chromosomes, eventually the germ cells of the two groups cannot fuse with each other.

Evolution and Classification

- Characteristics are details of appearance or behaviour; in other words, a particular form or a particular function. That we have four limbs is thus a characteristic.
- The more characteristics two species will have in common, the more closely they are related. And the more closely they are related, the more recently they will have had a common ancestor. We can thus build up small groups of species with recent common ancestors, then super-groups of these groups with more distant common ancestors, and so on. In theory, we can keep going backwards like this until we come to the notion of a single species at the very beginning of evolutionary time.
- wings of bats are skin folds stretched mainly between elongated fingers. But the wings of birds are a feathery covering all along the arm. The designs of the two wings, their structure and components, are thus very different. This makes them analogous characteristics, rather than homologous characteristics.

Fossils

- When organisms die, every once in a while, the body or at least some parts may be in an environment that does not let it decompose completely. All such preserved traces of living organisms are called fossils.

- There are two ways to know how old the fossils are. If we dig into the earth and start finding fossils, it is reasonable to suppose that the fossils we find closer to the surface are more recent than the fossils we find in deeper layers. The second way of dating fossils is by detecting the ratios of different isotopes of the same element (Carbon 14 dating) in the fossil material.

Evolution By Stages

- Complex organs, like the eyes, are created bit-by-bit over generations. Even an intermediate stage , such as a rudimentary eye, can be useful to some extent.
- Also, a change that is useful for one property to start with can become useful later for quite a different function. Feathers, for example, can start out as providing insulation in cold weather. But later, they might become useful for flight. Some dinosaurs had feathers, although they could not fly using the feathers. Birds seem to have later adapted the feathers to flight. This, of course, means that birds are very closely related to reptiles, since dinosaurs were reptiles!
- Another way of tracing evolutionary relationships depends on the idea was that changes in DNA during reproduction are the basic events in evolution. If that is the case, then comparing the DNA of different species should give us a direct estimate of how much the DNA has changed during the formation of these species
- Molecular Phylogeny is based on the idea that organisms which are more distantly related will accumulate a greater number of differences in their DNA.

SOURCES OF ENERGY

A good source of energy would be one

1. which would do a large amount of work per unit volume or mass,
2. be easily accessible,
3. be easy to store and transport, and
4. perhaps most importantly, be economical.

CONVENTIONAL SOURCES OF ENERGY

Fossil Fuels

- The growing demand for energy was largely met by the fossil fuels – coal and petroleum. The fossil fuels are non-renewable sources of energy, so we need to conserve them. The oxides of carbon, nitrogen and sulphur that are released on burning fossil fuels are acidic oxides. These lead to acid rain. It also adds to the problems of air pollution and Green House Gas effect.

Thermal Power Plants

- Large amount of fossil fuels are burnt every day in power stations to heat up water to produce steam which further runs the turbine to generate electricity. The transmission of electricity is more efficient than transporting coal or petroleum over the same distance. Therefore, many thermal power plants are set up near coal or oil fields.

Hydro Power Plant

- Hydro power plants convert the potential energy of falling water into electricity. Since there are very few water-falls which could be used as a source of potential energy, hydro power plants are associated with dams. A quarter of our energy requirement in India is met by hydro power plants.
- The water level rises in the dams built across rivers and in this process the kinetic energy of flowing water gets transformed into potential energy. The water from the high level in the dam is carried through pipes, to the turbine, at the bottom of the dam
- Problems with dams: The dams can be constructed only in a limited number of places, preferably in hilly terrains. Large areas of agricultural land and human habitation are to be sacrificed as they get submerged. Large eco-systems are destroyed when submerged under the water in dams. The vegetation which is submerged rots under anaerobic conditions and gives rise to large amounts of methane which is also a green-house gas. It creates the problem of satisfactory rehabilitation of displaced people.

Improvements in Technology for using Conventional Sources of Energy

1. Bio Mass

- Woods and cow dung are the examples of bio mass as these fuels are sourced from plants or animals. Their efficiency can be enhanced using proper technologies. When wood is burnt in a limited supply of oxygen, water and volatile materials present in it get removed and charcoal is left behind as the residue. Charcoal burns without flames, is comparatively smokeless and has a higher heat generation efficiency.
- Similarly, cow-dung, various plant materials like the residue after harvesting the crops, vegetable waste and sewage are decomposed in the absence of oxygen to give bio-gas. Since the starting material is mainly cow-dung, it is popularly known as 'gobar-gas'.
- Bio-gas is an excellent fuel as it contains up to 75% methane. It burns without smoke, leaves no residue like ash in wood, charcoal and coal burning. Its heating capacity is high. Bio-gas is also used for lighting. The slurry left behind is removed periodically and used as excellent manure, rich in nitrogen and phosphorous.

2. Wind Energy

- Unequal heating of the landmass and water bodies by solar radiation generates air movement and causes winds to blow. This kinetic energy of the wind can be used to do work.
- To generate electricity, the rotatory motion of the windmill is used to turn the turbine of the electric generator. The output of a single windmill is quite small and cannot be used for commercial purposes. Therefore, a number of windmills are erected over a large area, which is known as wind energy farm.
- Denmark is called the country of 'winds'. More than 25% of their electricity needs are generated through a vast network of windmills. In terms of total output, Germany is the leader, while India is ranked fifth in harnessing wind energy for the production of electricity.
- But there are many limitations in harnessing wind energy. Firstly, wind energy farms can be established only at those places where wind blows for the greater part of a year. The wind speed should also be higher than 15 km/h to maintain the required speed of the turbine. Furthermore, there should be some back-up facilities (like storage cells). Establishment of wind energy farms requires large area of land.

NON CONVENTIONAL SOURCES OF ENERGY

Solar Energy

- Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, solar thermal energy, solar architecture etc.
- The limitation that solar devices can be used only during daytime can be overcome by the use of the solar cells that convert solar energy into electricity. A large number of solar cells are, combined in an arrangement called solar cell panel that can deliver enough electricity for practical use.
- The principal advantages associated with solar cells are that they have no moving parts, require little maintenance and work quite satisfactorily without the use of any focussing device. It can be set up in remote inaccessible areas.
- Silicon, which is used for making solar cells, is abundant in nature but availability of the special grade silicon for making solar cells is limited. The entire process of manufacture is still very expensive, silver used for interconnection of the cells in the panel further adds to the cost.

Energy From The Sea

Tidal Energy:

Tidal energy is harnessed by constructing a dam across a narrow opening to the sea. A turbine fixed at the opening of the dam converts tidal energy to electricity.

Wave Energy:

The waves are generated by strong winds blowing across the sea. Wave energy would be a viable proposition only where waves are very strong. A wide variety of devices have been developed to trap wave energy for rotation of turbine and production of electricity.

Ocean Thermal Energy:

The water at the surface of the sea or ocean is heated by the Sun while the water in deeper sections is relatively cold. This difference in temperature is exploited to obtain energy in ocean-thermal- energy conversion plants. These plants can operate if the temperature difference between the water at the surface and water at depths up to 2 km is 20 K (20°C) or more. The warm surface-water is used to boil a volatile liquid like ammonia. The vapours of the liquid are then used to run the turbine of generator. The cold water from the depth of the ocean is pumped up and condense vapour again to liquid.

Geothermal Energy

- Due to geological changes, molten rocks formed in the deeper hot regions of earth's crust are pushed upward and trapped in certain regions called 'hot spots'. When underground water comes in contact with the hot spot, steam is generated. Sometimes hot water from that region finds outlets at the surface. Such outlets are known as hot springs. The steam trapped in rocks is routed through a pipe to a turbine and used to generate electricity.

Nuclear Energy

- In a process called nuclear fission, the nucleus of a heavy atom (such as uranium, plutonium or thorium), when bombarded with low-energy neutrons, can be split apart into lighter nuclei. When this is done, a tremendous amount of energy is released if the mass of the original nucleus is just a little more than the sum of the masses of the individual products.
- In a nuclear reactor designed for electric power generation, such nuclear 'fuel' can be part of a self-sustaining fission chain reaction that releases energy at a controlled rate. The released energy can be used to produce steam and further generate electricity.
- In a nuclear fission, the difference in mass, ”m, between the original nucleus and the product nuclei gets converted to energy E at a rate governed by the famous equation, E = ”m c2, first derived by Albert Einstein in 1905, where c is the speed of light in vacuum.
- The major hazard of nuclear power generation is the storage and disposal of spent or used fuels – the uranium still decaying into harmful subatomic particles (radiations). Risk of accidents, limited availability of Uranium and high cost of installation further adds to the disadvantages.

OUR ENVIRONMENT

Ecosystem and its components

- All the interacting organisms in an area together with the non-living constituents of the environment form an ecosystem. Thus, an ecosystem consists of biotic components comprising living organisms and abiotic components comprising physical factors like temperature, rainfall, wind, soil and minerals.
- While forests, ponds and lakes are the natural ecosystems, gardens and crop fields are examples of man made eco systems.
- All green plants and certain bacteria which can produce food by photosynthesis come under this category of producers. The organisms which consume the food produced, either directly from producers or indirectly by feeding on other consumers are the consumers. Consumers can be classed variously as herbivores, carnivores, omnivores and parasites.
- The microorganisms, comprising bacteria and fungi, break-down the dead remains and waste products of organisms. These microorganisms are the decomposers as they break-down the complex organic substances into simple inorganic substances that go into the soil and are used up once more by the plants.

Food Chain and Webs

- The series or organisms taking part at various biotic levels form a food chain. Each step or level of the food chain forms a trophic level. The autotrophs or the producers are at the first trophic level. They fix up the solar energy and make it available for heterotrophs or the consumers. The herbivores or the primary consumers come at the second, small carnivores or the secondary consumers at the third and larger carnivores or the tertiary consumers form the fourth trophic level.

- The autotrophs capture the energy present in sunlight and convert it into chemical energy. This energy supports all the activities of the living world.
- However, when one form of energy is changed to another, some energy is lost to the environment in forms which cannot be used again. The flow of energy between various components of the environment has been extensively studied and it has been found that – green plants in a terrestrial ecosystem capture about 1% of the energy of sunlight that falls on their leaves and convert it into food energy. When green plants are eaten by primary consumers, a great deal of energy is lost as heat to the environment, some amount goes into digestion and in doing work and the rest goes towards growth and reproduction. An average of 10% of the food eaten is turned into its own body and made available for the next level of consumers. Therefore, 10% can be taken as the average value for the amount of organic matter that is present at each step and reaches the next level of consumers. Since so little energy is available for the next level of consumers, food chains generally consist of only three or four steps. The loss of energy at each step is so great that very little usable energy remains after four trophic levels. There are generally a greater number of individuals at the lower trophic levels of an ecosystem, the greatest number is of the producers. The length and complexity of food chains vary greatly. Each organism is generally eaten by two or more other kinds of organisms which in turn are eaten by several other organisms. So instead of a straight line food chain, the relationship can be shown as a series of branching lines called a food web. Thus two inferences can be obtained from the study of the flow of energy

I. The flow of energy is unidirectional.

II. The energy available at each trophic level gets diminished progressively due to loss of energy at each level.

Chemicals can also enter the food chain through, say, the use of pesticides. As these chemicals are not degradable, these get accumulated progressively at each trophic level. As human beings occupy the top level in any food chain, the maximum concentration of these chemicals get accumulated in our bodies. This phenomenon is known as biological magnification.

Depleting Ozone Layer

- Ozone, is a deadly poison. However, at the higher levels of the atmosphere, ozone performs an essential function. It shields the surface of the earth from ultraviolet (UV) radiation from the Sun. The higher energy UV radiations split apart some moleculer oxygen (O2) into free oxygen (O) atoms. These atoms then combine with the molecular oxygen to form ozone.
- The amount of ozone in the atmosphere began to drop sharply in the 1980s. This decrease has been linked to synthetic chemicals like chlorofluorocarbons (CFCs) which are used as refrigerants and in fire extinguishers. In 1987, the United Nations Environment Programme (UNEP) succeeded in forging an agreement to freeze CFC production at 1986 levels. It is now mandatory for all the manufacturing companies to make CFC-free refrigerators throughout the world.

Garbage Management

- Substances that are broken down by biological processes are said to be biodegradable.
- Substances that are not broken down in this manner are said to be non- biodegradable. These substances may be inert and simply persist in the environment for a long time or may harm the various members of the eco-system
- Changes in packaging have resulted in much of our waste becoming non-biodegradable.

SUSTAINABLE MANAGEMENT OF NATURAL RESOURCES

- Awareness about the problems caused by unthinkingly exploiting our resources has been a fairly recent phenomenon in our society.
- Coliform is a group of bacteria, found in human intestines, whose presence in water indicates contamination by disease-causing microorganisms.
- We need not feel powerless or overwhelmed by the scale of the problems because there are many things we can do to make a difference.

The five R's to save the environment: Refuse, Reduce, Reuse, Repurpose and Recycle.

1. Refuse: Refuse to buy products that can harm you and the environment, say No to single-use plastic carry bags.
2. Reduce: This means that you use less. You save electricity by switching off unnecessary lights and fans. You save water by repairing leaky taps.
3. Reuse: This is actually even better than recycling because the process of recycling uses some energy. In the 'reuse' strategy, you simply use things again and again. Instead of throwing away used envelopes, you can reverse it and use it again.
4. Repurpose: This means when a product can no more be used for the original purpose, think carefully and use it for some other useful purpose. For example, cracked crockery, or cups with broken handles can be used to grow small plants
5. Recycle: This means that you collect plastic, paper, glass and metal items and recycle these materials to make required things instead of synthesising or extracting fresh plastic, paper, glass or metal.

- The concept of sustainable development encourages forms of growth that meet current basic human needs, while preserving the resources for the needs of future generations. Economic development is linked to environmental conservation.
- We need to manage out resources because these are limited and with rise in human population, demand for these resources will rise at exponential rates. This management should also ensure equitable distribution of resources so that all, and not just a handful of rich
- Principles of conservation and sustainable management were well established in the pre-historic India.
- During the Vedic period, both productive as well as protective aspect of forest vegetation were emphasised. During Vedic period, the concept of cultural landscape such as sacred forests and groves, sacred corridors and a variety of ethno-forestry practices were evolved

Forest And Wildlife

- Forests are 'biodiversity hotspots'. One of the main aims of conservation is to try and preserve the biodiversity we have inherited.
- The local people need large quantities of firewood, small timber and thatch. Bamboo is used to make slats for huts, and baskets
- In addition to the people gathering fruits, nuts and medicines from the forests, their cattle also graze in forest areas
- The traditional Forest dwelling communities had developed practices to ensure that the resources were used in a sustainable manner.
- The Forest Department in independent India took over from the British but local knowledge and local needs continued to be ignored in the management practices. Thus vast tracts of forests have been converted to monocultures of pine, teak or eucalyptus.
- Industries would consider the forest as merely a source of raw material for its factories. And huge interest-groups lobby the government for access to these raw materials at artificially low rates.
- There have been enough instances of local people working traditionally for conservation of forests. For example, the case of Bishnois community living in western Rajasthan on the border of the Thar desert. Conservation of forest and wildlife has been a religious tenet for them.
- The Government of India has recently instituted an 'Amrita Devi Bishnoi National Award for Wildlife Conservation' in the memory of Amrita Devi Bishnoi, who in 1731 sacrificed her life along with 363 others for the protection of 'khejri' trees in Khejrali village near Jodhpur in Rajasthan.
- Management of protected areas by keeping the local people out or by using force cannot possibly be successful in the long run.
- Forest resources ought to be used in a manner that is both environmentally and developmentally sound – in other words, while the environment is preserved, the benefits of the controlled exploitation go to the local people, a process in which decentralised economic growth and ecological conservation go hand in hand.

Management of Forests

- The Chipko Andolan ('Hug the Trees Movement') was the result of a grassroot level effort to end the alienation of people from their forests.
- Sal forest of Midnapore district (West Bengal) is another successful example of forest management with the participation of local villagers by making them the stakeholders.

Water For All

- Rains in India are largely due to the monsoons. This means that most of the rain falls in a few months of the year. Despite nature's monsoon bounty, failure to sustain water availability underground has resulted largely from the loss of vegetation cover, diversion for high water demanding crops, and pollution from industrial effluents and urban wastes.
- Parts of Himachal Pradesh had evolved a local system of canal irrigation called kulhs in which the water flowing in the streams was diverted into man- made channels which took this water to numerous villages down the hillside.

Criticisms about large dams address three problems in particular –

i. Social problems because they displace large number of peasants and tribals without adequate compensation or rehabilitation, \
ii. Economic problems because they swallow up huge amounts of public money without the generation of proportionate benefits,
iii. Environmental problems because they contribute enormously to deforestation and the loss of biological diversity.

Water Harvesting

- Watershed management emphasises scientific soil and water conservation in order to increase the biomass production. The aim is to develop primary resources of land and water, to produce secondary resources of plants and animals for use in a manner which will not cause ecological imbalance.
- Water harvesting is an age-old concept in India. Khadins, tanks and nadis in Rajasthan, bandharas and tals in Maharashtra, bundhis in Madhya Pradesh and Uttar Pradesh, ahars and pynes in Bihar, kulhs in Himachal Pradesh, ponds in the Kandi belt of Jammu region, and eris (tanks) in Tamil Nadu, surangams in Kerala, and kattas in Karnataka are some of the ancient water harvesting, including water conveyance, structures still in use today
- In largely level terrain, the water harvesting structures are mainly crescent shaped earthen embankments or low, straight concrete-and- rubble "check dams" built across seasonally flooded gullies. Their main purpose, however, is not to hold surface water but to recharge the ground water beneath.

Coal and Petroleum

- Coal and petroleum were formed from the degradation of bio-mass millions of years ago and hence these are resources that will be exhausted in the future no matter how carefully we use them.
- When these are burnt, the products are carbon dioxide, water, oxides of nitrogen and oxides of sulphur. When combustion takes place in insufficient air (oxygen), then carbon monoxide is formed instead of carbon dioxide. Of these products, the oxides of sulphur and nitrogen and carbon monoxide are poisonous at high concentrations and carbon dioxide is a greenhouse gas. Some simple choices can make a difference in our energy consumption patterns.

Think over the relative advantages, disadvantages and environment-friendliness of the following:

(i) Taking a bus, using your personal vehicle or walking/cycling.
(ii) Using LED bulbs or fluorescent tubes in your homes.
(iii) Using the lift or taking the stairs.
(iv) Wearing an extra sweater or using a heating device (heater or 'sigri') on cold days.

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