CHAPTER 01: EFFECTS OF ELECTRIC CURRENT

Appliances - Energy change:

- Electric iron - electrical energy is converted into heat energy
- Electric fan - electrical energy is converted into mechanical energy
- Electromagnet - electrical energy is converted into magnetic energy
- Electric heater - electrical energy is converted into heat energy
- Storage battery - electrical energy is converted into chemical energy. (while charging)
- Induction cooker - electrical energy is converted into heat energy
- Mixie - electrical energy is converted into mechanical energy

Heating Effect of Electric Current

- Electric iron, electric heater, electric bulb etc. are the appliances working on the heating effect of electricity.
- Two small pieces of thin copper wire and nichrome wire of nearly equal length and thickness, then the resistance of the nichrome wire is greater than that of copper wire.
- Copper wire and nichrome wire are connected in series, then the current passing through them are same.
- The nichrome wire becomes red hot while passing electricity through the circuit since resistance of nichrome is more.
- Resistivity of nichrome is more than that of copper.

Current:

- If the ammeter shows a **current** I ampere on applying a potential difference V across the resistor of resistance R is

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

- Unit – Ampere (A)

Volt:

- The potential difference between two points will be **one volt** if one joule of work is done in moving one coulomb of charge from one point to the other.
- Unit – Volt (V)

Joule's Law:

- The **heat** generated (H) in a current carrying conductor is **directly proportional** to the product of the square of the **current** (I) in the conductor, the **resistance** of the conductor (R) and the **time** (t) of flow of current.

$$H = I^2Rt$$

$$H = VIt$$

$$H = \frac{V^2t}{R}$$

I - Current, R - Resistance, V - Voltage, t - Time,

P – Power, H - heat

The factors affecting the heat produced

1. Electric current
2. Resistance of the conductor
3. Time of flow of electric current

Series Connection:

- When a circuit is completed by connecting the resistors one after the other, it is called **series** connection.

- Effective resistance is **the sum** of the resistance of all the resistors when they are connected in series.

$$R = R_1 + R_2 + R_3 + \ldots$$

Parallel Connection:

- The current completes the circuit by getting divided into each branch since the resistors are connected in parallel.
- The total current in the circuit is the sum of the current through all the branch circuits
- Effective resistance,

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

Resistors in series

- Only one path for current flow in a closed circuit.
- Effective resistance increases
- The current through each resistor is same.
- The potential difference across each resistor is different. It gets divided as per the value of resistors.
- Each resistor cannot be controlled by using separate switches.

Resistors in parallel

- Effective resistance decreases.
- The current through each resistor is different. It gets divided as per the value of resistors.
- The potential difference across each resistor is same.
- Each resistor can be controlled by using separate switches.

Heating effect of Electricity - Uses

Heating Coils:

- It is an electrical device that converts current to heat
- Heating coil (Main part)
- Heating coils are made of Nichrome
- Nichrome is an alloy of nickel, chromium and iron.

The peculiarities of Nichrome

1. High resistivity
2. High melting point (1400˚C)
3. ability to remain in red hot condition for a long time without getting oxidized.
4. The substance is high resistance to corrosion.
5. The operating temperature is 900˚C

Safety fuse

- Safety fuse is a device that works on the heating effect of electric current.
- The Main Part: Fuse wire
- Fuse wire: Alloy of tin and lead
- Fuse wire has a relatively low melting point.
- The fuse wire connected to a circuit in series.
- Safety fuse is a mechanism to safe electrical appliances by stopping huge current due to short circuit or overloading in a circuit.
- When an excessive current flows through it, the wire melts and the circuit is broken.
- In each circuit the fuse wire should be used in accordance with the current flowing through it.

- Safety fuse is a device which protects us and the appliances from danger when an excess current flows through the circuit.

Power:

- The amount of energy consumed by an electrical appliance in unit time is its power.
- The unit of heat is **joule** (J)
- The unit of power is **joule/second** (J/s) or watt
- The unit of power is **watt** (W)

Different Types of Lamp:

- Incandescent lamp
- Discharge lamp
- Fluorescent lamp
- CFL
- Arc lamp
- LED Bulb

Incandescent lamp:

- Working: Heat is produced when current flows through the tungsten filament and produces white light.
- Main part Filament, Filament is made of tungsten.
- Tungsten can become white hot and emit white light for a long time.
- In order to avoid oxidation of tungsten, the bulb is evacuated.
- The presence of inert gases with low pressure in the incandescent bulb helps to reduce the evaporation of the filament. Nitrogen is usually used for this purpose now.
- At normal temperature and pressure, nitrogen behaves like an inert gas. Small increase in temperature does not influence the expansion of nitrogen.

- Major part of energy supplied filament lamp is lost as heat. Hence the efficiency of these devices is less.

Properties of tungsten:

1. High resistivity.
2. High melting point high ductility.
3. Ability to emit white light in the white-hot condition.
4. Highest tensile strength.
5. Excellent corrosion resistance.
6. It is malleable

Discharge lamps

- Discharge lamps are glass tubes fitted with two electrodes.
- Working: When a high potential difference is applied the gas molecules get excited. Excited atoms come back to their original states for attaining stability. During this process the energy stored in them will be radiated as light.
- Depending on the difference in the energy levels lights of different colours and other radiations are emitted.

LED bulb (Light emitting diode bulb)

- LEDs are Light Emitting Diodes.
- As there is no filament, there is no loss of energy in the form of heat.
- Since there is no mercury in it, it is not harmful to environment.
- Very small in size
- Lower power consumption.
- Energy Efficient.
- Durable Quality.
- Provide long life span.

Units:

- Time – Seconds (s)
- Resistance – Ohm (Ω)
- Current – Ampere (A)
- Potential Difference or Voltage – Volt(V)
- Heat – Joule(J)
- Energy – Joule (J)
- Power or Energy consumed – Watt (W)

Formula:

- $V = IR$
- $H = I^2Rt$
- $P = I^2R$

Other:

- Milli (m) – 10^{-3}
- Micro (μ) – 10^{-6}
- Nano (n) – 10^{-9}
- Pico (p) – 10^{-12}

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CHAPTER 02: MAGNETIC EFFECT OF ELECTRIC CURRENT

Magnetic field:

- The magnetic field lines of the bar magnet and that of the electromagnets are similar.
- Magnetic field lines are continuous.
- Magnetic field lines forming closed loops.
- A freely suspended magnet aligns in the north-south direction.
- The presence of the magnetic field and the polarity can be understood using a magnetic compass.
- The magnetic strength/ magnetism of an electromagnet is temporary.
- The magnetic field around an electromagnet is created due to the flow of current through the coils in it.
- A magnetic field will be developed when current passes through a straight conductor.
- A magnetic field is developed around a current carrying conductor.
- The magnetic needle is deflected as a result of the mutual action of this magnetic field and that around the magnetic needle.

Right Hand Thumb Rule:

- It is used to find the direction of magnetic field.
- **Right Hand Thumb Rule**: Imagine you are holding a current carrying conductor with the right hand in such a way, that the thumb points in the direction of the current. The direction in which the other fingers encircle the conductor gives the direction of the magnetic field.
- The thumb points in the direction of the current.
- Other fingers points in the direction of magnetic field.
- Right Hand Thumb Rule is also known as **Right Hand Screw Rule**.

Right Hand Screw Rule:

- If a right-hand screw is rotated in such a way that its tip advances along the direction of the current in the conductor, then the direction of rotation of the screw gives the direction of the magnetic field around the conductor.
- When the electric current passes in the clockwise direction, the magnetic field lines appear to move away from us into the coil through the central part of the coil. But if the electric current passes in the anti-clockwise direction, the magnetic field lines appear to move out towards us from the coil through its centre.
- The strength of the magnetic field increases when the number of turns of the coil or current is increased.

Solenoid:

- A solenoid is a coiled conductor wound up in the shape of a spring.
- A **solenoid** is an insulated wire wound in the shape of a helix. Such coiled conductors are used to make use of the magnetic effect of electricity.
- When current flows through the solenoid, it behaves like a bar magnet.
- The end of the solenoid at which current flows in the clockwise direction will be the South Pole and the end at which current flows in the anti-clockwise direction will be the North Pole.
- The strength of magnetic field increases when the number of turns or electric current increases.
- A current carrying solenoid is stretched to increase the distance between the coils, the magnetic strength decrease.

The Factors affecting the strength of magnetic field are

- Number of turns
- Intensity of current
- Area of cross section of the solenoid

The factors that influence the direction of motion of the conductor

- Direction of current
- Direction of magnetic field

Fleming's Left-Hand Rule

Hold the forefinger, the middle finger and the thumb of the left hand in mutually perpendicular directions. If the forefinger indicates the direction of the magnetic field and the middle finger, the direction of the current, then the thumb will indicate the direction of motion of the conductor.

Motor principle

A conductor, which can move freely and which is kept in a magnetic field, experiences a force when current passes through it and it moves

- The working of electric motor is based on this principle.
- The motor principle is also used in devices like fan, mixie etc.
- Armature is the metallic coil wound round a soft iron core so that it is free to rotate.
- If the rotation of the armature is to be sustained the direction of current through the armature should continuously keep on changing.
- The split rings help to change the direction of current through the coil after every half rotation.
- Split rings is also called **split ring commutator.**
- AC generator – slip rings
- DC generator – split rings

Loud speaker:

- The voice coil situated in magnetic field.
- Main Parts: Magnet, Voice coil, Diaphragm.

- **Working:** The electrical pulses from a microphone are strengthened using an amplifier and sent through the voice coil of a loudspeaker. The voice coil, which is placed in the magnetic field, moves to and fro rapidly, in accordance with the electrical pulses. These movements make the diaphragm vibrate, thereby reproducing sound.

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CHAPTER 3: ELECTRO-MAGNETIC INDUCTION.

Electromagnetic induction:

- Keeping the solenoid at rest bring one end of a magnet moves towards the solenoid and then take it back at the same speed. The needle deflects and suddenly comes back to the initial position.
- Galvanometer is a device used to detect the presence of even a small current.
- When introducing a bar magnet (North or South) quickly into the coil, there is a momentary deflection of the galvanometer needle along one direction.
- When the magnet is stationary, galvanometer needle comes back to the initial position.
- When withdrawing the magnet (North or South) quickly, there is a momentary deflection of the galvanometer needle in the opposite direction and comes back to the initial position.
- The magnetic flux associated with a coil changes by the relative motion of the coil or magnet.
- Whenever there is a change in the magnetic flux linked with a coil, an emf is induced in the coil. This phenomenon is **electromagnetic induction**.
- The emf developed due to electromagnetic induction is called **induced emf**.
- The current obtained due to electromagnetic induction is called **induced current**.
- Faraday is known as the father of electricity.

The factors on which the direction of induced current in electromagnetic induction depends:

- Direction of magnetic field
- Direction of motion (solenoid or magnet)

Deflection of Galvanometer needle increases:

1. Number of turns increases.
2. Strong magnet is used.
3. Increase the speed of motion.

Fleming's right-hand rule:

Imagine a conductor moving perpendicular to a magnetic field. Stretch the forefinger, middle finger and the thumb of the right hand in mutually perpendicular directions. If the fore finger represents the direction of the magnetic field, and the thumb represents the direction of motion of the conductor, then, the middle finger represents the direction of the induced current

- A current that flows only in one direction continuously is direct current (DC).
- Current that changes direction at regular intervals of time, is an alternating current (AC).

Generators

- The device which produces electricity on the basis of electromagnetic induction by the continuous motion of either the solenoid or the magnet is called a **generator**.

AC generator

- Generator gives alternating current.

Main parts:

Field magnet

The magnet that creates magnetic flux in the generator

Armature

An arrangement of insulated conducting wire wound on a soft iron core. This can be made to rotate about an axis.

Slip rings

Metal rings which are welded together with the armature coil. They rotate along with the armature on the same axis of rotation as the armature

Brushes

They are arrangements which always make contact with the slip rings. Current flows through them to the external circuits

- **Working:** When the armature rotates in the magnetic field, an alternating is induced in the coil. The current is carried to the external circuit through the brushes keeping contact with the slip rings.
- **Different stages of the rotation of the armature:**
  During the first half of rotation the current begins from zero and reaches the maximum positive value, then decreases gradually and comes to zero. In the second half, the current reaches the maximum negative value, then decreases gradually and reaches zero.
- As a result of variation of the magnetic flux linked with a conductor, a current is induced in it, the direction of which changes continuously. This is known as **alternating Current** (AC).
- The induced current developed in one direction during the first half rotation of the armature of the AC generator and the induced current developed in the opposite direction during the next half of the rotation constitute one cycle of an AC.
- The number of cycles in one second is called the frequency of AC.

- Since the rubbing of slip rings on brushes produce sparks it is the magnet that is made to rotate in AC generators.
- The frequency of AC in our houses is 50 Hz.

AC Generator:

- Direction Change Continuously.
- Varying emf.

DC battery:

- Direction Constant.
- Constant emf.

DC Generator:

- Direction Constant.
- Varying emf.

Mutual Induction

- The coil into which we give current for the production of magnetic field is the primary coil and the coil in which induced emf is generated is the secondary coil.
- Consider two coils of wire kept side by side. When the strength or direction of the current in one coil changes, the magnetic flux around it changes. As a result, an emf is induced in the secondary coil. This phenomenon is the **mutual induction**

Transformer

- A **transformer** is a device that works on the principle of mutual induction.
- Transformer is a device for increasing or decreasing the voltage of an AC without any change in the electric power.

Transformers are of two types

- The one which increases AC voltage is **step up transformer.**
- The one which decreases AC voltage is a **step-down transformer.**
- Power in the primary and secondary are same.
- In a step-up transformer the voltage in the secondary coil is more and the current is less. But in a step-down transformer the secondary voltage is less and the current is more.

Self-induction

- The change in magnetic flux due to the flow of an AC in a solenoid will generate a back emf in the same solenoid in a direction opposite to that applied to it. This phenomenon is known as the **self-induction**.
- **Inductors** are coils used to oppose the changes in electric current in a circuit. They are used to reduce current in a circuit to the desired value without loss of power.

Moving coil microphone

- Moving coil microphone is another device that works based on the principle of electromagnetic induction.

The working of Moving coil microphone:

- The voice coil is situated in a magnetic field. The diaphragm connected to the voice coil vibrates in accordance with the sound waves falling on it. As a result, electrical signals corresponding to the sound waves are generated in the voice coil. In the microphone, mechanical energy is converted into electrical energy.
- When a sound is produced in front of a microphone, electric signals in accordance with the sound is generated in the coil. The weak signals obtained from the microphone are strengthened by an amplifier.

- The signals reaching the amplifier are strengthened and sent to the loud speaker. The loud speaker reproduces the original sound

Power Transmission and Distribution

- The principle of electromagnetic induction is used worldwide to generate electricity on a large scale. AC generators are used to produce electricity for the purpose of distribution.
- Power stations are places where electricity is generated on a large scale for distribution.
- Three Phase AC Generators are used in power stations
- Single Phase Generators have only one set of coils in between the poles of a field magnet.
- Three Phase Generators are used for the large-scale production of electricity.
- In power generators, three armature coils are arranged around the field magnet at an angular separation of 120°.
- When the field magnet rotates, three alternating currents of different phases are generated simultaneously
- In India electricity is produced at 11 kV (11000 V) in the in-power stations.
- When electricity is transmitted to distant places there is loss of energy in the conductors in the form of heat is called transmission loss.
- The voltage is increased up to 220 kV at the power station
- As a result, the current and loss of energy in the form of heat decreases. Later the voltage is lowered at different stages of power transmission and electricity is made available to the distribution transformer at 11 kV.
- 230 V required for house hold purposes is made available by distribution transformers. 400 V needed for industrial purposes are also obtained from distribution transformers.

- 4 wires are coming out from a distribution transformer.
- Three phase line are connected to a point is called neutral.
- The line starting from this point is neutral line.
- The neutral potential is zero.
- Potential difference between Two phase line is 400V
- Potential difference between phase line and neutral line is 230V
- Potential difference between neutral line and earth is 0V
- Potential difference between phase line and earth is 230V

Household Electrification:

Order: Watt Hour meter - main fuse - main - switch - fuses - switches appliances.

- Fuse is connected to the phase line.
- The switches are connected to the phase line
- In house all appliances are connected in parallel to neutral line through switches.

Kilowatt hour:

- The commercial unit of electrical energy is kilowatt hour (kWh).
- A device of power 1000 watt (1kW), when used for one hour (1h), consumes one unit of electrical energy (1 kWh)

Safety measures in household electrification

1. Safety Fuse
2. MCB (Miniature Circuit Breaker), ELCB (Earth Leakage Circuit Breaker)

Three pin Plug and Earthing

- In order to ensure safety, three pin plugs are used in certain appliances.

Earthing for better safety:

- The pin E of a three-pin plug comes into contact with the earth line. The pin is connected to the body of the appliance.
- The flow of current to the earth through a circuit of low resistance increases the current. As a result heat generated in the fuse wire increases and the circuit gets broken. This ensures the safety of instrument and the person handling it.
- The length and thickness of the earth pin is more than that of the other pins.

Rectifier:

- Rectifier is a device that converts AC into DC.
- The main part of the rectifier is an electronic component named diode.
- This conducts current only in one direction.
- Rectifiers are used in different electronic components.

Electric Shock

- Electric shock occurs when we touch bare wires or cable with damaged insulation or when lightning strikes.
- Severe injuries may occur when current flows through our body.
- If somebody gets an electric shock, the main switch should be switched off immediately.
- Separate the electrocuted person using a dry wooden piece or a dry insulator material.
- Never touch the affected person using bare hands.
- Sometimes high voltage shocks may not cause any damage. Even then one should seek medical help immediately, because it may affect the brain. Epilepsy, depression, anxiety etc., may occur.

- Even if the voltage is small it may lead to unconsciousness, damage to touching sensation decrease in vision and hearing disability etc.

Precautions

- Never handle electric equipment's or operate switches when the hands are wet.
- Insert plug pins into socket and withdraw them only after switching off.
- Do not operate devices of high power using ordinary sockets.
- Wear rubber footwear while operating electric devices.
- Do not touch the interior parts of the cable TV adapters. Ensure that there is an insulated cap for the adapters.
- Do not fly kites near electric lines.
- Do not use table fan to dry hair.
- Ensure that there are no tall buildings or tall trees near electric lines.
- Ensure that the main switch and ELCB are switched off when maintenance work is being carried out at home.

Precautions during some Special Circumstances

- During lightning, avoid doing any work that will bring you in contact with electric circuits.
- Disconnect the plugs from the socket whenever there is a chance of lightning.
- During rain and wind, electric lines are likely to touch the ground. This may cause danger. We have to be cautious on such occasions.
- If water enters home due to floods or other reasons, disconnect electric connections. Reconnect it only after ensuring that the main switch and the switch board are perfectly dry.
- Always hire a licensed electrician for all wiring jobs.

- Don't remove a plug from a power point by pulling on the chord – pull the plug instead.

Causes of electric shock:

- Faulty appliances
- Damaged extension cords
- Electrical appliances coming contact with water.
- Downed powerlines.
- Lightning strike.

First aid to be given in the case of electric shock:

- As a result of electric shock:
    1. Body temperature decreases.
    2. Viscosity of blood increases.
    3. Blood clotting.
    4. Muscles contract.
- First aid should be given only after disconnecting the victim from the electric wire.

How to provide the first aid:

- Raise the temperature of the body by massaging.
- Give artificial respiration.
- Massage the muscles and bring them to the original condition.
- Start first aid for the functioning of the heart (Apply pressure on the chest regularly)
- Taking the person to the hospital immediately.

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4 REFLECTION

Reflection of Light:

- Light falling on the surface of an object comes back to the same medium is called Reflection of Light.
- The angle of incidence is the angle made by the incident ray with the normal at the point of incidence.
- The angle of reflection is the angle made by the reflected ray with the normal at the point of incidence.
- The normal is a line at right angle to the mirror surface at the point of incidence.

Laws of Reflection:

- When light is reflected from a smooth surface, the angle of incidence and angle of reflection are equal.
- The incident ray, reflected ray and normal to the surface are in the same plane.

When light falls on a rough surface, it undergoes an irregular reflection. This is **scattered reflection**.

In the dust particles of the atmosphere, light undergoes scattered reflection. This is **scattering**.

Image formation by Plane Mirror:

- 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.
- The image is laterally inverted.

Multiple Reflection and Image Formation

- The relation between the angle between the mirrors and the number of images:

$$n = \frac{360}{\theta} - 1$$

Field of View of Mirrors and the Nature of Images

Plane mirror:

- The image is behind the mirror.
- Distance to object and distance to image from the mirror are the same.
- The image is virtual, erect and is of the same size as that of the object.
- Use – For observing the face

Convex mirror

- Image is always formed in between the pole of the mirror and the principal focus.
- The image is diminished, virtual and erect.
- Use - Used as rear-view mirror.

Concave mirror:

Position(object) - Position(image) - Image Size - Nature (image):

At infinity - At F - Highly diminished point-sized - Real and inverted

Beyond C - Between F and C - Diminished - Real and inverted

At C - At C - Same size - Real and inverted

Between C and F - Beyond C - Enlarged - Real and inverted

At F - At infinity - Highly enlarged - Real and inverted

Between P and F - Behind the mirror - Enlarged - Virtual and erect

Mirror equation:

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

This is known as **mirror equation**.

New Cartesian Sign Convention:

In all experiments related to lenses and mirrors the distances are measured in the same way as in graphs.

- Distances are measured considering the Pole of the mirror as the origin (O).
- Those measured to the right from O are positive and those in the opposite direction are negative.
- Distances measured upwards from X axis are positive and those downwards are negative. The incident ray is to be considered as travelling from left to right.

Magnification:

$$m = \frac{h_i}{h_o} = -\frac{v}{u}$$

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5 REFRACTION OF LIGHT

- The ray of light entering water undergoes a deviation at the point on the surface where the media get separated.

Speed of light and optical density:

Medium	- speed of light (m/s)
Vacuum	- 3×10^8 m/s
Water	- 2.25×10^8 m/s
Glass	- 2×10^8 m/s
Diamond	- 1.25×10^8 m/s

- The characteristics of each medium influences the speed of light that passes through the respective medium.
- Optical density is a measure that shows how a medium influences the speed of light passing through it.
- Optical density increases, the speed of light decreases.

Refraction of Light:

It is the difference in the optical densities that causes the deviation.

- When a ray of light entering obliquely from one transparent medium to another, its path undergoes a deviation at the surface of separation. This is **refraction.**

Refraction in different media:

- While entering from air to glass (from a medium of lower optical density to that of a greater one) the refracted ray deviates towards the normal.

- While entering from glass to air (from a medium of greater optical density to that of a lower one) the refracted ray deviates away from the normal.
- The angle of incidence, angle of refraction and the normal at the point of incidence are in the same plane.
- No deviation takes place in the case of a light ray falling normally on a medium.

Note:

- When light passes obliquely from a medium of higher optical density to a medium of lower optical density, the refracted ray deviates away from the normal.
- When light is incident obliquely, from a medium of lower optical density to a medium of greater optical density, the refracted ray deviates towards the normal.

Laws of Refraction

- The angle of incidence, the angle of refraction and the normal at the point of incidence on the surface of separation of the two media will always be in the same plane.
- The ratio of the sine of the angle of incidence to the sine of the angle of refraction $\frac{\sin i}{\sin r}$ will always be a constant. This is known as **Snell's law.**
- The constant from Snell's law is known as refractive index (n).

Speed of light in media and refractive index

- The refractive index of one medium with respect to another is called **relative refractive index**.
- The refractive index of a medium with respect to vacuum is called **absolute refractive index**.

Total Internal Reflection:

- When a ray of light passes from a medium of greater optical density to that of lower optical density, the angle of incidence at which the angle of refraction becomes 90° is the critical angle.
- The critical angle in water is 48.6°.
- When a ray of light passes from a medium of higher optical density to a medium of lower optical density at an angle of incidence greater than the critical angle, the ray is reflected back to the same medium without undergoing refraction. This phenomenon is known as **total internal reflection.**

Practical applications of total internal reflection:

- It is used in endoscopy
- It is used in optical communication.
- It is used in many optical instruments like telescopes, microscopes, binoculars etc.
- The brilliance of diamond is due to total internal reflection.
- The phenomenon of mirage.

OFC:

Total internal reflection is made use of in optical fibre cables. Through optical fibres, thousands of signals of different frequencies can be sent to distant places simultaneously, making use of total internal reflection of light, without losing the intensity.

Lens:

A lens is a transparent medium having spherical surfaces.

Optic centre - Optic centre is the midpoint of a lens (P).

Centre of curvature - A lens has two spherical surfaces as parts of the lens.

Centre of curvature (C) is the centre of the imaginary spheres of which the sides of the lens are parts.

Principal axis - Principal axis is the imaginary line that passes through the optic centre joining the two centres of curvature.

The principal focus:

- Light rays incident parallel and close to the principal axis after refraction converges to a point on the principal axis of a convex lens. This point is **the principal focus of a convex lens.**
- Light rays incident parallel and close to the principal axis diverge from one another after refraction. These rays appear to originate from a point on the same side. This point is **the principal focus of a concave lens.**

It is impossible to produce real convergence of light using a concave lens. Therefore, the principal focus of a concave lens is virtual.

Focal length

- Focal length is the distance from the optic centre to the principal focus. This is denoted by the letter **f.**

Formation of image using a lens:

Image formed by concave lens:

Position(object) - Position(image) - Image Size - Nature (image)

At infinity - At F - Highly diminished point-sized - Real and inverted

Beyond 2F - Between F and 2F - Diminished Real and inverted

At 2F - At 2F - Same size - Real and inverted

Between 2F and F - Beyond 2F - Enlarged - Real and inverted

At F - At infinity - Highly enlarged - Real and inverted

Between O and F - On the same side of the lens as object - Enlarged - Virtual and erect

Image formed by concave lens:

- Virtual image.
- Images are always smaller than object.
- Upright image.

Magnification:

- Magnification is the ratio of the height of the image to the height of the object.

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

- Magnification shows how many times the image is larger than the object.
- If magnification is negative, the image will be real and inverted.
- If magnification is positive, the image will be virtual and erect.

Power:

- Power is a term related to the focal length of a lens.
- Power of a lens is the reciprocal of focal length expressed in metres.
- Unit of power is dioptre. It is represented by D.
- The power of a convex lens is positive and that of a concave lens is negative.

Atmospheric Refraction

- When light passes through media of different optical densities it undergoes successive refractions. Hence the source of light appears like **twinkling**.

- Light coming from distant stars passes through different layers of air. Each layer differs from the other in their optical densities. Hence light undergoes successive refraction. Since stars at a greater distance they appear like a point source. The rays of light appear to come from different points on reaching the eye after refraction. This is the reason for the **twinkling of stars**.

Type your text

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6 VISION AND THE WORLD OF COLOURS

Eye and Vision:

- Near point is the nearest point at which the objects can be seen distinctly.
- The near point of an eye with healthy vision is 25 cm.
- Far point is the farthest point at which the objects can be seen distinctly.
- The far point of an eye with healthy vision is at infinity.
- The ability of the eye to form an image on the retina by adjusting the focal length of the lens in the eye, by varying the curvature of the lens, irrespective of the position of the object, is the power of **accommodation.**

Long sightedness:

- Since the image is not formed at the retina, instead of being formed at the retina, nearer objects cannot be seen clearly even though distant objects are clearly seen. This defect of the eye is the **long sightedness.** The near point of the eye of such a person will be at a distance of more than 25 cm.
- The light rays from a close by 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,
  (ii) the eyeball has become too small.
- This defect can be corrected by using a convex lens of appropriate power.

Nearsightedness:

- For some persons, even though nearby objects can be seen clearly, they may not be able to see distant objects clearly. This defect is the **nearsightedness.** The near point of such persons will not be at infinity. It will be at a definite distance from the eye.
- The image of a distant object is formed Infront of the retina.

- This defect may arise due to excessive curvature of the eye lens, or elongation of the eyeball.
- This defect can be corrected by using a **concave lens** of suitable power.
- For elderly people the distance to the near point is greater than 25 cm. This is due to the diminishing ability of the ciliary muscles. For such people the power of accommodation will be less. This is **presbyopia**.

Eye Donation

Eye donation is one of the noblest donations.

Dispersion of light

- Any light that is composed of more than one color is a **composite light**.
- Dispersion is the phenomenon of splitting up of a composite light into its constituent colours.
- The regular array of colours formed by dispersion is the visible spectrum.

Rainbow:

- Dispersion of light caused by the water droplets in the atmosphere causes rainbow.
- Sunlight, when it passes through water droplets, undergoes refraction and internal reflection. The light ray emerging from the water droplets which make the same angle with the line of vision have the same colour. These droplets appear in the form of an arc of a particular colour. Thus, there is **red colour at the upper edge** and **violet colour at the lower edge**. All the other colours are seen in between, depending on their wavelengths.
- When the position of the sun is near the horizon, the rainbow appears to be bigger.
- When seen from an aeroplane, the rainbow is seen as a circle.
- When the sun is much above the horizon, the rainbow disappears.

Recombination of colours:

- Pass white light through a prism obtain the constituent colours on the screen. A prism similar to the first is placed in inverted position, adjacent to the first, obtain white light on the screen.

Persistence of vision:

- When an object is viewed by a person, its image remains in the retina of the eye for a time interval 0.0625s after seeing it. This phenomenon is called **persistence of vision**.
- If more than one scene is viewed within 0.0625s, the effect of all these scenes will be felt by the eye simultaneously.

Scattering of Light:

- Scattering is the change in direction brought out by the irregular and partial reflection of light when it hits the particles of the medium

Scattering and Wavelength:

- Rate of scattering and the size of the particles are interrelated.
- As the size of the particle increases, the rate of scattering also increases.
- If the size of the particles is greater than the wavelength of light, then the scattering is same for all colours.

Colours of the raising and the setting sun:

- During sunrise and sunset, light reaching us from the horizon has to travel long distances through the atmosphere. During this long journey, colours of shorter wavelength would be almost fully lost due to scattering. Then, the **red light which undergoes only less amount of scattering** decides the colour of the horizon. That is why the **sun appears red** during sunset and sunrise.

Tyndal Effect:

- When rays of light pass through a colloidal fluid or suspension, the tiny particles get illuminated due to scattering. Because of this, the path of light is made visible. This phenomenon is **Tyndal Effect**.
- The intensity of scattering depends on the size of particles in the colloid.
- As the size increases , the intensity of scattering increases.

Light Pollution:

- The use of light in excess in a non -judicious manner is referred to as light pollution.

The consequences of light pollution:

- The life cycle of living beings will be affected adversely.
- Sky watching becomes impossible due to diminished sky vision.
- The light from tall flats misleads the migrating birds. It affects the accuracy of their judgement of direction.
- The excess light from the high beam of headlight in vehicles causes a hindrance to the vision of others and can cause accidents.

The excessive use of lighting devices increases energy consumption and creates energy crisis.

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7 ENERGY MANAGMENT

Fuels are substances that release plenty of heat energy on burning.

The conditions favorable for the complete combustion of different fuels:

- The solid fuels must be dry.
- Liquid fuels must evaporate easily.
- The ignition temperature should be attained.
- Sufficient oxygen must be available for burning

Combustion of fuels

- Fuels burn with the help of oxygen.
- Generally **complete combustion** is a reaction in which fuels react intensively with oxygen, producing carbon dioxide, steam, heat and light.
- If sufficient oxygen is not available, the rate of combustion decreases.
- If oxygen is not sufficient, large quantities of carbon monoxide, soot and a little of carbon dioxide will be formed. This type of burning is **partial combustion**.

Pollution test is conducted to know whether the components in the gases released from the vehicle exceeded the permissible limits.

Fossil fuels:

- Fossil fuels are formed by the transformation of plants and animals that went under the earth's crust millions of years ago. The transformation took place in the absence of air under high pressure and high temperature
- Coal, petroleum and natural gases are fossil fuels. They are not replenished or renewed in proportion to their consumption. Hence, they are non-renewable energy sources

- Coal is the most abundant fossil fuel on the earth. The main component of coal is carbon.
- Based on the carbon content, it is classified into four groups as peat, lignite, anthracite and bituminous coal.
- When coal is distilled in the absence of air, the substances obtained are ammonia, coal gas, coal tar and coke.
- We make liquefied natural gas (LNG) and compressed natural gas (CNG) from the natural gas obtained along with petroleum. The main component of all these is methane. These are used as fuels in vehicles, industries and thermal power stations.
- The importance of LNG is that natural gas can be liquefied and transported to distant places conveniently. It can again be converted into gaseous form at atmospheric temperature and distributed through pipe lines.
- The full form of LPG is liquefied petroleum gas. This is a colourless, odourless gas obtained through the fractional distillation of petroleum.
- Domestic LPG produces an odour since ethyl mercaptan is added as an indicator to detect gas leakage.
- The main constituent of LPG is butane.

Biomass

- From ancient times, we have been using firewood, dried cow dung etc., as fuel. Since these fuels are obtained from plants and animals, they are known as bio-waste or biomass.
- The burning of such bio-wastes will be partial combustion.

Biogas:

- When bio waste is deposited in a biogas plant in the absence of oxygen, biogas is formed by the action of bacteria. Its main constituents are methane and carbon dioxide.

- The slurry discharged from the biogas plant is good manure.
- When biomass is converted into biogas, not only a fuel of greater calorific value is obtained but the atmospheric pollution is also minimised.

Calorific value

- The amount of heat liberated by the complete combustion of 1 kg of fuel is its calorific value. Its unit is kilojoule/kilogram.
- Some fuels and their calorific values:

Hydrogen	-	150000 kJ/kg
CNG	-	50000 kJ/kg
Dried cow dung	-	6000 - 8000 kJ/kg
LPG	-	55000 kJ/kg
Biogas	-	30000 - 40000 kJ/kg
Coal	-	25000 - 33000 kJ/kg
Petrol	-	45000 kJ/kg
Methane	-	50000 kJ/kg

Hydrogen and hydrogen fuel cell

- Hydrogen is a fuel with the highest calorific value. This is highly inflammable and explosive in nature. So it is difficult to store and transport it. We make use of hydrogen fuel cell to produce electricity by combining hydrogen and oxygen.

The properties that a good fuel:

- Should be easily available.
- Should be of low cost.
- Should have a high calorific value.

- Should cause minimum atmospheric pollution on combustion.
- Should be easily storable.
- A liquid fuel must not evaporate quickly at ordinary temperatures

Electrical energy:

- Electrical energy is the most important form of energy. Its speciality is that it can easily be converted into many other forms.
- Power stations are the centres where electricity is produced on a large scale for distribution.
- The mechanical energy required for running power generators is made available in different ways. Power stations can be classified based on the nature of the source providing the energy required to operate the generator.
- Flowing water - hydroelectric power stations

HYDROELECTRIC POWER STATIONS

- Water stored at a height is allowed to flow down through a penstock pipe. The energy of the flowing water is used to rotate the turbine and electricity is generated.
- Such power stations are established at Pallivasal, Moolamattom, etc., in Kerala.
- **The energy change taking place here is:**
  Potential energy - Kinetic energy - Mechanical energy - Electrical energy.

THERMAL POWER STATION

- Fuels like coal, naphtha, lignite, etc., are ignited. The heat energy thus liberated is used to convert water into steam at high temperature and pressure. The energy of steam is used to rotate the turbines to generate electricity.
- Such power stations are established at Neyveli, Kayamkulam , etc.

- **The energy change taking place here is:**
  Chemical energy - Heat energy - Mechanical energy - Electrical energy.

Electrical energy from solar energy:

- Solar cell is a means for converting solar energy into electrical energy.
- This is a p-n junction diode.
- When solar energy falls on N side of a solar cell, a small electric current is obtained due to the flow of electrons to P region from N region. This phenomenon is the photovoltaic effect. It is the electrical energy thus obtained that is stored in batteries and used whenever necessary.

Solar panel:

- The voltage and current obtained from a solar cell is insignificant. A large number of solar cells are suitably assembled to form a solar panel. The electric current obtained from a large number of such cells can be stored in a battery and used as and when it is needed.
- Solar panel is used extensively in lighting street lamps. They are used to meet the energy requirement of artificial satellites.
- Nowadays solar photo voltaic (SPV) power plants capable of producing electricity of thousands of kilowatts are in use.

The solar powerplant at the International Airport in Nedumbassery is an example.

The specialties of a solar cooker:

- A box with blackened interior
- A glass cover for the box
- A mirror outside the box

Solar Water Heater:

- Solar water heater, solar cooker etc., are devices that make direct use of solar heat radiations.

- Hot water required for hospitals and hotels for cooking food, and for washing vessels in houses etc., can be produced using solar water heater.

Solar Thermal Power Plant

- Solar thermal power plant generates electricity using solar energy. Concave reflectors are used to focus the sun's rays on the blackened pipes filled with water. As a result, water boils and vaporises. The steam rotates the steam turbine, so that the generator attached to the turbine is activated.
- About 10 such solar power plants are functioning in India, the majority of which are in Rajasthan.

Energy from wind

- Wind energy is a form of energy that is bot h environment friendly and renewable.
- Electricity is obtained by turning the turbine of generator using the wind power. Here production of electricity does not incur any recurring expenditure. But it has certain limitations. This can be established only at those places where wind is available for most time of the year. We may require storage systems to u se electricity when there is no wind.
- About 2 hectares of land is needed for the production of one megawatt power.
- The expense to establish a wind mill is very high and that for repairing it in the event of damages caused by heavy rain, cyclones, heat etc., is also very high.

Energy from sea

- Two third of the surface of the Earth is sea. Hence ocean is a major source of energy. Sea waves, high tide, heat from the ocean etc., are the phenomena that we can make use of while producing energy from sea.

Tidal Energy

- Tidal energy is not exploited in Kerala since the rise in water due to high tide is less than a metre.

Energy from waves

- We can operate a generator by turning the turbine by using the power of sea waves. In India also such methods for the production of electricity from sea waves are in operation on an experimental basis.

Ocean thermal energy

- The surface of ocean is relatively hot due to solar radiations. But the temperature will be very low at the deep levels.
- Ocean Thermal Energy Conversion Plants (OTEC) produce energy, making use of this difference in temperature.
- The temperature of the surface of ocean and the regions at 2 m depth will vary by more than 20 K in temperature.
- The heat at the surface boils volatile liquids like ammonia. Using the gas obtained, turbine is rotated. The cold water at the bottom liquefies the gas again. By the continuous action of this we get electrical energy.

Geo thermal energy

- Though the surface of the earth has cooled down making it habitable, the interior is still in the molten form. Magma, which is at a higher temperature, comes out of the core through its softer regions. Such places are known as **hot spots.** Underground water at this place receives heat energy from the hotspot and is converted into steam. This steam, which is confined to the region between rocks, is brought out by drilling pipes through the rocks. Using this steam, turbine is rotated to produce electricity.

Nuclear fission

Nuclear fission is the process by which the nuclei of greater mass are split into lighter nuclei, using neutrons. The mass of small nuclei formed is less than that of parent nucleus. It means that there is loss of matter during such a splitting. The matter that is lost is converted into energy. According to Einstein's equation $E = mc^2$, even if the matter converted is very small, the energy produced will be very large. Uncontrolled fission will end in a huge explosion. This is the process that takes place in an atom bomb.

Nuclear fusion

- Nuclear fusion is the process in which lighter nuclei are combined to form heavier ones. In this process the matter lost is converted into energy. You know that energy is produced in the stars and the Sun in this way.
- This is the principle used for making a hydrogen bomb. The scientific world has not yet been able to produce energy commercially by controlled nuclear fusion.

There are power stations to control fission reaction and produce electricity. They are known as **thermal power stations.**

Nuclear reactor is a system that converts nuclear energy into electrical energy.

Enriched uranium is the fuel used in nuclear reactors. India has developed the indigenous technology of using carbide fuel in nuclear reactors. The power station at Kalpakkam in Tamilnadu makes use of such a reactor. Dangerous radioactive radiations and products are also formed in nuclear reactions.

Nuclear Power stations

- Using nuclear energy water is converted to steam at a high temperature and pressure. The force of steam is used to turn the turbines to generate electrical energy.

- Such power stations are established at Tarapur, Kalpakkam, Kota, and Koodamkulam.
- **Energy change taking place here is:**
  Nuclear energy – Heat energy - Mechanical energy -Electrical energy

Nuclear Pollution

- The pollution caused by the presence of radioactive substances and radiations in water, air and environment is known as nuclear pollution.
- The nuclear decomposition of polluted materials results in the dangerous pollutions. As a result of nuclear decomposition alpha, beta and gamma radiations spread out. Density of polluting substance, the type of radiation, proximity of pollution to physical organs etc., are the factors that determine the probability of danger. Nuclear hazards can be artificial or natural.

Normal

- Cosmic rays from outer space
- Radiations from radioactive materials on the Earth

Manmade

- The use of radioactive isotopes in the medical field.
- Wastes from nuclear reactors.

Precautions to face nuclear hazards

- Shift out to safe places (Concrete buildings, buildings constructed using bricks etc.)
- Strictly follow the directions from the concerned authorities
- Observe the symbols showing the nuclear radiations and behave accordingly.
- Reduce the density of population in places likely to experience nuclear hazards.

- If necessary, consume potassium iodide tablets or take food rich in iodine.

Renewable Sources of energy:

- The natural sources of energy obtained from sunlight, wind, rain, high tide etc. can be replenished. Hence these are examples for renewable sources of energy. They do not pollute the environment.
- Petroleum, coal, natural gases, nuclear energy etc., are non-renewable sources. They are harmful to the environment as well.

Green Energy:

- Green energy is the energy produced from natural sources that does not cause environmental pollution. All the energy produced from renewable sources belong to this category. The renewable sources like solar energy, wind energy, energy from waves and energy from biomass are considered as green energy. This is also referred to as **clean energy**.
- But the energy produced from nonrenewable sources such as petroleum and coal, and the nuclear energy are named **brown energy**. These are sources which cause environmental problems including global warming.

Green Energy:

Solar cells, tidal energy, hydroelectric power, windmills.

Brown Energy:

atomic reactors, diesel engines, thermal power stations

Energy crisis:

- Energy crisis is the consequence of increasing demand but decreasing availability

Reducing energy crisis:

- Judicious utilisation of energy.
- Maximum utilisation of solar energy
- Minimising the wastage of water.
- Making use of public transportation as far as possible.
- Construction and beautifying of houses and roads in a scientific manner.
- Controlling of the street lamps with LDR (Light Dependent Resistor).
- Timely maintenance of machines.
- Limiting the size of newly constructed buildings.
- Ensuring of maximum efficiency of the machines used.

The devices that can be used at home to reduce energy consumption.

- Hot box
- Pressure cooker
- Energy efficient oven

The local activities that can be taken up to spread social awareness:

- Poster publicity
- Classes
- Jatha (procession)

LDR:

LDR is a variable resistor that works based on the intensity of light.

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