SURESH' IAS ACADEMY

TARGETING

TNPSC

GROUP-II 2023

QUESTION WITH SIMPLIFIED ANSWER

MAINS WRITTEN EXAM

18th TEST

Marks : 300
Time : 3 Hrs

SCIENCE & TECH

PHYSICS - II

- Heat
- Light and sound
- Magnetism
- Force, motion and energy,
- Electricity and electronics

English Medium

THOOTHUKUDI 0461 - 4000970 99445 11344 | TIRUNELVELI 0462 - 2560123 98942 41422 | RAMANATHAPURAM 04567 - 355922 75503 52916 | MADURAI 0452 - 2383777 98431 10566 | CHENNAI 044 - 47665919 97555 52003

TEST 18 வெற்றி ஒன்றே இலக்கு

Answer Key - English

Unit - 1

1) When you make a sharp turn while driving a car you tend to lean sideways why?

Reason for a person to lean sideways during a sharp turn in car : Inertia **3**

- The inherent property of a body to resist any change in its state of rest or the state of uniform motion, unless it is influenced upon by an external unbalanced force, is known as 'inertia'.

Types of Inertia **3**

a) Inertia of rest: The resistance of a body to change its state of rest is called inertia of rest.
- Eg: When you vigorously shake the branches of a tree, some of the leaves and fruits are detached and they fall down

b) Inertia of motion: The resistance of a body to change its state of motion is called inertia of motion.
- Eg: An athlete runs some distance before jumping. Because, this will help him jump longer and higher

c) Inertia of direction: The resistance of a body to change its direction of motion is called inertia of direction.
- Eg: When you make a sharp turn while driving a car, you tend to lean sideways

2) Automobiles are fitted with springs and shock absorbers to reduce jerks. What is the basic phenomena and briefly explain it?

Reason for th eautomobiles to be fitted with springs & shock absorbers to reduce jerks:Impulse **4**

- Large force acting for a very short interval of time is called as 'Impulsive force'.
- When a force F acts on a body for a period of time t, then the product of force and time is known as 'impulse' represented by 'J'
- Impulse, $J = F \times t$ .....(1)
- By Newton's second law $F = \Delta p / t$ (Δ refers to change)

  $\Delta p = F \times t$ .....(2)
- From (1) and (2) $J = \Delta p$
- Impulse is also equal to the magnitude of change in momentum. Its unit is $kgms^{-1}$ or Ns.
- **Change in momentum** can be achieved in two ways. They are:

1. a large force acting for a short period of time and
2. a smaller force acting for a longer period of time.

Examples: **2**

- Automobiles are fitted with springs and shock absorbers to reduce jerks while moving on uneven roads.
- In cricket, a fielder pulls back his hands while catching the ball. He experiences a smaller force for a longer interval of time to catch the ball, resulting in a lesser impulse on his hands.

3) Write a short note on projectile motion with day to day application?

Projectile Motion **3**

- When an object is thrown in the air with some initial velocity (NOT just upwards), and then allowed to move under the action of gravity alone, the object is known as a projectile.
- The path followed by the particle is called its trajectory.

Examples of projectile

1. An object dropped from window of a moving train.
2. A bullet fired from a rifle.
3. A ball thrown in any direction.
4. A javelin or shot put thrown by an athlete.
5. A jet of water issuing from a hole near the bottom of a water tank.

Projectile motion in day to day application **3**

1. The water coming out of a hose attached to a water source or a water tap follows a projectile motion when it is held at an angle.
2. The projectile motion helps a stuntman perform a number of stunts. The vertical velocity is one of the most important parameters required by a stuntman to make a car jump along a ramp and land safely on the other side of the setup.

3. An athlete who practices javelin throw directs the sharp edge of the javelin in the air at a particular angle.

4) Are we moving with the same speed both day and night with respect to sun? 6

- Earth orbits the Sun in an elliptical orbit.
- Let us specify the velocity of the centre of Earth with respect to Sun as $\overrightarrow{v_c}$
- This $\overrightarrow{v_c}$ is due to the elliptical motion of the Earth around the Sun.
- We know that at the same time Earth is also spinning on its own axis.
- Due to this spinning, all objects on the surface of the Earth undergo circular motion with velocity $\overrightarrow{v_s}$ with respect to the axis of rotation of the Earth.
- **Direction at night:** At night both $\overrightarrow{v_c}$ and $\overrightarrow{v_s}$ are either in the same direction or at an acute angle with each other. -So, the velocity of an object on the surface of Earth with respect to Sun at night time is $\overrightarrow{v_{night}} = \overrightarrow{v_c} + \overrightarrow{v_s}$.
- **Direction at day:** During the day $\overrightarrow{v_c}$ and are either in opposite directions or at an obtuse angle with each other.
- So, the velocity of the object with respect to Sun at day time $\overrightarrow{v_{day}} = \overrightarrow{v_c} - \overrightarrow{v_s}$.
- **Conclusion**: any object on the surface of the Earth travels faster with respect to Sun during night than during day time.
- This happens due to the rotation of the Earth

5) How friction can be minimized in our everday life applications?

Increasing and minimising Friction

Area of contact 2

- Friction can be increased by increasing the area of the surfaces in contact.
- For example, brake shoes in a cycle have to be adjusted so that they are as close as possible to the rim of the wheel, in order to increase the friction.

Using lubricants 2

- A substance which reduces the frictional force is called a lubricant.
- Eg. Grease, coconut oil, graphite, castor oil, etc.
- The lubricants fill up the gaps in the irregular surfaces between the bodies in contact.
- This provides a smooth layer thus preventing a direct contact between their rough surfaces.

Using ball bearing 2

- Since rolling friction is smaller than sliding friction, sliding is replaced by rolling with the usage of ball bearings.
- For the same reason, lead shots are used in the bearing of a cycle hub

6) Which sound cannot be heard by human ear. List out the everyday application of it?

Ultrasonic Waves 2

- Ultrasonic sound is the term used for sound waves with Frequencies greater than 20,000 HZ.
- These waves cannot be heard by the human ear, but the audible frequency range for other animals includes ultrasound frequencies.

Examples

- Ultrasonic whistles are used in cars to alert deer to oncoming traffic so that they will not leap across the road in front of cars.

Applications of Ultrasonic waves 4

1. The ultrasonic waves allow different tissues such as organs and bones to be 'seen' or distinguished by bouncing of ultrasonic waves by the objects examined which are defected, analysed and stored in a computer.
2. An echogram is an image obtained by the use of reflected ultrasonic waves.
3. Ultrasonic sound is having application in marine surveying also.
4. Ultrasounds can be used in cleaning technology where Minute foreign particles can be removed from objects placed in a liquid bath through which ultrasound is passed.
5. Ultrasounds can also be used to defect cracks and flaws in metal blocks.
6. Ultrasonic waves are made to reflect from various parts of the heart and from the image of the heart this technique is called "echo cardiography".
7. Ultrasound may be employed to break small 'stones' formed in the kidney into fine grains. These grains later get flushed out with urine.
8. It is extensively used in medical applications like 'sonogram'.
9. It is used in the SONAR system to detect the depth of the sea and to detect enemy submarines.
10. It is also employed in dish washers.
11. Another important application of ultra sound is the Galton's whistle. This whistle is

inaudible to the human ear, but it can be heard by the dog & is used to train the dogs for investigation.

7) a) Why do people sweat more before a heavy rain?

b) Water wets the glass surface while mercury does not why?

a) Why do people sweat more before a heavy rain? 3

- In hot dry summer days the temperature of our body is high, and as a mechanism of cooling our bodies, we sweat and since the atmosphere bodies are dry (less amount of water vapour is present), the sweat evaporates and thus, lowering our body temperature.
- **Humidity**: In hot humid days, sweating occurs because sweat does not evaporate easily in humid weather occurs, as the air already has enough water vapour in it.
- As a result, sweat remains on the skin & the body does not cool down efficiently, unlike during hot, dry days when sweat quickly evaporates from the skin.

b) Water wets the glass surface while mercury does not why? 3

Surface tension :

- Surface tension is a force per unit length acting in the plane of interface between the liquid and the bounding surface.
- Its unit is N/m and the dimensions are $[ML^{-2}]$.
- Surface tension is a property that arises due to the intermolecular forces of attraction among the molecules of the liquid.
- Greater the intermolecular forces of attraction; higher is the surface tension of that liquid.

Adhesive force

- Attractive forces between molecules of different types

Cohesive force :

- Attractive forces between molecules of the same types

Explanation :

- Surface tension is a property that arises due to the intermolecular forces of attraction among the molecules of the liquid.
- In the case of mercury taken in a glass tube, adhesive forces are weaked than cohesive forces.
- So, the mercury molecules does not wet the glass.
- In the case of water taken in a glass tube, adhesive forces are stronger than cohesive forces therefore the water molecules wets the glass.

8) Why a female's voice is shriller than a male's voice?

Reason for female voice to be more shriller than male 6

Pitch

- The pitch is the characteristic of sound that enables us to distinguish between a flat sound and a shrill sound.
- Higher the frequency of sound, higher will be the pitch.
- High pitch adds shrillness to a sound.
- **High pitch sounds:** The sound produced by a whistle, a bell, a flute and a violin
- Normally, the voice of a female has a higher pitch than a male.
- That is why a female's voice is shriller than a male's voice.
- **Low pitch sounds** :Some examples are the roar of a lion and the beating of a drum.

9) Describe about Aurora borealis and Aurora Australias? 4

- People living at high latitude regions (near Arctic or Antarctic) might experience dazzling coloured natural lights across the night sky.
- This ethereal display on the sky is known as aurora borealis (northern lights) or aurora australis (southern lights). These lights are often called as polar lights.
- The lights are seen above the magnetic poles of the northern and southern hemispheres. They are called as "Aurora borealis" in the north and "Aurora australis" in the south.
- **Phenomenon**: This occurs as a result of interaction between the gaseous particles in the Earth's atmosphere with highly charged particles released from the Sun's atmosphere through solar wind.
- These particles emit light due to collision and variations in colour are due to the type of the gas particles that take part in the collisions.

Colour of the aurora 2

- A pale yellowish – green colour is produced when the ionized oxygen takes part in the collision and
- A blue or purplish – red aurora is produced due to ionized nitrogen molecules.

10) Which is formed by opaque object? Explain its properties.

Shadows 2

- Light is obstructed by certain materials.
- Light travels in a straight line which cannot go around such objects.
- That is why we see shadow. Shadow is always against, opposite side of light source.
- It is caused by opaque objects that stop light from propagating.

Parts of shadow 2

- **Umbra**: When an opaque object is placed in the path of light from a point source, a uniform dark shadow will appear on the screen.
- **Penumbra**: When an opaque object is placed in the path of light coming from a broad source of light, a small umbra will appear on the screen and an illuminated shadow area appears around umbra.

Properties of shadow 2

1. All objects do not form shadows. Only opaque objects form shadows
2. Shadows will be formed in the opposite side of light source
3. It cannot be determined the characteristics of an object by its shadow.
4. The shadow will be always darker, whatever may be the color of light rays
5. Light source, opaque object are shadow all are in a straight line.
6. The size of shadow depends upon the distance between light source and object and the distance between object and the screen.

11) What is periscope? What are the applications of periscope in various fields?

Periscope 3

- It is an instrument used for viewing bodies or ships, which are over and around another body or a submarine.
- **Principle**: law of reflection of light. It consists of a long outer case and inside this case mirrors or prisms are kept at each end, inclined at an angle of 45°.
- Light coming from the distant body, falls on the mirror at the top end of the periscope and gets reflected vertically downward.
- This light is reflected again by the second mirror kept at the bottom, so as to travel horizontally and reach the eye of the observer.

Applications 3

- It is used in warfare and navigation of the submarine.
- In military it is used for pointing and firing guns from a 'bunker'.
- Photographs of important places can be taken through periscopes without trespassing restricted military regions.
- Fiber optic periscopes are used by doctors as endoscopes to view internal organs of the body.

12) a) What are the advantages of LED TV?
b) List the Merits of LED bulb?

a) What are the advantages of LED TV?

LED Television 3

- An LED TV is actually an LCD TV (Liquid Crystal Display) with LED display.
- An LED display uses LEDs for backlight and an array of LEDs act as pixels. LEDs emitting white light are used in monochrome (black and white) TV;
- Red, Green and Blue (RGB) LEDs are used in colour television.

Advantages of LED television

- It has brighter picture quality.
- It is thinner in size.
- It uses less power and consumes very less energy.
- Its life span is more & reliable.

b) List the Merits of LED bulb? 3

LED BULB

- An LED bulb is a semiconductor device that emits visible light when an electric current passes through it.
- The colour of the emitted light will depend on the type of materials used.

Merits of a LED bulb

- As there is no filament, there is no loss of energy in the form of heat. It is cooler than the incandescent bulb.
- In comparison with the fluorescent light, the LED bulbs have significantly low power requirement.
- It is not harmful to the environment.
- A wide range of colours is possible here.-It is cost-efficient and energy efficient.
- Mercury and other toxic materials are not required.
- One way of overcoming the energy crisis is to use more LED bulbs.

13) Explain Magnetic resonance Imaging and its applications.

Magnetic resonance Imaging 3

- MRI is Magnetic Resonance Imaging which helps the physicians to diagnose or monitor

treatment for a variety of abnormal conditions happening within the head, chest, abdomen and pelvis.

- **Procedure of MRI:** It is a non invasive medical test. The patient is placed in a circular opening (actually interior of a solenoid which is made up of superconducting wire) and large current is sent through the superconducting wire to produce a strong magnetic field.
- **Output:** So, it uses more powerful magnet, radio frequency pulses and a computer to produce pictures of organs which helps the physicians to examine various parts of the body.

Applications of MRI **3**

1. Health care professionals use MRI scans to diagnose a variety of conditions, from torn ligaments to tumors.
2. MRIs are very useful for examining the brain and spinal cord.
3. MRI demonstrates superior ability to investigate the anatomical, metabolic, perfusion, functional, and molecular characteristic of various tissues and organs without radiation injury or invasiveness;
4. therefore, it has been performed in the detection, diagnosis, staging, grading, and treatment of various diseases

14) What are the factors in consumption of electricity in houses and industries? 6

Factors in Consumption of electrical energy

- Electricity is consumed both in houses and industries. Consumption of electricity is based on two factors:

1. Amount of electric power and
2. Duration of usage.

- **Electric Power:** Electrical energy consumed is taken as the product of electric power and time of usage. For example, if 100 watt of electric power is consumed for two hours, then the power consumed is 100 x 2 = 200 watt hour.
- **Duration of Usage:** Consumption of electrical energy is measured and expressed in watt hour, though its SI unit is watt second.

Measurement of Electricity in realtime

- In practice, a larger unit of electrical energy is needed.
- This larger unit is kilowatt hour (KWh).
- One kilowatt hour is otherwise known as one unit of electrical energy.
- One kilowatt hour means that an electric power of 1000 watt has been utilized for an hour. Hence,
- 1 kWh = 1000 watt hour = 1000 x (60 x 60) watt second = 3.6×10^6 J

15) Write a short notes on two distinct types of electric current, we encounter in our everyday life?

Types of current **1**

- There are two distinct types of electric currents that we encounter in our everyday life: direct current (dc) and alternating current (ac).

Direct current **2**

- **Flow of Elections:** Electrons move from negative terminal of the battery to positive of the battery. Battery is used to maintain a potential difference between the two ends of the wire.
- **Sources of DC current:** Battery ,solar cells, thermocouples etc.
- **Examples** of devices which work on dc are cell phones, radio, electric keyboard, electric vehicles etc.

Alternating current **3**

- Here the direction of the current in a resistor or in any other element changes its direction alternately
- **Frequency:** The alternating current varies sinusoidally with time. This variation is characterised by a term called as frequency.
- **Flow of electrons:** In ac, the electrons do not flow in one direction because the potential of the terminals vary between high and low alternately thus electrons move to and fro in the wire carrying alternating current.
- **Example**: Transformers, induction motors, and induction heaters,fans bulbsAir conditioners all operate on alternating current (AC).

16) What are the everyday applications of electromagnets?

Applications of Electromagnets

Speaker **2**

- Inside the speaker, an electromagnet is placed in front of a permanent magnet. The permanent magnet is fixed firmly in position whereas the electromagnet is mobile.
- The electromagnet is attached to a cone made of a flexible material such as paper or plastic which amplifies these vibrations, pumping sound waves into the surrounding air towards our ears.

Magnetic Levitation Trains 1

- Magnetic levitation (Maglev) is a method by which an object is suspended with no support other than magnetic fields.
- There are 2 types of magnets are used in magentic levitation trains. One wheel is to repel the train from the track.
- Another magnet used to accelerate the train according to magnetic principles the speed and inertia of the train is controlled.

Medical System 1

- Nowadays electromagnetic fields play a key role in advanced medical equipments such as hyperthermia treatments for cancer, implants and magnetic resonance imaging (MRI).
- Many of the medical equipments such as scanners, x-ray equipments and other equipments also use the principle of electromagnetism for their functioning.

Uses in Home Appilances 2

- Electromagnet uses in the home include an electric fan, electric doorbell, induction cooker, magnetic locks
- In an electric doorbell when the button is pressed, due to the electromagnetic forces the coil gets energized and the bell sounds

17) How the Zener diode is working under Electronics? 4

- **Origin:** Zener diode is a heavily doped silicon diode used in reverse biased condition and is named after its inventor C. Zener. It is specially designed to be operated in the breakdown region.
- **Doping level:** The doping level of the Silicon diode can be varied to have a wide range of breakdown voltages from 2 V to over 1000 V.
- **Zener breakdown:** It occurs due to the breaking of covalent bonds by the strong electric field set up in the depletion region by the reverse voltage.
- It produces an extremely large number of electrons and holes which constitute the reverse saturation current.
- The current is limited by both external resistance and power dissipation of the diode.

Zener diode (a) commercial picture(b) circuit symbol

- It looks like an ordinary p-n junction diode except the cathode lead approximating the shape of a 'z' letter. The arrow head points the direction of conventional current.
- In Figure (a), black ring indicates the cathode lead.

Applications 2

- The zener diode can be used as

1. Voltage regulators
2. Calibrating voltages
3. Provide fixed reference voltage in a network for biasing
4. Protection of any gadget against damage from accidental application of excessive voltage.

18) Dangers of Electricity and precautions to be taken - Explain. 6

Dangers of electricity and precautions to be taken

- The following are the possible dangers as for as electric current is concerned.

1. **Damaged insulation:** Do not touch the bare wire. Use safety glows and stand on insulating stool or rubber slippers while handling electricity.
2. **Overload of power sockets:** Do not connect too many electrical devices to a single electrical socket.
3. **Inappropriate use of electrical appliances:** Always use the electrical appliances according to the power rating of the device like ac point, TV point, microwave oven point etc.
4. **Environment with moisture and dampness:** Keep the place, where there is electricity, out of moisture and wetness as it will lead to leakage of electric current.
5. **Beyond the reach of children:** The electrical sockets are to be kept away from the reach of little children who do not know the dangers of electricity.

Unit - 2

1) Explain the basic principle of turning a tap and also mention the other applications.

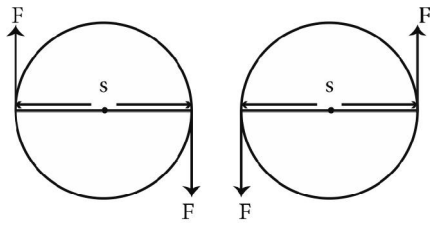
Basic principle of turning a tap:

Moment of the Force 4

- The rotating or turning effect of a force about a fixed point or fixed axis is called moment of the force about that point or torque (τ).
- It is measured by the product of the force (F) and the perpendicular distance (d) between the fixed point or the fixed axis and the line of action of the force.

Expression: $\tau = F \times d$

- Torque is a vector quantity. It is acting along the direction, perpendicular to the plane containing the line of action of force and the distance. Its SI unit is Nm.
- **Couple**: Two equal and unlike parallel forces applied simultaneously at two distinct points constitute a couple. The line of action of the two forces does not coincide.
- It does not produce any translatory motion since the resultant is zero. But, a couple results in causes the rotation of the body.
- **Moment of a couple:** Rotating effect of a couple is known as moment of a couple.



(a) & (b)

- **Examples**: Turning a tap, winding or unwinding a screw, spinning of a top, etc. **4**
- Moment of a couple is measured by the product of any one of the forces and the perpendicular distance between the line of action of two forces.
- The turning effect of a couple is measured by the magnitude of its moment.-Moment of a couple = Force × perpendicular distance between the line of action of forces
  $M = F \times S$
- The unit of moment of a couple is newton metre (N m) in SI system and dyne cm in CGS system.
- By convention, the direction of moment of a force or couple is taken as positive if the body is rotated in the anti-clockwise direction and negative if it is rotate in the clockwise direction. They are shown in Figure. (a and b)

Application of Torque **4**

1. Gears:

- A gear is a circular wheel with teeth around its rim. It helps to change the speed of rotation of a wheel by changing the torque and helps to transmit power.

2. Seasaw

- Since there is a difference in the weight of the persons sitting on it, the heavier person lifts the lighter person.
- When the heavier person comes closer to the pivot point (fulcrum) the distance of the line of action of the force decreases. It causes less amount of torque to act on it.
- This enables the lighter person to lift the heavier person.

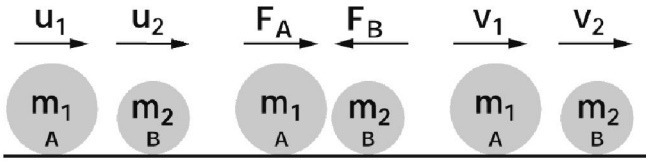
3. Steering Wheel

- A small steering wheel enables you to maneuver a car easily by transferring a torque to the wheels with less effort.

2) Explain the principle of conservation of Linear momentum? And what are the everyday applications of conservation of linear momentum?

Principle of Conservation of Linear Momentum **6**

- There is no change in the linear momentum of a system of bodies as long as no net external force acts on them.
- Let us prove the law of conservation of linear momentum with the following illustration:



Conservation of Linear Momentum

- Let two bodies A and B having masses m_1 and m_2 move with initial velocity u_1 and u_2 in a straight line.
- Let the velocity of the first body be higher than that of the second body. i.e., $u_1 > u_2$.
- During an interval of time t second, they tend to have a collision.

By Newton's II law of motion **2**

- After the impact, both of them move along the same straight line with a velocity v_1 and v_2 respectively.
- Force on body B due to A, $F_A = m_2 (v_2 - u_2)/t$.
- Force on body A due to B, $F_B = m_1 (v_1 - u_1)/t$.

By Newton's III law of motion, **4**

- Action force = Reaction force
  $F_B = -F_A$
  $m_1(v_1 - u_1)/t = -m_2 (v_2 - u_2)/t$
  $m_1v_1 + m_2v_2 = m_1u_1 + m_2u_2$
- The above equation confirms in the absence of an external force, the algebraic sum of the momentum after collision is numerically equal to sum of the momentum before collision.
- Hence the law of conservation of linear momentum is proved.

3) Describe briefly about the various types of motion with everyday applications.

Types of motion 8

- In our day to day life the following kinds of motion are observed:

a) Linear motion

- An object is said to be in linear motion if it moves in a straight line.
- **Examples:** An athlete running on a straight track.-A particle falling vertically downwards to the Earth.

b) Circular motion

- Circular motion is defined as a motion described by an object traversing a circular path.
- **Examples :** The whirling motion of a stone attached to a string.
- The motion of a satellite around the Earth.

c) Rotational motion

- If any object moves in a rotational motion about an axis, the motion is called 'rotation'.
- **Examples** : Rotation of a disc about an axis through its centre.
- Spinning of the Earth about its own axis.

d) Vibratory motion

- If an object or particle executes a to–and– fro motion about a fixed point, it is said to be in vibratory motion.
- This is sometimes also called oscillatory motion.
- **Examples** : Vibration of a string on a guitar.
- Movement of a swing.
- Other types of motion like elliptical motion and helical motion are also possible.

Motion in One, Two and Three Dimensions 1

- Let the position of a particle in space be expressed in terms of rectangular coordinates x, y and z.
- When these coordinates change with time, then the particle is said to be in motion.
- However, it is not necessary that all the three coordinates should together change with time.
- Even if one or two coordinates change with time, the particle is said to be in motion.
- Then we have the following classification.

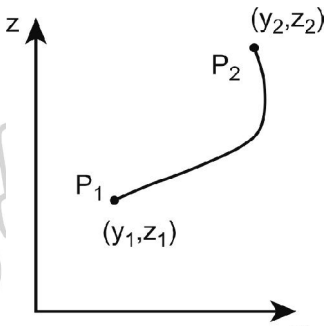
i) Motion in one dimension 3

- One dimensional motion is the motion of a particle moving along a straight line.
- This motion is sometimes known as rectilinear or linear motion. In this motion, only one of the three rectangular coordinates specifying the position of the object changes with time.
- For example, if a car moves from position A to position B along x–direction, then a variation in x–coordinate alone is noticed.
- **Examples:** Motion of a train along a straight railway track.
- An object falling freely under gravity close to Earth.

ii) Motion in two dimensions

- If a particle is moving along a curved path in a plane, then it is said to be in two dimensional motion.
- In this motion, two of the three rectangular coordinates specifying the position of object change with time.
- For instance, when a particle is moving in the y – z plane, x does not vary, but y and z vary as shown in Figure.
- **Examples** : Motion of a coin on a carrom board.
- An insect crawling over the floor of a room.**i**

ii) Motion in three dimensions



Motion of a particle along two dimensions

- A particle moving in usual three dimensional space has three dimensional motion.
- In this motion, all the three coordinates specifying the position of an object change with respect to time. When a particle moves in three dimensions, all the three coordinates x, y and z will vary.

Examples

- A bird flying in the sky.
- Random motion of a gas molecule.
- Flying of a kite on a windy day

4) a) Boiling water in a cooking pot is an example of which principle? Explain it.

b) We feel the heat energy though our hands are not touching the hot objects why?

a) Boiling water in a cooking pot is an example of which principle? Explain it. 6

Heat transfer

- Heat is a energy in transit which is transferred

from one body to another body due to temperature difference.
- There are three modes of heat transfer: Conduction, Convection and Radiation.

Conduction
- Conduction is the process of direct transfer of heat through matter due to temperature difference.
- When two objects are in direct contact with one another, heat will be transferred from the hotter object to the colder one.
- The objects which allow heat to travel easily through them are called conductors.

Convection
- Convection is the process in which heat transfer is by actual movement of molecules in fluids such as liquids and gases.
- In convection, molecules move freely from one place to another. It happens naturally or forcefully.
- Boiling water in a cooking pot is an example of convection. Water at the bottom of the pot receives more heat.
- Due to heating, the water expands and the density of water decreases at the bottom.
- Due to this decrease in density, molecules rise to the top. At the same time the molecules at the top receive less heat and become denser and come to the bottom of the pot.
- This process goes on continuously. The back and forth movement of molecules is called convection current.
- To keep the room warm, we use room heater. The air molecules near the heater will heat up and expand.

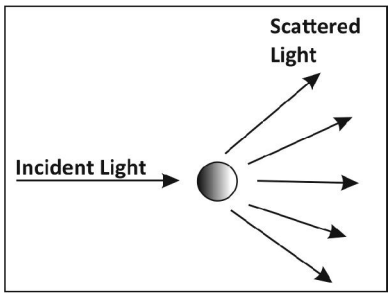
b) We feel the heat energy though our hands are not touching the hot objects why?

Heat Radiation: 6
- When we keep our hands near the hot stove we feel the heat even though our hands are not touching the hot stove.
- Here heat transferred from the hot stove to our hands is in the form of radiation. We receive energy from the sun in the form of radiations.
- **No medium for transfer of Energy:** These radiations travel through vacuum and reach the Earth.
- It is the peculiar character of radiation which requires no medium to transfer energy from one object to another.
- The conduction or convection requires medium to transfer the heat.
- Radiation is a form of energy transfer from one body to another by electromagnetic waves.
- **Example**:

1. Solar energy from the Sun.
2. Radiation from room heater.

5) Why sky appears in blue and clouds are in white? Explain its basic principles.

Phenomenon behind the appearance of blue & white color of sky and clouds 3



Scattering of light

- **Scattering of Light:** When sunlight enters the Earth's atmosphere, the atoms and molecules of different gases present in the atmosphere refract the light in all possible directions.
- This is called as 'Scattering of light'. In this phenomenon, the beam of light is redirected in all directions when it interacts with a particle of medium.
- The interacting particle of the medium is called as 'scatterer'

Types of scattering 3
- When a beam of light, interacts with a constituent particle of the medium, it undergoes many kinds of scattering.

On the basis of initial & final energy
- Based on initial and final energy of the light beam, scattering can be classified as,

1. Elastic scattering
2. Inelastic scattering

1. Elastic scattering
- If the energy of the incident beam of light and the scattered beam of light are same, then it is called as 'elastic scattering'.

2. Inelastic scattering

- If the energy of the incident beam of light and the scattered beam of light are not same, then it is called as 'inelastic scattering'.

On the basis of nature and size 3

- The nature and size of the scatterer results in different types of scattering.
- They are Rayleigh scattering, Mie scattering, Tyndall scattering, Raman scattering.

1. Rayleigh scattering

- The scattering of sunlight by the atoms or molecules of the gases in the earth's atmosphere is known as Rayleigh scattering.

Rayleigh's scattering law

- Rayleigh's scattering law states that, "The amount of scattering of light is inversely proportional to the fourth power of its wavelength".
- Amount of scattering $'S' \propto \frac{1}{\lambda^4}$

Reason for blue colour of sky 3

- According to this law, the shorter wavelength colours are scattered much more than the longer wavelength colours.
- When sunlight passes through the atmosphere, the blue colour (shorter wavelength) is scattered to a greater extent than the red colour (longer wavelength).
- This scattering causes the sky to appear in blue colour.

Reason for Red colour at sunrise and sunset

- At sunrise and sunset, the light rays from the Sun have to travel a larger distance in the atmosphere than at noon.
- Hence, most of the blue lights are scattered away and only the red light which gets least scattered reaches us.
- Therefore, the colour of the Sun is red at sunrise and sunset.

2. Mie scattering

- Mie scattering takes place when the diameter of the scatterer is similar to or larger than the wavelength of the incident light.
- It is also an elastic scattering. The amount of scattering is independent of wave length.
- Mie scattering is caused by pollen, dust, smoke, water droplets, and other particles in the lower portion of the atmosphere.

Reason for White colour of Clouds

- Mie scattering is responsible for the white appearance of theclouds.
- When white light falls on the water drop, all the colours are equally scattered which together form the white light.

6) Explain the power of a lens along with the difference of Convex and Concave lens?

Power of a Lens 8

- When a ray of light falls on a lens, the ability to converge or diverge these light rays depends on the focal length of the lens.
- This ability of a lens to converge (convex lens) or diverge (concave lens) is called as its power.
- Hence, the power of a lens can be defined as the degree of convergence or divergence of light rays.
- Power of a lens is numerically defined as the reciprocal of its focal length.

$$p = \frac{1}{f}$$

- **Dioptre:** The SI unit of power of a lens is dioptre. It is represented by the symbol D.
- If focal length is expressed in 'm', then the power of lens is expressed in 'D'.
- Thus 1D is the power of a lens, whose focal length is 1metre. $1D = 1m^{-1}$.
- By convention, the power of a convex lens is taken as positive whereas the power of a concave lens is taken, as negative.

Differences between a Convex Lens and a Concave Lens 4

S. No	Convex Lens	Concave Lens
1	A convex lens is thicker in the middle than at edges.	A concave lens is thinner in the middle than at edges.
2	It is a converging lens.	It is a diverging lens.
3	It produces mostly real images.	It produces virtual images.
4	It is used to treat hyper meteropia.	It is used to treat myopia.

7) Write an essay on the uses of ultrasonic waves?

Ultrasonic Waves **1**

- Ultrasonic sound is the term used for sound waves with Frequencies greater than 20,000 HZ.
- These waves cannot be heard by the human ear, but the audible frequency range for other animals includes ultrasound frequencies.

Source of ultrasonic waves **1**

- Ultrasonic waves are produced when an electrical signal generator sends a burst of electrical energy to a piezoelectric crystal in the transducer causing the crystal to vibrate and convert the electrical pulses into mechanical vibrations (sound waves)

Properties of Ultrasonic Waves **2**

1. Ultrasonic waves vibrate at a frequency greater than the audible range for humans (20 kilohertz).
2. They have smaller wavelengths. As a result, their penetrating power is high.
3. They cannot travel through vacuum.
4. Ultrasonic waves travel at the speed of sound in the medium. They have maximum velocity in a denser medium.
5. In a homogeneous medium, they travel at a constant velocity.

Examples

- Ultrasonic whistles are used in cars to alert deer to oncoming traffic so that they will not leap across the road in front of cars.

Uses of Ultrasonic waves **8**

In Medical Field

- It is used as a medical diagnostic tool
- An important use of ultrasound is in examining inner parts of the body.
- The ultrasonic waves allow different tissues such as organs and bones to be 'seen' or distinguished by bouncing of ultrasonic waves by the objects examined.
- The waves are defected, analysed and stored in a computer.
- An echogram is an image obtained by the use of reflected ultrasonic waves.

Marine Surveying

- Ultrasonic sound is having application in marine surveying also.
- It is used in the SONAR system to detect the depth of the sea and to detect enemy submarines.

Cleaning technology

- Ultrasounds can be used in cleaning technology.
- Minute foreign particles can be removed from objects placed in a liquid bath through which ultrasound is passed.
- Ultrasounds can also be used to defect cracks and flaws in metal blocks.

Echo Cardiography

- Ultrasonic waves are made to reflect from various parts of the heart and from the image of the heart this technique is called "echo cardiography".

Removal of Kidney Stones

- Ultrasound may be employed to break small 'stones' formed in the kidney into fine grains. These grains later get flushed out with urine.
- It is extensively used in medical applications like 'sonogram'.
- It is also employed in dish washers.

Galton's whistle

- Another important application of ultra sound is the Galton's whistle.
- This whistle is inaudible to the human ear, but it can be heard by the dogs.
- It is used to train the dogs for investigation.

8) Write a applications of Echo and necessary conditions for hearing Echo.

Conditions necessary for hearing echo **6**

- The persistence of hearing for human ears is 0.1 second. This means that you can hear two sound waves clearly, if the time interval between the two sounds is at least 0.1 s.
- Thus, the minimum time gap between the original sound and an echo must be 0.1 s.
- The above criterion can be satisfied only when the distance between the source of sound and the reflecting surface would satisfy the following equation:

$$\text{Velocity} = \frac{\text{Distance Travelled by sound}}{\text{Time taken}}$$

$$v = \frac{2d}{t} \Rightarrow d = \frac{vt}{2}$$

- Since, t = 0.1 second, then $d = \frac{v \times 0.1}{2} = \frac{v}{20}$

- Thus the minimum distance required to hear an echo is 1/20th part of the magnitude of the velocity of sound in air.
- If you cosider the velocity of sound as 344 ms^{-1}, the minimum distance required to hear an echo is 17.2 m.

Applications of echo **6**

1. Some animals communicate with each other over long distances and also locate objects by sending the sound signals and receiving the echo as reflected from the targets.
2. The principle of echo is used in obstetric ultrasonography, which is used to create real-time visual images of the developing embryo or fetus in the mother's uterus. This is a safe testing tool, as it does not use any harmful radiations.
3. This technique is also used to find the depth of sea or distance of submarines.
4. It also helps to estimate the distance or hills and mountains.
5. This technique is also very helpful in the medical field as well. Doctors use this phenomenon in cardiography, sonogram and many other medical diagnoses
6. Echo is used to determine the velocity of sound waves in any medium

9) Explain the applications of hysteresis loop with suitable examples? 2

- **Hysteresis:** The phenomenon of lagging of magnetic induction behind the magnetising field is called hysteresis.
- Hysteresis means 'lagging behind'.

Hysteresis loss **2**

- During the magnetisation of the specimen through a cycle, there is loss of energy in the form of heat. This loss is attributed to the rotation and orientation of molecular magnets in various directions.
- It is found that the energy lost (or dissipated) per unit volume of the material when it is carried through one cycle of magnetisation is equal to the area of the hysteresis loop.

Applications of hysteresis loop **8**

1. Obtain information through hysteresis loop

- The significance of hysteresis loop is that it provides information such as retentivity, coercivity, permeability, susceptibility and energy loss during one cycle of magnetisation for each ferromagnetic material.

2. Used for selection of suitable material of the following

- The study of hysteresis loop will help us in selecting proper and suitable material for making electromagnets, transformers, permanent magnets, generators etc.

3. Permanent magnets:

- The materials with high retentivity, high coercivity and low permeability are suitable for making permanent magnets.
- **Examples**: Carbon steel and Alnico
- **Uses:** In electric clocks, microphones, speakers, generators, motors.

4. Electromagnets:

- The materials with high initial permeability, low retentivity, low coercivity and thin hysteresis loop with smaller area are preferred to make electromagnets.
- **Examples**: Soft iron and Mumetal (Nickel Iron alloy)
- **Uses:** In electric bells, transformer cores, loudspeakers and telephone diaphragms

5. Core of the transformer:

- The materials with high initial permeability, large magnetic induction and thin hysteresis loop with smaller area are needed to design transformer cores.
- **Examples**: Soft iron

10) Explain a safety measure devised to prevent people from getting shocked?

Earthing **4**

- A safety measure devised to prevent people from getting shocked if the insulation inside electrical devices fails is called earthing.
- **Electrical earthing**: It can be defined as the process of transferring the discharge of electrical energy directly to the earth with the help of low resistance wire.
- We get electrical energy from different sources. Battery is one such source. We use it in wall clocks, cell phones etc. For the working of refrigerators, air conditioners, washing machines, televisions, laptops and water heaters we use domestic power supply.
- **Purpose of Earth wire:** Usually an electric appliance such as a heater, an iron box, etc. are fitted with three wires namely live, neutral and earth. The earth wire is connected to the metallic body of the appliance.
- This is done to avoid accidental shock. Suppose due to some defect, the insulation of the live wire inside an electric iron is burnt

then the live wire may touch the metallic body of the iron.
- If the earth wire is properly connected to the metallic body, current will pass into the earth through earth wire and it will protect us from electric shock.
- The earth, being a good conductor of electricity, acts as a convenient path for the flow of electric current that leaks out from the insulation.

Install GFCI Outlets **2**

- If you are working with equipment that uses electricity, plug it into a ground-fault circuit interrupter or a GFCI outlet. You may even use a GFCI-protected extension cord. GFCI detects electrical faults and shuts off the power. This prevents you from getting an electrical shock.

Fuses **2**

- They are built as a safety measure if there is too much current flowing through a circuit.
- Fuses have a thin metal strip (usually made of copper or zinc) that keeps the connection open. However, if an electrical current exceeds the maximum current allowed within that fuse it will overheat and cause the metal strip to melt.
- The destroyed metal strip breaks the connection and stops electricity from flowing through.
- Fuses are there to protect appliances from electric power surges and overheating which is one of the main causes of electric fires. The fuse has to be replaced after one fault.

Arc Fault circuit Breakers **2**

- AFCIs are a special type of electrical safety device.
- Normal circuit breakers detect faults when the current exceeds the maximum rated value, however, there are faults that occur when this value is not reached.
- An electric arc fault (or an electric arc flash) occurs when a current flows through an air gap between conductors. These can be caused by dust or corrosion on the surface of the conductor, poor installation of the system, or normal wear and tear of the parts.
- AFCIs measure the chopped current wave as opposed to the heat which GFCIs are unable to do.
- If an anomaly is detected the AFCI will trip and break the connection, preventing an electric fire.

Lightning arrester **2**

- The function of an external lightning protection system is to intercept, conduct and disperse a lightning strike safely to earth.
- Without such a system a building's structure, electronic systems and the people working around or within it are all at risk.

11) a) Which effect is used to utilize in automobiles as automotive for increasing fuel efficiency?

b) What is spherical mirror? Write its types and uses.

a) Which effect is used to utilize in automobiles as automotive for increasing fuel efficiency?

Seebeck effect **6**

- Seebeck discovered that in a closed circuit consisting of two dissimilar metals, when the junctions are maintained at different temperatures an emf (potential difference) is developed.
- **Thermoelectric Current:** The current that flows due to the emf developed is called thermoelectric current.
- **Thermocouple:** The two dissimilar metals connected to form two junctions is known as thermocouple.
- If the hot and cold junctions are interchanged, the direction of current also reverses. Hence the effect is reversible.
- The magnitude of the emf developed in a thermocouple depends on (i) the nature of the metals forming the couple and (ii) the temperature difference between the junctions.

Applications of Seebeck effect

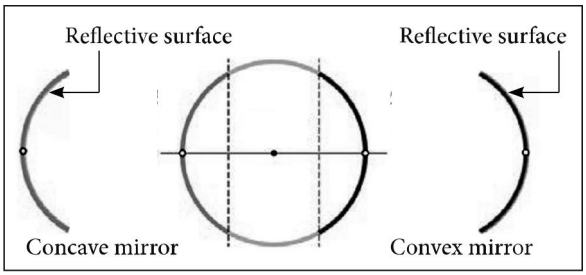
1. Seebeck effect is used in thermoelectric generators (Seebeck generators). These thermoelectric generators are used in power plants to convert waste heat into electricity.
2. This effect is utilized in automobiles as automotive thermoelectric generators for increasing fuel efficiency.
3. Seebeck effect is used in thermocouples and thermopiles to measure the temperature difference between the two objects.

b) What is spherical mirror? Write its types and uses. **6**

Spherical Mirrors

- Spherical mirrors are one form of curved mirrors.
- If the curved mirror is a part of a sphere, then it is called a 'spherical mirror'.

- It resembles the shape of a piece cut out from a spherical surface.
- One side of this mirror is silvered and the reflection of light occurs at the other side.



Spherical mirrors

Concave mirror

- A spherical mirror, in which the reflection of light occurs at its concave surface, is called a concave mirror.
- These mirrors magnify the object placed close to them.
- The most common example of a concave mirror is the make-up mirror.

Convex mirror

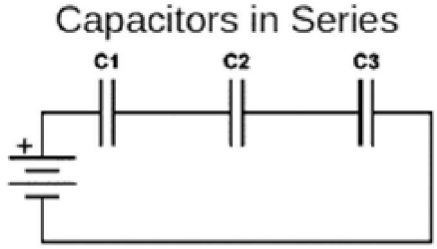
- A spherical mirror, in which the reflection of light occurs at its convex surface, is called a convex mirror.
- The image formed by these mirrors is smaller than the object.
- Most common convex mirrors are rear viewing mirrors used in vehicles.

12) Explain about the capacitors in series and parallel connection?

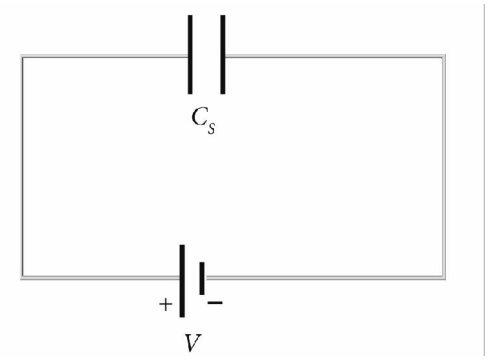
Capacitor in series and parallel **6**

i) **Capacitor in series** : Consider three capacitors of capacitance C_1, C_2 and C_3 connected in series with a battery of voltage V.

- As soon as the battery is connected to the capacitors in series, the electrons of charge –Q are transferred from negative terminal to the right plate of C_3 which pushes the electrons of same amount –Q from left plate of C_3 to the right plate of C_2 due to electrostatic induction.



Equivalent Capacitance with same total charge



- Similarly, the left plate of C_2 pushes the charges of –Q to the right plate of C_1 which induces the positive charge + Q on the left plate of C_1.
- At the same time, electrons of charge –Q are transferred from left plate of C_1 to positive terminal of the battery.
- By these processes, each capacitor stores the same amount of charge Q. The capacitances of the capacitors are in general different, so that the voltage across each capacitor is also different and are denoted as V_1, V_2 and V_3 respectively.
- The sum of the voltages across the capacitor must be equal to the voltage of the battery. $V=V_1+V_2+V_3$
- Since, Q = CV, we have $V=\frac{Q}{C_1}+\frac{Q}{C_2}+\frac{Q}{C_3}$

$$=Q\left(\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}\right) \quad \text{.....(1)}$$

- If three capacitors in series are considered to form an equivalent single capacitor C_s shown in Figure (b), then we have $V=\frac{Q}{C_s}$.

Substituting this expression into equation, we

$$\frac{Q}{C_s}=Q\left(\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}\right)$$

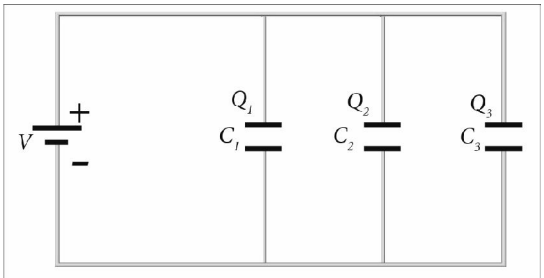
get $\frac{1}{C_s}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}$ .....(2)

- Thus, the inverse of the equivalent capacitance C_s of three capacitors connected

in series is equal to the sum of the inverses of each capacitance.

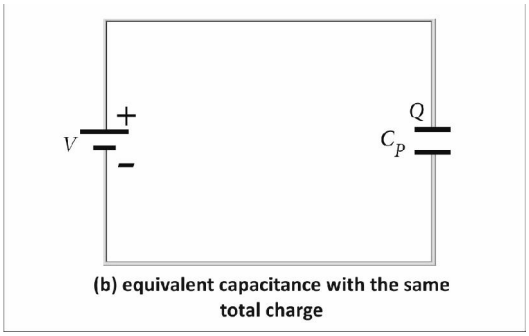
- This equivalent capacitance C_s is always less than the smallest individual capacitance in the series.

ii) Capacitance in parallel **6**



(a) capacitors in parallel

- Consider three capacitors of capacitance C_1, C_2 and C_3 connected in parallel with a battery of voltage V as shown in Figure (a).
- Since corresponding sides of the capacitors are connected to the same positive and negative terminals of the battery, the voltage across each capacitor is equal to the battery's voltage.
- Since capacitances of the capacitors are different, the charge stored in each capacitor is not the same. Let the charge stored in the three capacitors be Q_1, Q_2, and Q_3 respectively.
- According to the law of conservation of total charge, the sum of these three charges is equal to the charge Q transferred by the battery,
  $Q = Q_1 + Q_2 + Q_3$ .....(3)
  Since $Q = CV$,
  we have
  $Q = C_1V + C_2V + C_3V$ .....(4)



(b) equivalent capacitance with the same total charge

- If these three capacitors are considered to form a single equivalent capacitance C_p which stores the total charge Q as shown in the Figure (b), then we can write $Q = C_pV$. Substituting this in equation,
  we get
  $C_pV = C_1V + C_2V + C_3V$
  $C_p = C_1 + C_2 + C_3$
- Thus, the equivalent capacitance of capacitors connected in parallel is equal to the sum of the individual capacitances.
- The equivalent capacitance C_p in a parallel connection is always greater than the largest individual capacitance.
- In a parallel connection, it is equivalent as area of each capacitance adds to give more effective area such that total capacitance increases.

Unit - 3

1) State and explain in detail any two of the fundamental forces in nature and also explain the everyday applications of forces **1**

- There are four fundamental forces in nature and named as gravity, weak nuclear force, electromagnetism and strong nuclear force.

Gravitational force **1**

- According to Newton's law of gravity, it states that the gravitational force between two bodies is proportional to the product of their masses and inversely proportional to the square of the distance between them
- When considered for massive objects, like the sun, or giant planets, gravitational force is considered to be strong as the masses of these objects are also large.
- On an atomic level, this force is considered weak.

Electromagnetic Force **3**

- We know that all matter is made up of atoms.
- Atoms in turn has a dense nucleus, protons, neutron and electrons.
- By their nature, all particles are only attracted to particles that have an opposite charge and repel those with like charges.
- These are electromagnetic forces.
- These have a long - range and the effect of their forces diminishes over distance due to the shielding effect.
- However, sub - atomically, they have short - range and are considered strong force but still weaker than strong nuclear forces.

Strong Nuclear Forces **3**

- Out of the four Fundamental Forces, nuclear forces are the strongest attractive forces.
- The strong Nuclear force binds protons and neutrons in a nucleus. It is evident that

without some attractive force, a nucleus will be unstable due to the electric repulsion between its protons.
- It is charge independent
- It acts equally between a proton and proton, a neutron and a neutron, a proton and a proton.
- Its range is extremely small of about nuclear dimensions (10^{-15}m).
- It is responsible for the stability of nuclei.
- Recent developments have, however indicated that protons and neutrons are built out of still more elementary constituents called quarks.

Weak Nuclear Forces **3**

- Weak Force is the force existing between the elementary particles which are responsible for certain processes to take place at low probability.
- **Example :** Weak nuclear forces are responsible for the radioactive decay, specifically the beta decay neutrino interactions.
- It has every short range and this force is as the name suggests weak in nature.

Everyday application of forces **4**

1. a comb get charged when you continuously brush your hair where the subatomic particles held together. It is because of Electromagnetic forces!
2. The revolving of the moon around the earth is due to gravitational attraction between them.
3. The formation of tides in the ocean is due to the gravitational force acting between the earth and the moon
4. The fusion of hydrogen into helium in the sun's core due to strong nuclear force
5. Weak nuclear forces are responsible for the radioactive decay, specifically the beta decay neutrino interactions.

2) Explain the common defects of vision and the lenses used to rectify them.

Defects in Eye **3**

- A normal human eye can clearly see all the objects placed between 25cm and infinity.
- But, for some people, the eye loses its power of accommodation.
- This could happen due to many reasons including ageing.
- Hence, their vision becomes defective.

Myopia **3**

- Myopia, also known as short sightedness, occurs due to the lengthening of eye ball.
- With this defect, nearby objects can be seen clearly but distant objects cannot be seen clearly.
- The focal length of eye lens is reduced or the distance between eye lens and retina increases.
- Hence, the far point will not be infinity for such eyes and the far point has come closer.
- **Image formed:** the image of distant objects are formed before the retina.
- **Corrected using:** A concave lens.
- The focal length of the concave lens to be used is computed as follows:
- Let a person with myopia eye can see up to a distance x. Suppose that he wants to see all objects farther than this distance, i.e., up to infinity.
- Then the focal length of the required concave lens is f = –x.
- If the person can see up to a distance x and if he wishes to see up to a distance y, then, the focal length of the required concave lens is,

$$f = \frac{xy}{x - y}$$

Hypermeteropia **3**

- Hypermeteropia, also known as long sightedness, occurs due to the shortening of eye ball.
- With this defect, distant objects can be seen clearly but nearby objects cannot be seen clearly.
- The focal length of eye lens is increased or the distance between eye lens and retina decreases.
- Hence, the near point will not be at 25cm for such eyes and the near point has moved farther.
- **Image formed:** the image of nearby objects are formed behind the retina.
- **Corrected using:** A convex lens.
- The focal length of the convex lens to be used is computed as follows:
- Let a person with hypermeteropia eye can see object beyond a distance d.
- Suppose that he wants to see all objects closer than this distance up to a distance D.

- Then, the focal length of the required convex lens is
- $f = \frac{dD}{d-D}$

Presbyopia 3

- Due to ageing, ciliary muscles become weak and the eye-lens become rigid (inflexible) andso the eye loses its power of accommodation.
- Because of this, an aged person cannot see the nearby objects clearly.
- So, it is also called as 'old age hypermetropia'.
- Some persons may have both the defects of vision - myopia as well as hypermetropia.
- This can be corrected by 'bifocal lenses'.
- In which, upper part consists of concave lens (to correct myopia) used for distant vision and the lower part consists of convex lens (to correct hypermetropia) used for reading purposes.

Astigmatism 3

- In this defect, eye cannot see parallel and horizontal lines clearly. It may be inherited or acquired.
- It is due to the imperfect structure of eye lens because of the development of cataract on the lens, ulceration of cornea, injury to the refracting surfaces, etc.
- **Corrected using:** Astigmatism can be corrected by using cylindrical lenses.

3) Getting a shock from a door knob after rubbing your foot on a carpet floor. Why? How this principle works in lightning and thunder?

Reason for getting a shock from a door knob after rubbing your foot on a carpet floor 3

- It is because of Discharge
- Discharge occurs when electrons on the hand are quickly pulled to the positively charged doorknob.
- This movement of electrons, which is felt as a shock, causes the body to lose negative charge. Electric discharge takes place in a medium, mostly gases.

Principle behind Lightning and Thunder 6

- Lightning is another example of discharge that takes place in clouds.
- Lightning is produced by discharge of electricity from cloud to cloud or from cloud to ground. During thunderstorm air is moving upward rapidly.
- This air which moves rapidly, carries small ice crystals upward. At the same time, small water drops move downward.
- When they collide, ice crystals become positively charged and move upward and the water drops become negatively charged and move downward.
- So the upper part of the cloud is positively charged and the lower part of the cloud is negatively charged.
- When they come into contact, electrons in the water drops are attracted by the positive charges in the ice crystals. Thus, electricity is generated and lightning is seen.
- Sometimes the lower part of the cloud which is negatively charged comes into contact with the positive charges accumulated near the mountains, trees and even people on the earth.
- This discharge produces lot of heat and sparks that results in what we see as lightning.

Occurance of Thunder 3

- Huge quantities of electricity are discharged in lightning flashes and temperatures of over 30,000°C or more can be reached. This extreme heating causes the air to expand explosively fast and then they contract.
- This expansion and contraction create a shock wave that turns into a booming sound wave, known as thunder.

Reason for a Lightning to be seen before Thunder 3

- Sometimes lightning may be seen before the thunder is heard.
- This is because the distance between the clouds and the surface is very long and the speed of light is more than the speed of sound.

4) Which device is used to detect very small currents? Explain its construction, theory and precautions to use the device?

Tangent law and Tangent Galvanometer 1

- Tangent galvanometer is a device used to detect very small currents. It is a moving magnet type galvanometer. Its working is based on tangent law.

Tangent law 3

- When a magnetic needle or magnet is freely suspended in two mutually perpendicular uniform magnetic fields, it will come to rest in the direction of the resultant of the two fields.

- Let B be the magnetic field produced by passing current through the coil of the tangent galvanometer and B_H be the horizontal component of Earth's magnetic field.
- Under the action of two magnetic fields, the needle comes to rest making angle è with B_H, such that

$$B = B_H \tan\theta \quad \text{.....(1)}$$

Construction 4

- Tangent Galvanometer (TG) consists of copper coil of several turns wound on a non-magnetic circular frame. The frame is made up of brass or wood which is mounted vertically on a horizontal base table (tur table) with three levelling screws.
- The TG is provided with two or more coils of different number of turns. Most of the equipments we use in laboratory, contains coils of 2 turns, 5 turns and 50 turns which are of different thickness and are used for measuring currents of different strengths.
- At the centre of turn table, there is a small upright projection on which a compass box is placed. Compass box consists of a small magnetic needle which is pivoted at its centre, such that the centres of both magnetic needle and circular coil exactly coincide.
- A thin aluminium pointer attached perpendicular to the magnetic needle moves over a graduated circular scale. The circular scale is divided into four quadrants and they are graduated in degrees, each quadrant being numbered from 0° to 90° In order to avoid parallax error in measurement, a mirror is placed below the aluminium pointer.

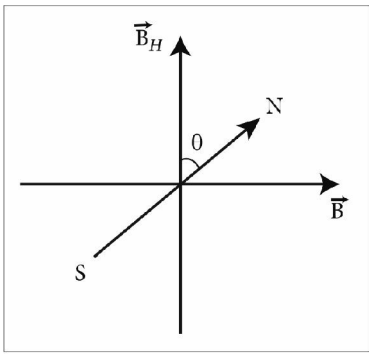
Precautions 2

1. All the nearby magnets and magnetic materials are kept away from the instrument.
2. Using spirit level, the levelling screws at the base are adjusted so that the small magnetic needle is exactly horizontal and also coil (mounted on the frame) is exactly vertical.
3. The plane of the coil is kept parallel to the small magnetic needle by rotating the coil about its vertical axis. So that, the coil remains in magnetic meridian.
4. The compass box alone is rotated such that the aluminium pointer reads 0^o – 0^o.

Theory 2

- In the tangent galvanometer experiment, when no current is passed through the coil, the small magnetic needle lies along horizontal component of Earth's magnetic field.
- When the circuit is closed, the electric current will pass through the circular coil and produce magnetic field at the centre of the coil. Now there are two fields which are acting mutually perpendicular to each other.

They are: 3



Resultant position of pivoted of needle

1. The magnetic field (B) due to the electric current in the coil acting normal to the plane of the coil.
2. the horizontal component of Earth's magnetic field (B_H)

- Because of these crossed fields, the pivoted magnetic needle deflects through an angle θ. From tangent law (equation (1)),

$B = B_H \tan\theta$

- When an electric current is passed through a circular coil of radius R having N turns, the magnitude of magnetic field at the centre is,

$$B = \mu_o \frac{NI}{2R} \quad \text{.....(2)}$$

- From equation (1) and (2) equation, we get

$$\mu_o \frac{NI}{2R} = B_H \tan\theta$$

- The horizontal component of Earth's magnetic field is given by $B_H = \frac{\mu_o N}{2R} \frac{I}{\tan\theta}$

5) Define friction? Give examples of the utility of friction in day to day life?

Friction 2

- We walk on roads without falling. But, we tend to fall when we walk on wet surfaces. why?

- We walk on the roads safely because of the friction between the feet and the road.
- But, the friction is less when we walk on wet surface and so we tend to fall.
- Frictional force or friction arises when two or more bodies in contact move or tend to move, relative to each other.
- It acts always in the opposite direction of the moving body.
- This force is produced due to the geometrical dissimilarities of the surface of the bodies, which are in relative motion.
- Friction can produce the following effects.
- Friction opposes motion.
- It causes wear and tear of the surfaces in contact.
- It produces heat.

Types of Friction **2**

- Friction can be classified into two basic types: static friction and kinetic friction.

Static friction

- The friction experienced by the bodies, which are at rest is called static friction.
- Eg. All the objects are rigidly placed to be at rest on the earth.

Kinetic friction

- Friction existing during the motion of bodies is called kinetic friction.
- Kinetic friction can be further classified into sliding friction and rolling friction.

Sliding Friction

- When a body slides over the surface of another body, the friction acting between the surfaces in contact is called sliding friction.

Rolling Friction:

- When a body rolls over another surface, the friction acting between the surfaces in contact is called rolling friction.
- Rolling friction is less than sliding friction. That is why wheels are provided in vehicles, trolleys, suitcases etc.

Factors affecting Friction **3**

- Some of the factors which affect friction are given below.

a. Nature of a surface

- Moving an object on a rough surface will be difficult, but we can easily move it on a smooth surface.
- It is because, friction varies between the surfaces.

b. Weight of the body

- It is easy to pedal your cycle without any load on its carrier.
- With a load placed on its carrier, it is difficult to move it because the weight on the carrier increases the friction between the surface of the tyre and the road.

c. Area of contact

- For a given weight, the friction is directly related to the area of contact between the two surfaces.
- If the area of contact is greater, then, the friction will be greater too.
- A road roller has a broad base, so it offers more friction on the road.
- But, a cycle has the least friction, since the area of contact of the tyre with the surface of the road is less.

Examples of Friction in Day to day life **8**

1. **Walking** – When we walk on the ground or the floor, it is the frictional force that is responsible for holding our feet to the ground. On slippery surfaces or ice, the friction present is less, which is why we tend to slip on these surfaces.
2. **Writing** – While writing, the tip of the pen is in contact with the paper surface which produces rolling friction in the case of a ballpoint pen or sliding friction in the case of a pencil.
3. **Skating** – During skating, the skate blade rubs against the surface of the ice which generates heat. This causes the ice to melt which in turn reduces the friction between the blade and the ice surface, and hence skating is possible.
4. **Lighting a matchstick** – A matchstick lightens when its tip is rubbed against a rough surface that imparts high friction. This generates heat that is responsible for converting the red phosphorous into white phosphorous and the matchstick lightens up.
5. **Driving of the vehicle on a surface** - When a vehicle is being driven, a force is generated on the wheel by the engine, which makes the vehicle move in the forward direction. There is a presence of friction between the wheels and the road that opposes the forward motion of the vehicle. Hence, the vehicle avoids skidding.
6. **Applications of breaks in the vehicle to stop it**- When the brakes are applied, a strong frictional force is applied to the wheels of the

vehicle. This results in the generation of a large amount of heat occur due to the conversion of the kinetic energy of the moving vehicle into heat. Hence, the vehicle stops moving.

7. **Flight of airplanes-** Similar to vehicles moving on the road, any object moving forward in the air or any fluid experiences a drag force, which opposes the forward motion of the object in the fluid. This force is caused due to the impact of air on the object and the displacement of air as the object moves forward.
8. **Drilling a nail into the wall**- When a nail is driven into a wall, the materials nearby gets compressed. This imparts a force on the nail. This normal force that is exerted due to the compressed layers of the wall is converted into the sheer force that is resistive in nature. this force is the frictional force acting on the nail.

6) Motor bikes and cars engines have less efficiency. Explain about how the applications are increasing the efficiency of automobiles? 1

- In the modern technological world, the role of automobile engines plays a vital role in for transportation.
- In motor bikes and cars there are engines which take in petrol or diesel as input, and do work by rotating wheels.
- **Efficiency:** automobile engines have efficiency not greater than 40%.

Heat Engine **1**

- A heat engine is a system which converts heat into work by taking heat from the reservoir (hot body) to carry out some work. There is a discharge of some heat to the sink (cold body). In this system, there will also be some waste in the form of heat.
- **Principle of Heat Engine:** The second law of thermodynamics puts a fundamental restriction on efficiency of engines.
- Therefore understanding heat engines is very important.

Expression to obtain Efficiency **1**

- The efficiency is the fraction of heat input at high-temperature changes to work. In the second law of thermodynamics, it says that no engine is 100% efficient.
- Efficiency, η = Work done / Heat input
- We know that, Work done, $W = Q_1 - Q_2$
  Heat input = Q_1Then,
  Efficiency, $\eta = W / Q_1 \Rightarrow (Q_1 - Q_2) / Q_1$
  $\Rightarrow 1 - (Q_2 / Q_1)$

Reservoir: **1**

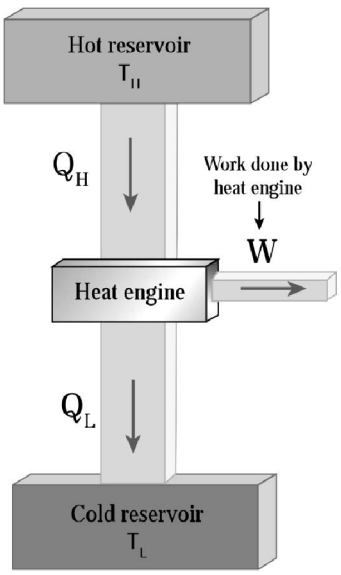
- It is defined as a thermodynamic system which has very large heat capacity.
- By taking in heat from reservoir or giving heat to reservoir, the reservoir's temperature does not change.
- The atmosphere can be taken as a reservoir.]
- Heat engine is a device which takes heat as input and converts this heat in to work by undergoing a cyclic process.
- A heat engine has three parts:

a) Hot reservoir
b) Working substance
c) Cold reservoir

- A Schematic diagram for heat engine is given below in the figure **5**

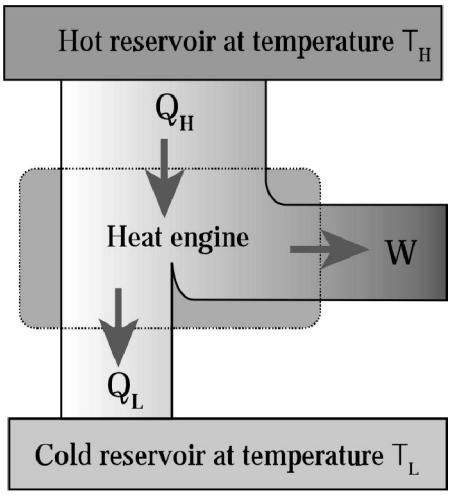
1. **Hot reservoir (or) Source:** It supplies heat to the engine. It is always maintained at a high temperature $T_{H.}$
2. **Working substance:** It is a substance like gas or water, which converts the heat supplied into work.

- A simple example of a heat engine is a steam engine. In olden days steam engines were used to drive trains.
- The working substance in these is water which absorbs heat from the burning of coal.
- The heat converts the water into steam.
- This steam is does work by rotating the wheels of the train, thus making the train move.



Heat Engine

3. **Cold reservoir (or) Sink:** The heat engine ejects some amount of heat (Q_L) in to cold reservoir after it doing work.
- It is always maintained at a low temperature T_L.
- For example, in the automobile engine, the cold reservoir is the surroundings at room temperature.
- The automobile ejects heat to these surroundings through a silencer.



Heat engine

- Since the heat engine returns to the same state after it ejects heat, the change in the internal energy of the heat engine is zero.
- The efficiency of the heat engine is defined as the ratio of the work done (out put) to the heat absorbed (input) in one cyclic process.
- Let the working substance absorb heat Q_H units from the source and reject Q_L units to the sink after doing work W units, as shown in the Figure.
- We can write Input heat = Work done + ejected heat
  $Q_H = W + Q_L$ $W = Q_H - Q_L$
- Then the efficiency of heat engine

$$\eta = \frac{\text{output}}{\text{input}} = \frac{W}{Q_H} = \frac{Q_H - Q_L}{Q_H}$$

$$\eta = \frac{\text{output}}{\text{input}} = \frac{W}{Q_H} = 1 - \frac{Q_L}{Q_H}$$

- Note here that Q_H, Q_L and W all are taken as positive, a sign convention followed in this expression.
- Since $Q_L < Q_H$, the efficiency (ç) always less than 1. This implies that heat absorbed is not completely converted into work.
- The second law of thermodynamics placed fundamental restrictions on converting heat completely into work.
- We can state the heat engine statement of second law of thermodynamics. This is also called Kelvin-Planck's statement.

Kelvin-Planck statement: 1

- It is impossible to construct a heat engine that operates in a cycle, whose sole effect is to convert the heat completely into work.
- This implies that no heat engine in the universe can have 100% efficiency.

Applications that increase Engine efficiency in automobiles 5

1. **Superchargers**
- A supercharger pressurizes air intake to above the normal atmospheric level so that more air can go into the engine, thus combining it with more fuel to produce more power.
- Nearly 50 percent more horsepower, if everything is installed correctly.

2. **Air Filters**
- Aftermarket air filters allow for more airflow into the engine for a more efficient use of the air/fuel combination, while also blocking contaminants and impurities that slowly degrade performance over time.

3. **Performance Chips**
- A performance chip sets new parameters for the functions of your choosing, such as telling your car's engine to use gas slightly more efficiently, or to intake more air for a bigger combustion.

4. **Cool Air intake kit**
- A cold air intake kit is an aftermarket system that brings cool air into the internal combustion engine.
- Cold air intake kits, however, can lead to higher performance and engine efficiency, based on the idea that colder air is denser than warm air, which means that it contains more of that necessary oxygen for a more dynamic combustion in the engine.

7) Define echoes, its conditions and applications? Explain the measuring velocity of sound by echo method?

Echoes 3

- An echo is the sound reproduced due to the reflection of the original sound from various

rigid surfaces such as walls, ceilings, surfaces of mountains, etc.

- If you shout or clap near a mountain or near a reflecting surface, like a building you can hear the same sound again. The sound, which you hear is called an echo.
- It is due to the reflection of sound. One does not experience any echo sound in a small room.
- This does not mean that sound is not reflected in a small room.
- This is because smaller rooms do not satisfy the basic conditions for hearing an echo.

Conditions necessary for hearing echo **5**

- The persistence of hearing for human ears is 0.1 second. This means that you can hear two sound waves clearly, if the time interval between the two sounds is at least 0.1 s.
- Thus, the minimum time gap between the original sound and an echo must be 0.1 s.
- The above criterion can be satisfied only when the distance between the source of sound and the reflecting surface would satisfy the following equation:

$$\text{Velocity} = \frac{\text{Distance Travelled by sound}}{\text{Time taken}}$$

$$v = \frac{2d}{t} \Rightarrow d = \frac{vt}{2}$$

- Since, t = 0.1 second, then $d = \frac{v \times 0.1}{2} = \frac{v}{20}$
- Thus the minimum distance required to hear an echo is 1/20th part of the magnitude of the velocity of sound in air.
- If you consider the velocity of sound as 344 ms^{-1}, the minimum distance required to hear an echo is 17.2 m.

Applications of echo **3**

- Some animals communicate with each other over long distances and also locate objects by sending the sound signals and receiving the echo as reflected from the targets.
- The principle of echo is used in obstetric ultrasonography, which is used to create real-time visual images of the developing embryo or fetus in the mother's uterus. This is a safe testing tool, as it does not use any harmful radiations.
- Echo is used to determine the velocity of sound waves in any medium.

Measuring velocity of sound by echo method

Apparatus required:

- A source of sound pulses, a measuring tape, a sound receiver, and a stop watch.

Procedure: **3**

- Measure the distance 'd' between the source of sound pulse and the reflecting surface using the measuring tape.
- The receiver is also placed adjacent to the source. A sound pulse is emitted by the source.
- The stopwatch is used to note the time interval between the instant at which the sound pulse is sent and the instant at which the echo is received by the receiver. Note the time interval as 't'.
- Repeat the experiment for three or four times. The average time taken for the given number of pulses is calculated.

Calculation of speed of sound: **1**

- The sound pulse emitted by the source travels a total distance of 2d while travelling from the source to the wall and then back to the receiver.
- The time taken for this has been observed to be 't'. Hence, the speed of sound wave is given by:

$$\text{Speed of sound} = \frac{\text{distance of travelled}}{\text{time taken}} = \frac{2d}{t}$$

8) How does the P - N junction diode acts as a rectifier?

P-N Junction diode **1**

- A P-n junction diode is formed when a p-type semiconductor is fused with an n-type semi conductor.

Rectifier **1**

- The process in which alternating voltage or alternating current is connected into direct voltage or direct current is known as rectification.
- The device used for this process is called as rectifier.

Types 4

- Two types of rectifiers namely half wave rectifier and full wave rectifier.

Half wave rectifier

- The half wave rectifier circuit is consists of a transformer, a p-n junction diode and a resistor.
- In a half wave rectifier circuit, either a positive half or the negative half of the AC input is passed through while the other half is blocked.
- Only one half of the input wave reaches the output.
- Therefore, it is called half wave rectifier. Here, a p-n junction diode acts as a rectifier diode.

Full wave rectifier

- The positive and negative half cycles of the AC input signal pass through the full wave rectifier circuit and hence it is called the full wave rectifier.
- It consists of two p-n junction diodes, a center tapped transformer, and a load resistor (R_L).
- The centre is usually taken as the ground or zero voltage reference point.
- Due to the centre tap transformer, the output voltage rectified by each diode is only one half of the total secondary voltage.

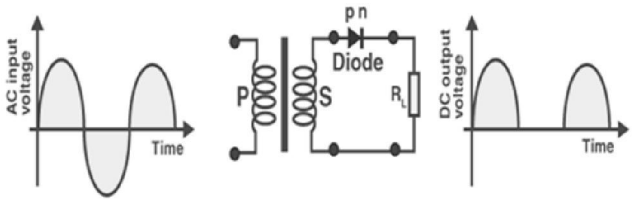
P-N junction diode as rectifier 2

- A p-n junction diode can work as an excellent rectifier since it offers a low resistance for the current to flow when it is forward biased; but a very high resistance when reverse biased. Thus, it allows current through it only in one direction and acts as a rectifier.

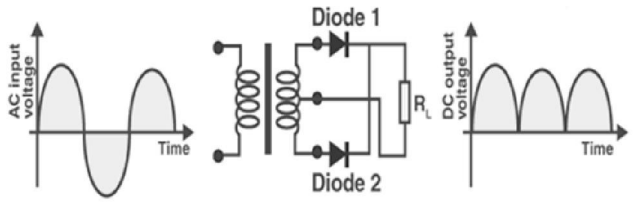
Two primary methods of diode rectification: 4

- Half Wave Rectifier and Full Wave Rectifier which differ in how efficiently they convert an AC source into a DC source.

1. Half-wave rectifiers use diodes in one direction to allow current during one cycle of the AC flow but block it in the other



2. Full-wave rectifiers use a combination of diodes in opposite directions to allow flow during both the cycles of the AC flow



Procedure 3

- When the voltage is applied to the P-N junction diode, which is a semiconductor diode, in such a way that the positive terminal of the battery is connected to the p-type end of the PN junction diode and the negative terminal of the battery is connected to the n-type end, the diode is said to be forward-biased. In this state, the P-N junction diode allows current to flow in the circuit.
- Similarly, when the voltage is applied to the P-N junction diode in such a way that the positive terminal of the battery is connected to the n-type end and the negative terminal of the battery is connected to the p-type end, the diode is said to be reverse biased. In this state, the diode does not allow the circuit to flow in the circuit.
- Thus, the diode allows current in forwarding bias conditions and blocks current in reverse bias condition.
- In simple words, a diode allows current in just one direction. This unique property of the diode allows it to act sort of a rectifier by converting an alternating current to a DC source.