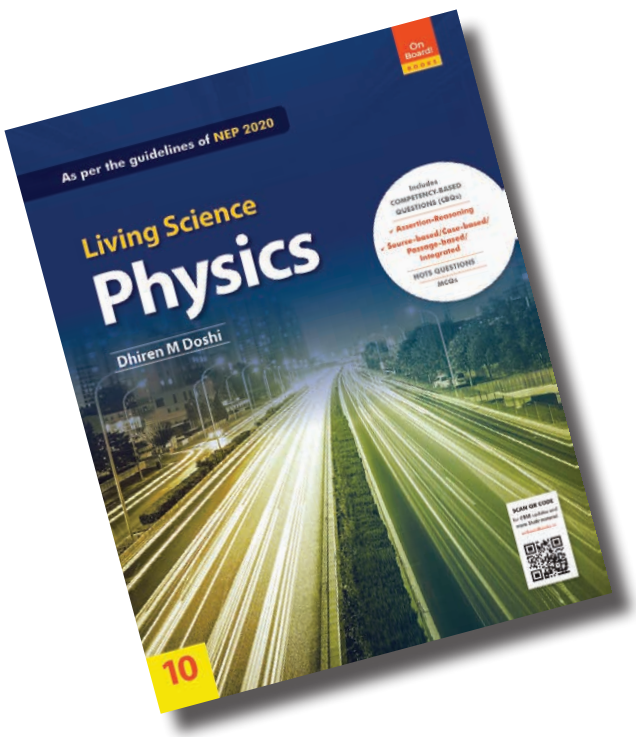
CBSE Living Science

PHYSICS

Book 10

TEACHER'S HANDBOOK



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CHAPTER – 1

ELECTRICITY

P. 11-12 Check Your Progress 1

A. Multiple-choice Questions

1. b **2.** b **3.** b **4.** c **5.** b

B. Very Short Answer Type Questions

1. Electrical energy

2. Electrons in a definite direction in conductor constitute electric current.

3. The conventional direction of electric current is from the positive terminal of the source of electric current (cell or battery) to its negative terminal.

4. We put the arrows on the connecting wires pointing from the positive terminal of the cell (or battery) towards the negative terminal of the cell (or battery) to show the direction of conventional current.

5. If two charged conductors are joined by a metallic wire (or they are placed in contact) then the direction of flow of electrons is determined by a quantity called the potential of the conductor.

6. Voltmeter

7. Battery

8. One volt is the potential difference between two points in a current-carrying conductor when 1 joule of work is done to move one coulomb of electric charge from one point to the other.

9. a. The conductor having excess of electrons is negatively charged and said to be at a lower potential.

b. The conductor having deficiency of electrons is positively charged and said to be higher potential.

10. One volt is the potential difference between two points in a current carrying conductor when 1 joule of work is done to move a charge of 1 coulomb from one point to the other.

C. Short Answer Type-I Questions

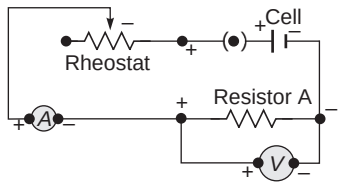
1. The potential difference (p.d) between two points in an electric field is defined as the amount of work done in moving a unit positive charge from one point to the other point. It is a scalar quantity. Potential difference is denoted by the symbol V.

2. Volt. Alessandro Volta.

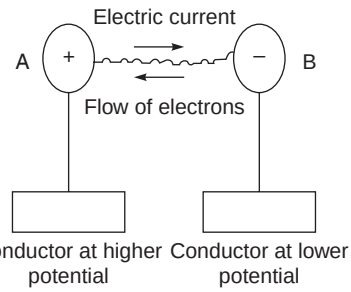
3. The electric potential (or simply potential) at a point in an electric field is defined as the amount of work done in bringing a unit positive charge from infinity to that point. The SI unit of electric potential is volt.

D. Short Answer Type-II Questions

1. Voltmeter is connected in parallel.



2.



E. Numerical Problems

1. Charge (Q) = 4 C

Potential difference (V) = 10 V

Work done (W) = ? (to be determined)

We know $V = \frac{W}{Q}$

$10 = \frac{W}{4}$

$W = 10 \times 4 = 40$ J

2. Charge (Q) = 1 C

Potential difference (V) = 9 V

Energy given to each coulomb of charge is the work done

So, $9\text{ V} = \frac{W}{1\text{ C}}$

$W = 9$ J

Hence, the energy is 9 J.

3. Work done (W) = 100 J

Charge (Q) = 5 C

Potential difference (V) = ?

Applying $V = \frac{W}{Q}$

$V = \frac{100}{5}$

$= 20$ V.

4. Work done (W) = 4×10^{-3} J

Charge (Q) = 16×10^{-6}

V = ?

We know $V = \frac{W}{C}$

$V = \frac{4 \times 10^3}{16 \times 10^{-6}} = 250$ V

5. Charge (Q) = 3 C

Potential difference (V) = 15 V

Work done (W) = ?

We know $V = \frac{W}{C}$

$15 = \frac{W}{3} = 45$ J

6. Potential difference (V) = 12 V

Charge (Q) = 1000 C

Work done (W) = ?

We know $V = \frac{W}{Q}$

$12 = \frac{}{1000}$

W = 12,000 J

7. Charge (Q) = 40 C

Work done = 60 J

Potential difference V = ?

We know $V = \frac{W}{Q}$

$V = \frac{60}{40} = 1.5$ V

8. Charge (Q) = 3 C

Work done (W) = (21 – 15) = 6 J

Potential difference (V) = ?

Applying $V = \frac{W}{Q}$

$V = \frac{6}{3} = 2$ V

P. 16-17 Check Your Progress 2

A. Multiple-choice Questions

1. c **2.** c **3.** d **4.** b **5.** b

B. Very Short Answer Type Questions

1. Electric current is expressed by the amount of electric charge flowing through a particular area per second.

2. Electrons

3. The electric current in a circuit is measured by means of an instrument called ammeter. An ammeter is always connected in series in a circuit through which the current is to be measured.

4. It stops the flow of charge.

5. The SI unit of current is ampere. It is denoted by the letter A.

6. It is named after the French Scientist, Andre – Marie Ampere..

7. When 1 coulomb of charge flows through a conductor in 1 second, then the current flowing through it is said to be 1 ampere.

8. Electric cell.

9. to detect the flow of current in an electric circuit.

C. Short Answer Type-I Questions

1. An electric cell maintains a constant potential difference between its electrodes by virtue of chemical reactions going on inside the cell, i.e. by converting chemical energy into electrical energy.

2. If Q is the net charge, flowing through any cross section of a conductor in time t, then current I is given by $I = \frac{Q}{t}$.

3. The circuit in which electric current flows is called a closed circuit. The bulb in this activity glows because the circuit is complete. It is said to be closed circuit.

The circuit in which electrical contact at any point is broken and hence no current flows is called an open circuit. When the key in this activity is opened, the bulb does not glow, because the circuit is incomplete. It is said to be an open circuit.

4. a. Glows.

b. Does not glow.

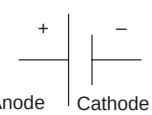
D. Short Answer Type-II Questions

1. a. Battery **b.** Key **c.** Resistor **d.** Ammeter **e.** Galvanometer **f.** Wire crossing

2. 1 A = 10^3 milliampere

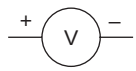
= 10^6 microampere

3.

a. Electric cell 

b. Key

c. Rheostat 

d. Voltmeter 

e. Electric bulb 

f. Wire joint 

4. A diagram which shows the arrangement of various electrical components used in an electric circuit with the help of their electrical symbols is called a circuit diagram.

E. Numerical Problems

1. Charge on an electron (e) = 1.6×10^{-19} C

Charge (Q) = 16 C

Number of electrons (n) = ?

We know $Q = ne$

$16 = n \times 1.6 \times 10^{-19}$

$$n = \frac{16}{1.6 \times 10^{-19}} = 10^{20}$$

2. Current (I) = 0.5 A

Time (t) = 20 min

= 1200 s

Amount of electricity charge (Q) = ?

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

$$0.5 = \frac{Q}{1200}$$

$= 1200 \times 0.5 = 600$ C

3. Charge (Q) = 20 C

Time (t) = 10 s

Current flowing (I) = ?

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

$$I = \frac{20}{10} = 2 \text{ A}$$

4. Charge on electron (e) = 1.6×10^{-19} C

Current (I) = 1 A

Time (t) = 1 s

Charge (Q) = ?

We know $Q = It$

$\therefore \quad Q = 1 \times 1 = 1$ C

Amount of charge $Q = ne$

$1 = n \times 1.6 \times 10^{-19}$

$$n = \frac{1}{1.6 \times 10^{-19}}$$

$= 6.25 \times 10^{18}$ electrons.

P. 21-22 Check Your Progress 3

A. Multiple-choice Questions

1. d **2.** c **3.** b **4.** b

5. d.

B. Very Short Answer Type Questions

1. We know $V = IR$, therefore $I = \frac{V}{R}$. Hence,

a. current becomes half, **b.** current becomes double, **c.** current becomes one third, **d.** increases four times

2. Resistance

3. Ohm

4. Current and potential difference

5. We know $V = IR$, therefore **a.** Current becomes double, **b.** current becomes half, **c.** current increases three times.

6. Ohm's law: According to Ohm's law, the electric current (I) flowing through a conductor is directly proportional to the potential difference (V) across its ends, provided the physical conditions (like temperature, pressure, etc.) remain the same, i.e. $I \propto V$ at constant temperature and pressure, etc.

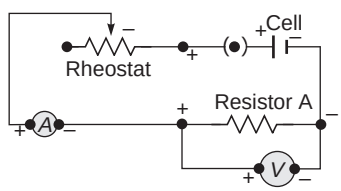
7. The property of a conductor by virtue of which it opposes the flow of electrons through it is called electric resistance.

8. One ohm is the resistance in a circuit transmitting a current of one ampere when the potential difference is of one volt.

9. $V = IR$

C. Short Answer Type-I Questions

1. Circuit diagram to verify Ohm's law



2. It is found that the ratio V/I has almost constant value for all the observations. This verifies Ohm's law because this shows that the current is directly proportional to the potential difference.

3. High resistances are measured in kilo ohm and mega ohm where

1 kiloohm (or 1 kΩ) = 10^3 Ω, and

1 megaohm (or 1MΩ) = 10^6 Ω

Low resistances are measured in milli ohm and micro ohm where

1 milliohm (or 1 mΩ) = 10^{-3} Ω

1 microohm (or 1 μΩ) = 10^{-6} Ω

4. $V = IR$

D. Short Answer Type-II Questions

1. If a graph is drawn between potential difference readings and the corresponding current readings, we will get a straight line graph showing that as the current through the wire increases, the potential difference across the wire increases linearly. In other words, current is directly proportional to the potential difference.

2. Nichrome wire, torch bulb, 10 W bulb offered resistance to the electric current but to a different extent. So, we observed that the current flowing through the circuit was different components.

3. a. Straight line on *V-I* graph (refer Fig. 1.23, Page 21 of textbook)

b. The slope of *V-I* graph at any point represents resistance of the material of the conductor.

E. Numerical Problems

1. Resistance $R = 6\ \Omega$, Current (I) = 3.5 A , Potential difference V = ?

We know that $V = IR$

$V = 3.5 \times 6 = 21$ V

2. Current (I) = 0.5 A

Resistance (R) = 5 W,

Potential difference (V) = ?

$V = IR$

$V = 0.5 \times 5 = 2.5$ V

3. Resistance $R = \frac{\Delta V}{\Delta I} = \frac{0.1}{0.5} = 0.2\ \Omega$

(graph is to be manually plotted).

4. Potential difference (V) = 9 V

Current (I) = 3 mA = 3×10^{-3} A

Resistance (R) = ?

We know $V = IR$

$9 = 3 \times 10^{-3} R$

$R = \frac{9}{3 \times 10^{-3}} = 3000\ \Omega$

5. Current (I) = 11 A

Potential difference (V) = 220 V

Resistance (R) = ?

We know $V = IR$

$220 = 11 \times R$

$R = \frac{220}{11} = 20\ \Omega$

6. Potential difference (V) = 220 V

Resistance (R) = 1100 Ω

Current I = ?

$V = IR$

$220 = I \times 1100$

$I = \frac{220}{1100} = 0.2$ A

7. Initial potential difference (V) = 250 V

Current (I) = 10 A

Resistance (R) = ?

$V = IR$

$250 = 10\ R$

$R = 250/10 = 25\ \Omega$

Now when potential difference = 300 V

Current (I) = ?

Substituting the value of R in $V = IR$

$300 = I \times 25$

$I = \frac{300}{25} = 12$ A

P. 27-28 Check Your Progress 4

A. Multiple-choice Questions

1. d **2.** a **3.** a **4.** d **5.** a

B. Very Short Answer Type Questions

1. Factors affecting the resistance of a conductor:

The electrical resistance of a conductor (or a wire) depends on the following factors.

- Length of the conductor
- Area of cross section of the conductor (or thickness of the conductor)
- Temperature of the conductor
- Nature of the material of the conductor

The resistance of a conductor is inversely proportional to its area of cross section, i.e.

$$R \propto \frac{1}{A}$$

2. Long wire. We know $R = \rho \frac{I}{A}$ where I is the length of the wire. Since R is directly proportional to length of wire, the longer the wire the greater will be the resistance.

3. The resistance of a conductor is inversely proportional to its area of cross section, i.e.

$$R \propto \frac{1}{A}$$

a. When the area of cross section is tripled the resistance becomes one-third.

b. if the area of cross section is reduced to one-fourth, the resistance increases four times.

4. The resistance of all pure metals increases with rise in temperature and decreases on lowering the temperature.

5. Nichrome has higher resistance.

6. Thinner wire, It increases.

7. Resistivity refers to the ability of substance to resist current flow.

8. Tungsten.

9. The substances which have infinitely high resistivity are called insulators. Examples are glass and plastic.

10. a. Copper, Aluminium.

b. Tungsten, Nichrome.

11. Copper and Aluminium.

C. Short Answer Type-I Questions

1. Factors affecting the resistivity:

The resistivity ρ depends on

- The nature of the material.
- The temperature of the material (wire).

2. Silver, graphite

3. The resistivity of an alloy is higher than its constituent metals because an alloy does not get oxidised at high temperatures.

4. Electricians wear rubber handgloves while working with electrical devices because rubber is an insulator and protects them from electric shocks. Substances having resistivity in the range of $10^{12}\ \Omega$ m to $10^{17}\ \Omega$ m are insulators.

D. Short Answer Type-II Questions

1. The resistance of a conductor is directly proportional to its length. Resistance will be **a.** tripled **b.** halved.

2. The resistivity of an alloy is higher than that of its constituent pure metals. Alloys do not oxidise (burn) readily at high temperature.

3.

Resistance	Resistivity
The property of a material due to which it opposes the flow of current through it, is called resistance.	Resistivity of a material is the resistance offered by 1 m length of wire of the material having an area of cross section of 1 m^2.
The resistance of a conductor depends on its length and thickness.	The resistivity of a material does not depend on its length or thickness and is the characteristic of the given material.
$R = \frac{V}{I}$ $\left(\frac{\text{Potential difference}}{\text{Current}}\right)$	$\rho = \frac{R \times A}{l}$ $\frac{\text{Resistance} \times \text{Area of cross section}}{\text{Length of the material}}$
ohm (Ω)	ohm – meter (Ω m)

D. Numerical Problems

1. Resistance (R) = 6 Ω

$$\text{Since } R = \frac{\rho l}{A}$$

When the wire is doubled on itself the length becomes half.

$\therefore$ The area of cross section = $2A$ (becomes double)

$$\text{New resistance } R' = \frac{\rho l / 2}{2A}$$

$$\text{Therefore } \frac{R'}{R} = \frac{\frac{\rho l / 2}{2A}}{\frac{\rho l}{A}} = \frac{\rho l}{4A} \times \frac{A}{\rho l} = \frac{1}{4}$$

$$R = 6\ \Omega$$

$$R' = ?$$

$$\frac{R'}{R} = \frac{4}{1}$$

$$\frac{R'}{6} = \frac{4}{1}$$

$$R' = \frac{6}{4} = 1.5\ \Omega$$

2. Let the original resistance be R. We know

$$R = \frac{\rho l}{A}$$

When the length is doubled length = $2l$

$$\text{New resistance } R' = \frac{\rho 2l}{\frac{A}{2}}$$

$$\frac{R'}{R} = \frac{\rho 2l}{\frac{A}{2}} \div \frac{\rho l}{A} = \frac{4}{1} \text{ or } \frac{R}{R'} = \frac{1}{4}$$

Hence the resistance becomes four times the original value.

3. Resistance (R) of silver wire = 6 Ω

Resistance of similar wire = 3 Ω

Length of similar wire = 80 cm = 0.8 mm

We know $R = \frac{\rho l}{A}$

For silver $R = \frac{\rho l}{A}$ or $6 = \frac{\rho l}{A}$ or $l = \frac{6A}{\rho}$

For copper $R' = \rho \frac{80}{A}$ or $3 = \rho \frac{80}{A}$ or $\rho = \frac{3A}{80}$

$\therefore \quad l = 6A \div \frac{3A}{80}$

$= 6A \times \frac{80}{3A} = 160 \text{ cm} = 1.6 \text{ m}$

4. Length of the conductor = (l) = 65 cm = 0.65 m

Resistance = 4 Ω

We know $R = \frac{\rho l}{A}$

$4 = \rho \times \frac{0.65}{A}$

$\rho = \frac{4A}{0.65}$ ... (1)

Length of the conductor (l') = 260 cm = 2.6 m

$R' = \frac{\rho l'}{A}$

Substituting the value of ρ from equation (1) in the above equation

$R' = \frac{4A}{0.65} \times \frac{2.6}{A} = 16 \ \Omega$

5. Potential difference (V) = 220 V

Resistance of bulb filament (R) = 660 Ω

Current (I) = ?

$V = IR$

$220 = I \times 660$

$I = \frac{220}{660} = 0.33 \text{ A}$

Resistance of heater = 100 Ω

$I = \frac{220}{100} = 2.20 \text{ A}$

6. It means that if we take a silver wire of length 1 m long and having an area of cross section of 1 m^2, then the resistance of this piece of silver wire will be 1.6×10^{-8} Ω.

7. Length of copper wire = 3 m

Area of cross section (A) = 1.7×10^{-6} m^2

Resistance (R) = 3×10^{-2} Ω

Resistivity (ρ) = ?

We know $R = \frac{\rho l}{A}$

$3 \times 10^{-2} = \rho \times \frac{3}{1.7 \times 10^{-6}}$

$\rho = \frac{3 \times 10^2 \times 10^{-6}}{3}$

$= 1.7 \times 10^{-8}$ Ω m

8. a. Diameter = 0.6 mm

$\therefore$ Radius = 0.3 mm = 3×10^{-4} m

Resistivity (ρ) = 17 Ω

Length of wire (l) = ?

Area of cross section = πr^2

$= \pi \times (3 \times 10^{-4})^2$

$= 28.286 \times 10^{-8}$ m^2

We know $R = \frac{\rho l}{A}$

Now substituting the values in the above equation

$17 = 1.7 \times 10^{-8} \times \frac{l}{28.286 \times 10^{-8}}$

$l = \frac{28.286 \times 10^{-8} \times 17}{1.7 \times 10^{-8}} = 282.86 \text{ m}$

b. We know $R = \frac{\rho l}{A}$

We also know $A = \pi r^2$ (where r is the radius)
Let the initial resistance be R

Therefore, $R = \frac{\rho l}{\pi r^2}$

When the diameter (d) is doubled, i.e. $2d$, then $r' = \frac{1}{2} \times 2d = d = 2r$ (since $d = 2r$)

Then resistance $R' = \frac{\rho l}{\pi (2r)^2} = \frac{\rho l}{\pi 4r^2}$

$\frac{R'}{R} = \frac{\rho l}{\pi 4r^2} \div \frac{\rho l}{\pi r^2} = \frac{1}{4}$

Therefore, the resistance becomes one-fourth.

c. We know $R = \frac{\rho l}{A}$

We also know $A = \pi r^2$ (where r is the radius)
Let the initial resistance be R

Therefore $R = \frac{\rho l}{\pi r^2}$

When the diameter (d) is halved, i.e. $\frac{d}{2}$, then

$r' = - \times \frac{d}{2} = \frac{d}{4} = \frac{2r}{4} = \frac{r}{2}$ (since $d = 2r$)

$R' = \frac{\rho l}{\pi \left(\frac{r}{2}\right)^2} = \frac{4\rho l}{\pi r^2}$

$$\frac{R^1}{R} = \frac{4\rho l}{\pi r^2} \div \frac{\rho l}{\pi r^2} = 4$$

Therefore, the resistance becomes 4 times.

9. Length of wire (l) = 2 m

Resistance (R) = 14 Ω

Diameter of the wire = 0.6 mm

$\therefore$ Radius = 0.3 mm = 3×10^{-4}

Area of cross section (A) = πr^2

$= 3.14 \times (3 \times 10^{-4})^2$

$= 28.26 \times 10^{-8}\ m^2$

Resistivity (ρ) = ?

We know $R = \frac{\rho l}{A}$

$$14 = \rho \frac{2}{28.26 \times 10^{-8}}$$

$$\rho = \frac{14 \times 28.26 \times 10^{-8}}{2}$$

$= 1.975 \times 10^{-6}\ \Omega$ m

$= 1.98 \times 10^{-6}\ \Omega$ m

10. Copper is a better conductor because the lower the resistivity, the better the conductor.

11. Given: Resistance of wire (R) = 10 Ω

Diameter of wire = 0.001 m

Cross-sectional area (A) = πr^2

$$= \frac{22}{7} \times \frac{0.001}{2}\ m \times \frac{0.001}{2}\ m$$

Length of wire (l) = 1 m = $7.85 \times 10^{-5}\ m^2$

$$\text{Resistivity } (\rho) = \frac{RA}{l}$$

$$= \frac{10\ \Omega \times 7.85 \times 10^{-5} m^2}{1\ m}$$

$= 7.85 \times 10^{-4}\ \Omega$ m

12. Given: length of wire (l) = 3 m

Area of cross section (A) = $1.56 \times 10^{-6}\ m^2$

Resistivity (ρ): $1.8 \times 10^{-8}\ \Omega$ m

$$\text{Resistance, } R = \frac{\rho l}{A}$$

$$R = 1.8 \times 10^{-8} \times 3 \times 1.56 \times 10^{-6}$$

$= 3.6 \times 10^{-2}\ \Omega$

13. Given: length of wire (l) = 10 m

Resistivity of silver (ρ): $1.6 \times 10^{-6}\ \Omega$ m

Area of cross section (A) = $2 \times 10^{-3}\ m^2$

$$\text{Resistance, } R = \frac{\rho l}{A}$$

$$= \frac{1.6 \times 10^{-6}\ \Omega\ m \times 10\ m}{2 \times 10^{-3} m^2}$$

$= 0.008\ \Omega$

14. Resistivity (ρ) = $1.7 \times 10^{-8}\ \Omega$ m

Diameter = 0.2 mm

$\therefore$ Radius = 0.1 mm = 1×10^{-4} m

Resistance = 2 Ω

We know $R = \frac{\rho l}{A}$

$$2 = 1.7 \times 10^{-8} \frac{l}{\pi(1 \times 10^{-4})^2}$$

$$l = \frac{3.14 \times 10^{-8} \times 2}{1.7 \times 10^{-8}}$$

$= 3.697$ m

If diameter is increased 4 times it will be 0.8 mm, then the radius = 0.4 mm = 4×10^{-4} m

$$R = \frac{1.7 \times 10^{-8} \times 3.694}{\pi(1 \times 10^{-4})^2} = 0.125\ \Omega$$

P. 38-40 Check Your Progress 5

A. Multiple-choice Questions

1. a **2.** b **3.** b **4.** b **5.** b

B. Very Short Answer Type Questions

1. Series and parallel

2. The following are the characteristics of the series circuit:
- The current in each resistor is the same.
- The total resistance in the circuit is equal to the sum of the individual resistances.
- The total resistance of the series circuit is more than the maximum resistance in the circuit.
- The current in the circuit is independent of the relative positions of the various resistors in the series.

3. Two or more resistors are said to be connected in series if they are connected one after the other such that the same current flows in one path through all the resistors when some potential difference is applied across the combination.

4. The main disadvantage of a series circuit is that if one device (resistor) fails, the current in the whole circuit ceases to flow.

5. When a number of resistances are connected in parallel, the reciprocal of the equivalent resistance is equal to the sum of the reciprocals

of the individual resistors.

6. The following are the characteristics of a parallel circuit:
- The potential difference (voltage) across each resistor is the same.
- The total current in the circuit is equal to the sum of currents in its parallel branches.
- The reciprocal of the total resistance is equal to the sum of the reciprocals of the individual resistances.
- The total resistance of the circuit is always less than the smallest resistance in the circuit.

7. The series arrangement is not used for domestic circuits because of the following disadvantages.

In series arrangement, if one appliance is switched off or gets fused, then all other appliances will also stop working because their electrical supply will be cut off due to breaking of the whole circuit. For example if a number of bulbs are connected in series (for making fancy lights, decorating buildings and trees during festivals or marriage functions or school functions) and if one bulb gets fused, then all other bulbs will also stop glowing.

In series arrangement, all the electrical appliances have only one switch so they cannot be operated independently with independent switches. For example if a number of bulbs are connected in series, it will have only one switch connected. So, all the bulbs can be switched on or switched off together and not separately.

In series arrangement, the voltage is shared by all the electrical appliances, so each electrical appliance does not get the required same voltage as that of the power supply line. Due to this, all the appliances will not work properly. For example, all the bulbs connected in series do not get the same voltage 220 V of the power supply line. They get less voltage and hence glow less brightly.

In series arrangement, the magnitude of resistance is maximum due to which very small amount of current flows from the power supply line. So, high power rating appliances like air conditioner and water heaters which need high current cannot work properly.

In series arrangement, the same current flows throughout a series circuit, due to which higher power rating appliances like air conditioners, water heaters and electric irons cannot draw sufficient high current needed for their proper functioning.

C. Short Answer Type-I Questions

1. In series arrangement, the same current flows throughout a series circuit, due to which higher power rating appliances like air conditioners, water heaters and electric irons cannot draw sufficient high current needed for their proper functioning.

2.

Resistors in series	Resistors in parallel
The current is same in every resistor.	The current is not the same as the current through each resistor is inversely proportional to the resistance of the resistor, i.e. $I \propto 1/R$
The potential difference across each resistor is not the same, it is directly proportional to the resistance of that resistor, i.e. $V \propto R$.	The potential difference across each resistor is the same.
The total resistance in the series circuit is more than the greatest resistance in the circuit.	The total resistance of the circuit is always less than the smallest resistance in the circuit.
$R = R_1 + R_2 + R_3$	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

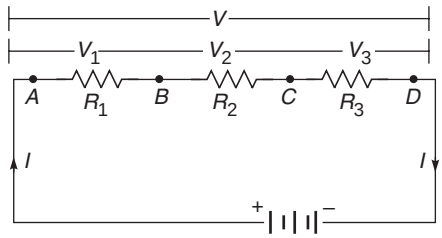
3.

Advantages of connecting electrical devices in parallel	Disadvantages of connecting electrical devices in series
All other appliances keep working normally.	All other appliances will stop working because their electrical supply will be cut off due to the broken circuit.

Each electrical appliance will have its independent switch. It can be operated independently.	All the electrical appliances will have only one switch, so they cannot be operated independently with independent switches.
Each electrical appliance gets the same voltage (220 V) as that of the power supply line (220 V), so all the electrical appliances work properly.	The voltage is shared by all the electrical appliances, so each electrical appliances does not get the required voltage (220 V) as that of the power supply line (220 V). So all the electrical appliances do not work properly.
The magnitude of the resistance is reduced due to which the current from the power supply is high. Even higher power rating appliances like air conditioners, water heaters etc., can draw the needed high current for their proper functioning.	The magnitude of the resistance is maximum due to which the current from the power supply is low. So higher power rating appliances cannot work properly.
Each electrical appliance can draw the required amount of current, so even high rating electrical appliances can draw high current needed for their proper functioning.	The same current flows throughout the circuit due to which high rating electrical appliances cannot draw sufficient high current needed for their proper functioning.

D. Short Answer Type-II Questions

1. To determine the equivalent resistance ($R_s = R_1 + R_2 + R_3 + ...$),



Consider three resistors of resistance R_1, R_2 and R_3 respectively connected in series. Let I be the current flowing through each resistor and V be the potential difference across the series combination. If V_1, V_2 and V_3 be the potential differences across the resistors R_1, R_2 and R_3 respectively, then

$$V = V_1 + V_2 + V_3 \quad \text{... (1)}$$

By Ohm's law, $V_1 = IR_1$, $V_2 = IR_2$ and $V_3 = IR_3$ or

$$V = I\,(R_1 + R_2 + R_3) \quad \text{... (2)}$$

If R_s be the effective or equivalent resistance of the series combination, then

$$V = IR_s \quad \text{... (3)}$$

From equations (2) and (3), we get

$$IR_s = I\,(R_1 + R_2 + R_3)$$

$$R_s = R_1 + R_2 + R_3.$$

2. Consider three resistors of resistance R_1, R_2 and R_3 respectively connected in parallel.

Let V be the potential difference across each resistor. The current I drawn from the cell divides into three parts (i.e. I_1, I_2 and I_3) at junction point A. Let the current I_1, I_2 and I_3 flow through the resistors R_1, R_2 and R_3 respectively.

$$\therefore \quad I = I_1 + I_2 + I_3$$

Since the potential difference between the two ends A and B is V, therefore by Ohm's law,

$$\text{Current in } R_1 \text{ is } I_1 = \frac{V}{R_1}$$

$$\text{Current in } R_2 \text{ is } I_2 = \frac{V}{R_2}$$

$$\text{Current in } R_3 \text{ is } I_3 = \frac{V}{R_3}$$

Now, $$I = I_1 + I_2 + I_3$$

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3} \quad \text{... (1)}$$

If the equivalent resistance of the combination between the points A and B is R_P then

$$I = \frac{V}{R_P} \quad \text{... (2)}$$

From equations (1) and (2) we get

$$\frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{V}{R_P} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$\frac{1}{R_P} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

Ammeter is connected in series and voltmeter is connected in parallel.

E. Numerical Problems

1. $R_1 = 5\ \Omega$; $R_2 = 10\ \Omega$; $R_3 = 15\ \Omega$; $R_4 = 20\ \Omega$.

The resistors are connected in series.

Hence total resistance $R = R_1 + R_2 + R_3 + R_4$

$R = 5 + 10 + 15 + 20 = 50\ \Omega$.

2. $R_1 = 8\ \Omega$; $R_2 = 10\ \Omega$; $R_3 = 5\ \Omega$;

The resistors are connected in series,

Equivalent resistance, $R = R_1 + R_2 + R_3$

$R = 5 + 10 + 5 = 23\ \Omega$.

3. $R_1 = 2\ \Omega$; $R_2 = 3\ \Omega$; $R_3 = 15\ \Omega$;

The resistors are connected in parallel

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

Total resistance $\frac{1}{R} = \frac{1}{2} + \frac{1}{3} + \frac{1}{15}$

$$\frac{1}{R} = \frac{15 + 10 + 2}{30} = \frac{27}{30} = \frac{10}{9} = 1.11\ \Omega.$$

4. $R_1 = 5\ \Omega$; $R_2 = 10\ \Omega$; $R_3 = 5\ \Omega$; $R_4 = 20\ \Omega$

The resistors are connected in parallel.

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

$$\frac{1}{R} = \frac{1}{5} + \frac{1}{10} + \frac{1}{15} + \frac{1}{20}$$

$$\frac{1}{R} = \frac{50}{120}$$

$$R = 2.4\ \Omega$$

5. Total resistance $R = 3\ \Omega$

$$\frac{1}{R} = \frac{1}{3}$$

$R_1 = 10\ \Omega$; $R_2 = 30\ \Omega$; $R_3 = ?$

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

$$\frac{1}{3} = \frac{1}{10} + \frac{1}{30} + \frac{1}{R_3}$$

$$\frac{1}{3} = \frac{4}{30} + \frac{1}{R_3}$$

$$\frac{1}{R_3} = \frac{1}{3} - \frac{4}{30}$$

$$\frac{1}{R_3} = \frac{6}{30}$$

$$\frac{1}{R_3} = \frac{1}{5}$$

$$R_3 = 5\ \Omega$$

6. a. $R_1 = 3.5\ \Omega$; $R_2 = 2\ \Omega$; $R_3 = 6\ \Omega$;

R_2 and R_3 are connected in parallel.

Reciprocal of total resistance

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{2} + \frac{1}{6} = \frac{4}{6} = \frac{2}{3}$$

$$R_T = \frac{3}{2}$$

R_1 is connected in series

Therefore total resistance $= 3.5 + \frac{3}{2} = \frac{7+3}{2}$

$$= 5\ \Omega$$

b. $R_1 = 3.2\ \Omega$; $R_2 = 3\ \Omega$; $R_3 = 6\ \Omega$; $R_4 = 18\ \Omega$

R_2 , R_3 and R_4 are connected in parallel.

$$\frac{1}{R_T} = \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{3} + \frac{1}{6} + \frac{1}{18}$$

$$= \frac{6 + 3 + 1}{18} = \frac{10}{18} = \frac{5}{9}$$

$$R_T = \frac{9}{5}$$

Total resistance $= R_1 + R_T = 3.2 + \frac{9}{5}$

$$= \frac{9}{5} = \frac{16 + 9}{5} = \frac{25}{5} = 5\ \Omega$$

c. Between A and B,

$R_1 = 5\ \Omega$; $R_2 = 20\ \Omega$;

Total resistance $\frac{1}{R_T} = \frac{1}{5} + \frac{1}{20} = \frac{5}{20} = \frac{1}{4}$

$R_T = 4\ \Omega$

Between B and C

$R_3 = 2\ \Omega$; $R_4 = 3\ \Omega$; $R_5 = 6\ \Omega$

$$\frac{1}{R_P} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} = \frac{3 + 2 + 1}{6} = \frac{6}{6} = 1\ \Omega$$

Total resistance $R_T + R_P = 4 + 1 = 5\ \Omega$

d. R_1, R_2 and R_3 are connected in series.

Hence total resistance = 2 + 3 + 5 = 10 Ω

Similarly R_4 , R_5 and R_6 are in series.

Hence total resistance = 1 + 4 + 5 = 10 Ω

Now these two are connected in parallel.

Hence, total resistance,

$$\frac{1}{R_P} = \frac{1}{10} + \frac{1}{10} = \frac{2}{10} = \frac{1}{5}\ \Omega$$

$$R_P = 5\ \Omega$$

e. R_1 and R_4 are in parallel.

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_4} = \frac{1}{2} + \frac{1}{4} = \frac{3}{4}$$

$$R_T = 3/4$$

R_2 and R_3 are in parallel,

$$\frac{1}{R_P} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{3} + 1 = \frac{4}{3}$$

$$R_P = \frac{3}{4}$$

Total resistance = $R_T + R_P$

$$= \frac{4}{3} + \frac{3}{4} = \frac{16+9}{12} = \frac{25}{12} = 2.5\ \Omega$$

7. Total resistance R = 50 Ω

R_1 = 5 Ω; R_2 = 10 Ω; R_3 = 5 Ω; R_4 = ?

$R = R_1 + R_2 + R_3 + R_4$

50 = 5 + 10 + 15 + R_4

50 = 30 + R_4

R_4 = 20 Ω

8. R_1 = 3 Ω; R_2 = 5 Ω; R_3 = 7 Ω; R_4 = 10 Ω

Potential difference = 10 V

We know $V = IR$

$V = I\ (R_1 + R_2 + R_3 + R_4)$

10 = I (3 + 5 + 7 + 10)

10 = 25 I

$$I = \frac{10}{25} = 0.4\ \text{A}$$

9. a. Current in 2 Ω resistor

$V = I_1R$

I_1 = 8 A

Current in 4 Ω resistor

$V = I_2T$

16 = I_2 × 4

I_2 = 4 A

Current in 8 Ω resistor

$V = I_3R$

16 = I_3 x 8

I_3 = 2 A

b. Total current in the circuit

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$= \frac{16}{2} + \frac{16}{4} + \frac{16}{8} = 8 + 4 + 2 = 14\ \text{A}$$

c. Total resistance (R_T)

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

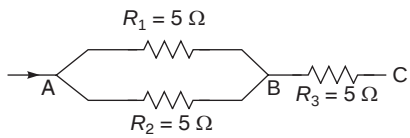
$$\frac{1}{R_T} = \frac{1}{2} + \frac{1}{4} + \frac{1}{8} = \frac{4+2+1}{8} = \frac{7}{8}$$

$$R_T = \frac{8}{7} = 1.14\ \Omega$$

10. To obtain 7.5 Ω resistance.

In order to get a resistance of 7.5 Ω from three resistors each of resistance 5 Ω, we connect two resistors in parallel and this parallel combination is connected in series with the third resistor as shown below.

a.



Calculation of the total resistance between A and B. Total resistance (R_P) in parallel circuit is given by $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$

$$\frac{1}{R_P} = \frac{1}{5} + \frac{1}{5} = \frac{2}{5}$$

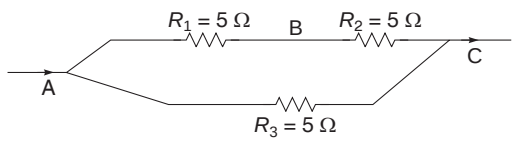
$$R_P = \frac{5}{2} = 2.5\ \Omega$$

Calculation of total resistance (R_P) in the circuit R_P = 2.5 Ω; R_3 = 5 Ω

When connected in series total resistance $R = R_P + R_3$ = 2.5 + 5 = 7.5 Ω

b. To obtain 3.33 Ω resistance

In order to get a resistance of 3.33 Ω from three resistors, each of resistance 5 Ω we connect two resistors in series and this series combination is connected in parallel with the third resistor as shown below.



Here R_1 = 5 Ω, R_2 = 5 Ω

Total resistance R_S when R_1 and R_2 are in series

$R_S = R_1 + R_2$

$R_S = 5 + 5 = 10\ \Omega$

$R_3 = 5\ \Omega$

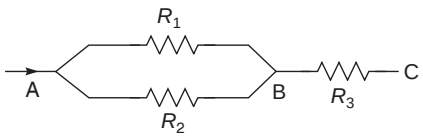
Total resistance R when R_S and R_3 are connected in parallel

$$\frac{1}{R} = \frac{1}{R} + \frac{1}{R}$$

$$\frac{1}{R} = \frac{1}{10} + \frac{1}{5} = \frac{1}{R} = \frac{1+2}{10} = \frac{3}{10}$$

$$R = \frac{10}{3} = 3.33\ \Omega$$

11. a.



Total resistance in parallel,

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{10} + \frac{1}{10} = \frac{2}{10} = \frac{1}{5}$$

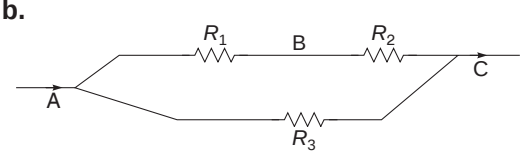
$R_P = 5\ \Omega$

Total resistance

$R_P + R_3 = 5\ \Omega + 10\ \Omega$

$= 15\ \Omega$

b.



Total resistance in series,

$R_S = R_1 + R_2 = 10 + 10$

$= 20\ \Omega$

$$\text{Total resistance} = \frac{1}{R_s} + \frac{1}{R_3} = \frac{1}{20} + \frac{1}{10} = \frac{3}{20}$$

$$R = \frac{20}{3} = 6.67\ \Omega$$

12. Potential difference = 220 V

Resistance of resistors = 22 Ω

When the resistors are separately used, current flowing can be calculated as

$V = IR$

$220 = I \times 22$

$$I = \frac{220}{22} = 10\ \text{A}$$

When connected in series, total resistance

$= 22 + 22 = 44\ \Omega$

$V = IR$

$220 = I \times 44$

$$I = \frac{220}{44} = 5\ \text{A}$$

When connected in parallel

$$\frac{1}{R_P} = \frac{1}{22} + \frac{1}{22} = \frac{2}{22} = \frac{1}{11}$$

$R_P = 11\ \Omega$

$V = IR$

$220 = I \times 11$

$$I = \frac{220}{11} = 20\ \text{A}$$

13. Potential difference = 220 V

Resistance of resistors = 44 Ω

Current flowing through the resistors separately

$V = IR$

$220 = I \times 44$

$$I = \frac{220}{44} = 5\ \text{A}$$

When connected in series, total resistance

$= 44 + 44 = 88\ \Omega$

$V = IR$

$220 = I \times 88$

$$I = \frac{220}{88} = 2.5\ \text{A}$$

When connected in parallel, total resistance,

$$\frac{1}{R_P} = \frac{1}{44} + \frac{1}{44} = \frac{2}{44} = \frac{1}{22}$$

$R_P = 22\ \Omega$

$V = IR$

$220 = I \times 22$

$$I = \frac{220}{22} = 10\ \text{A}$$

14. a. $$\frac{1}{R_P} = \frac{1}{6} + \frac{1}{30} = \frac{5+1}{30} = \frac{6}{30} = \frac{1}{5}$$

$R_P = 5\ \Omega$

$$\frac{1}{R'_P} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} = 1$$

$R'_P = 1$

Total resistance $(R_T) = R_P + R'_P$

$= 5 + 1 = 6\ \Omega$

b. Total current $(I) = \frac{V}{R} = \frac{10\ V}{6\ \Omega} = 1.67\ \text{A}$

15. Resistance of electric oven = 125 Ω

Resistance of toaster = 50 Ω

Resistance of geyser = 250 Ω

Potential difference = 220 V

Resistance of electric current = ?

Current taken by electric current = Current taken by all three appliances.

Current taken by all three appliances can be calculated from $V = IR$

$$I = \frac{V}{R}$$

Total resistance in parallel

$$\frac{1}{R_P} = \frac{1}{125} + \frac{1}{50} + \frac{1}{250} = \frac{2+5+1}{250} = \frac{8}{250}$$

$$R_P = \frac{250}{8}$$

$V = 220$ V

$$I = \frac{V}{R_P} = 220 \div \frac{250}{8} = 220 \times \frac{8}{250} = 7.04 \text{ A}$$

Current flowing through the item is 7.04 A

Resistance $\frac{V}{I} = 31.25\ \Omega$

16. a. A highest resistance will be when the resistors are connected in series

$R_S = 6 + 8 + 12 + 24 = 50\ \Omega$

b. Lowest resistance will be when they are connected in parallel

$$\frac{1}{R_P} = \frac{1}{6} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24} = \frac{4+3+2+1}{24} = \frac{10}{24} = 2.4\ \Omega$$

17. Total resistance = 6 + 8 + 10 = 24 Ω

Potential difference = 12 V

a. $V = IR$

$12 = I \times 24$

$$I = \frac{12}{24} = 0.5 \text{ A}$$

b. $V_1 = IR_1$

$V_1 = 0.5 \times 6 = 3$ V

c. $V_2 = IR_2$

$V_2 = 0.5 \times 8 = 4$ V

d. $V_3 = IR_3$

$V_3 = 0.5 \times 10 = 5$ V

18. a. Total resistance in parallel

$$\frac{1}{R_P} = \frac{1}{4} + \frac{1}{6} + \frac{1}{12} = \frac{3+2+1}{12} = \frac{6}{12} = \frac{1}{2}$$

$R_P = 2\ \Omega$

Let total resistance be $R_T = R_P + R_S$

$R_T = 2 + 2 = 4\ \Omega$

Current in the main circuit = $V = IR$

Now, $I = \frac{V}{R} = \frac{6\ V}{4\ \Omega} = 1.5$ A

b. Now, $I_1 = \frac{V}{R_1} = \frac{6\ V}{4\ \Omega} = 1.5$ A

Similarly, $I_2 = \frac{V}{R_2} = \frac{6\ V}{6\ \Omega} = 1$ A

and $I_3 = \frac{V}{R_3} = \frac{6\ V}{12\ \Omega} = 0.5$ A

P. 45-46 Check Your Progress 6

A. Multiple-choice Questions

1. d **2.** b **3.** c **4.** c **5.** c

B. Very Short Answer Type Questions

1. It is because a part of electrical energy is converted into heat energy. This is called heating effect of electric current.

2. A part of electrical energy getting converted into heat is called heating effect of current.

3. Conversion of electric to heat energy.

4. Joule's law of heating states that the amount of heat produced in a conductor, when current flows through it is directly proportional to square of current (I^2) through the conductor for a given resistance and time.

Resistance (R) of the conductor for a given current and time.

5. We know $H = I^2Rt$. Therefore, heat produced will be **a.** tripled if the resistance is tripled and **b.** will be reduced to one third if the resistance is reduced by one third.

6. The electric bulb is filled with small amount of chemically inactive gas such as nitrogen or argon to prevent oxidation and evaporation of the filament and hence prolong the life of the filament of an electric bulb.

7. If air were used in an electric bulb the filament, which becomes extremely hot when the light is on, would rapidly oxidise and burn out in seconds. Instead the bulb is filled with argon, which is inert.

8. Heating effect.

9. The maximum current which can flow through a fuse without melting it, is called its rating of a fuse.

10. Electric heater and electric toaster.

11. Filament bulbs are inefficient because most of the power consumed by the filament is emitted as heat and only a small part of electric power is emitted as light. On the other hand, fluorescent tubes are about three times as efficient as filament bulbs. Although initially more expensive than tungsten filament bulbs, the running costs are far less because the current consumed is less, they give more light and also last longer.

12. The cord of a heating element does not glow because it has negligible resistance, meaning that its resistance is very low, and it conducts electricity. But the heating element glows when electric current is passed through it because of its high resistance.

13. The heating elements of electric toasters and electric iron made of an alloy not a metal because an alloy has a very large resistance, so a large amount of electric energy is converted into a large amount of heat energy and has a high melting point, so it can be heated till red hot without melting.

14. The heating element of the heater is made up of alloy which has very high resistance so when current flows through the heating element, it becomes too hot and glows red. But the resistance of cord which is usually of copper and alluminium is very low so it does not glow.

C. Short Answer Type-I Questions

1. Electric heater, electric toaster

2. When voltage is applied to the bulb, electric current flows through the tungsten filament of the electric bulb. The filament gets heated to a high temperature and soon becomes hot and starts emitting light.

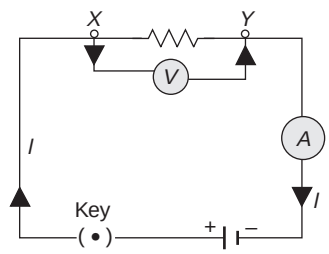
3. Filament bulbs are inefficient because most of the power consumed by the filament is emitted as heat and only a small part of electric power is emitted as light. On the other hand, fluorescent tubes are about three times as efficient as filament bulbs. Although initially more expensive than tungsten filament bulbs, the running costs are far less because the current consumed is less, they give more light and also last longer.

4. An electric fuse is a safety device consisting of a piece of thin wire of material (generally an alloy of tin and copper) having a low melting point and a high resistance, which melts and breaks the circuit if the current exceeds a safe value, hence, preventing the electrical appliances in the circuit from getting damaged.

D. Short Answer Type-II Questions

1. Consider a conductor XY of resistance $R\ \Omega$. Let the potential difference (in volts) be applied across the ends of XY. Let the steady current (in amperes) that passes from end X to end Y be I. If this current flows for t seconds, then the amount of electric charge transferred from point X to Y is

$$Q = I \times t \qquad \text{... (1)}$$



When electric charge Q moves against a potential difference V, the amount of work done (W) is given by

$$W = Q \times V \qquad \text{... (2)}$$

According to Ohm's law, $R = \frac{V}{I}$

or potential difference, $V = I \times R$ ... (3)

Now substituting the values of Q from equation (1) and V from equation (3) in equation (2), we get

$$W = I \times t \times I \times R$$

or $$H = I^2 \times R \times t \qquad \text{... (4)}$$

Equation (4), i.e. $H = I^2Rt$ is known as Joule's law of heating.

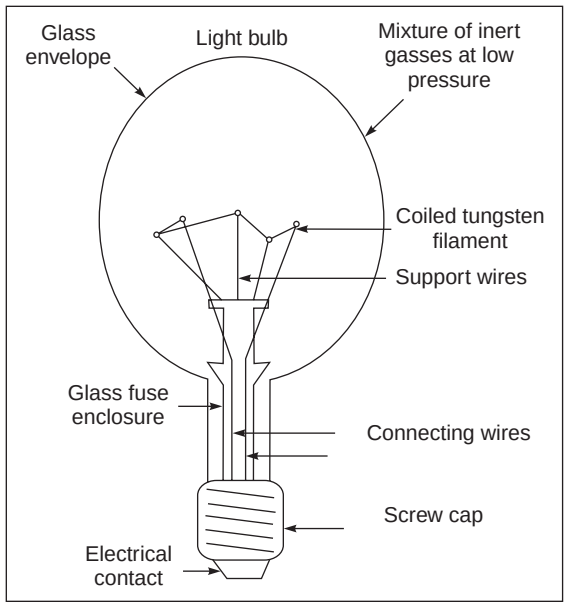
2. We know $H = I^2Rt$. Therefore, heat produced will be **a.** tripled if the time is tripled and **b.** will be reduced to one third if the time is reduced by one third.

3. **i.** It has a very large resistance, so large amount of electric energy is converted into a large amount of heat energy.

ii. It has a high melting point, so it can be heated till red hot without melting.

iii. It does not get oxidised (burnt away) easily even at a high temperature. (1000 °C)

4. Structure of an electric bulb.



5. Tungsten is used to make the filament of the bulb because

i. It has a very high resistance (high value of resistivity), so a large amount of electrical energy is converted into a large amount of heat energy.

ii. It has a high melting point (3380 °C), so it can be heated till red hot without melting.

iii. It does not get oxidised (burnt away) easily even at a high temperature (2500 °C).

E. Numerical Problems

1. Current drawn (I) = 5 A

Time (t) = 5 min = 5 × 60 s = 300 s

Resistance (R) = 80 Ω

Energy drawn (H) = ?

$$H = I^2Rt$$

$H = (5)^2 \times 80 \times 5 = 25 \times 80 \times 300$

= 600000 J = 600 kJ

2. Current drawn (I) = 10 A

Time (t) = 1 h = 3600 s

Resistance (R) = 80 Ω

Rate of generating heat per second

$$H = I^2Rt$$

$H = (10)^2 \times 80 \times 1 = 100 \times 80 \times 3600$

= 28800000 J.

Rate at which heat is developed = $\frac{28800000 \text{ J}}{3600 \text{ s}}$

= 8000 J/s

3. Charge (Q) = 80000 C

Potential difference (V) = 40 V

Heat produced = QV

= 80000 × 40 = 3200000 J = 3200 kJ

4. Charge (Q) = 90000 C

Potential difference (V) = 60 V

Heat produced = QV

= 90000 × 60 = 5400000 J = 5400 kJ

5. Resistance of toaster = 80 Ω

Current drawn = 10 A

Time = 2 min = 120 s

Heat developed (H) = ?

$$H = I^2Rt$$

$H = (10)^2 \times 80 \times 120 = 96000$ J = 960 kJ

6. Resistance = 100 Ω

Current drawn = 0.5 A

Time = 10 min = 600 s

Heat developed per second (H) = ?

$$H = I^2Rt$$

$H = (0.5)^2 \times 100 \times 1 = 25$ J/s

7. Suppose the resistance of each of the two wires be R. When the two resistance wires are connected in series, total resistance

$$R_S = R + R = 2R$$

When the two resistance wires are connected in parallel, total resistance

$$\frac{1}{R_P} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R}$$

$$R_P = \frac{R}{2}$$

Current produced = I

Time for which current flows = t

Therefore, heat produced when the wires are connected in series $H_1 = I^2 \times 2R \times t$

Heat produced when the wires are connected in parallel $H_2 = I^2 \times \frac{R}{2} \times t$

Ratio of heat produced in series and parallel combination will be

$$\frac{H_2}{H_1} = \frac{I^2 \times \frac{R}{2} \times t}{I^2 \times 2R \times t} = \frac{1}{4}$$

or $H_2 : H_1 = 1 : 4$

8. Given: Heat produced (H) = 400 J

Time (t) = 1 s

Resistance (R) = 4 Ω

Now, $H = I^2Rt$

$400\ J = I^2 \times 4\ \Omega \times 1\ s$

$I^2 = \frac{400\ J}{4\ \Omega \times 1\ s} = 100\ A$

$I = 10\ A$

$V = I \times R$

$= 10\ A \times 4\ \Omega = 40\ V$

P. 51-52 Check Your Progress 7

A. Multiple-choice Questions

1. a **2.** c **3.** c **4.** c **5.** c

B. Very Short Answer Type Questions

1. Electric power (P) can be defined as the rate of doing electric work.

2. Watt

3. One kilowatt hour is the amount of electrical energy consumed when an electrical appliance having a power rating of 1 kilowatt is used for 1 hour.

4. **a.** Power **b.** Electrical energy

5. One watt hour is the amount of electrical energy consumed when an electrical appliance having a power of 1 watt is used for 1 hour.

6. $P = I^2R$

7. $P = \frac{V^2}{R}$

8. **a.** 1000 W **b.** 10^6 W

9. The value of the voltage and electric power of an electrical appliance taken together is called its rating.

10. That it consumes 80 J of energy per second when a potential difference of 220 V is applied.

11. Power

C. Short Answer Type-I Questions

1. Relationship between electrical energy and electric power:

If V is the applied potential difference, I is the current flowing in the circuit and t is the time for which current is flowing in the circuit, then we know

$E = V \times I \times t$

and also, $P = V \times I$

$\therefore$ From the above two equations $E = P \times t$

2. **a.** Horsepower **b.** kilowatt-hour

4. Relationship between SI unit of electrical energy and commercial unit of electrical energy:

We know that SI unit of electrical energy is joule and the commercial unit of electrical energy is kilowatt-hour.

1 kilowatt-hour (1 kWh) = 1 kW × 1 h

= 1000 W × 1 h

= 1000 J/s × (60 × 60) s

= 1000 J/s × 3600 s

$= 3.6 \times 10^6$ J

1 kWh = 3.6×10^6 J

D. Short Answer Type-II Questions

1. Power of TV set = 200 W

Time = 4 h

$E = P \times t = 200 \times 4 = 800$ J

Power of electric motor = 600 W

Time = 2 h

$E = P \times t = 600 \times 2 = 1200$ J

Electric motor uses more energy.

2. Potential difference (V) = 220 V

Current (I) = 20 A

Power of bulb = 10 W

Power = $V \times I$

$P = 220 \times 20 = 4400$ W

So, maximum power = 4400 W

Power of each bulb = 10 W

Let the number of bulbs be n.

So, the number of bulbs connected in parallel

$n = \frac{4400}{10} = 440$ bulbs.

E. Numerical Problems

1. Power of the bulb = 100 W

Time = 10 h

$E = P \times t = 100 \times 10 = 100$ J

Power of AC = 1500 W

Time = 1 h

$E = P \times t = 1500 \times 1 = 1500$ J

$\therefore$ AC uses more energy.

2. Potential difference (V) = 220 V

Current (I) = 10 A

Maximum power = $V \times I = 220 \times 10 = 2200$ W

Power of each bulb = 10 W

Let the number of bulbs be *n.*

So, the number of lamps connected in parallel

$$n = \frac{2200}{10} = 220 \text{ bulbs.}$$

3. Potential difference (V) = 220 V

Power of lamp = 100 W

Power of television set = 250 W

We know, Power = $V \times I$

For lamp, $P = V \times I_1$

$$100 = 220 \times I_1$$

$$I_1 = \frac{100}{220} = \frac{10}{22}$$

For television set, $P = V \times I_2$

$$I_2 = \frac{250}{220} = \frac{25}{22}$$

Total current = $I_1 + I_2$

$$= \frac{10}{22} + \frac{25}{22} = \frac{35}{22}$$

= 1.59 A

4. Power = 2000 W = 2 kW

Potential difference = 220 V

The geyser is run for 2 hours everyday, i.e. 30 × 2 = 60 hours in month.

Using the formula $E = P \times t$

$$E = 2 \times 60$$

E = 120 kWh

Charge per unit = ₹ 4

Monthly bill = 120 × 4 = ₹ 480.

5. Power of the bulbs = 100 W, Number of bulbs = 5, Total power = 5 × 100 = 500 W

Energy consumed per day $E = P \times t$ = 500 × 6 = 3000 Wh or 3 kWh

Energy consumed per month = 3 × 30 = 90 kW

Power of the heater = 1500 W

Time = 2 hours per day, i.e. 2 × 30 = 60 hours per month

Energy consumed = $P \times t$ = 1500 × 60 = 90000 Wh or 90 kWh

Total energy consumed = 90 + 90 =180 kWh

Rate per unit = ₹ 4

Cost = 4 × 180 = ₹ 720

6. Power of geyser (P) = 1500 W

Potential difference (V) = 220 V

Power (P) = $V \times I$

$$1500 = 220 \times I$$

$$I = \frac{1500}{220} = \frac{75}{11}$$

Power of electric iron = 400 W

Potential difference = 220 V

Power (P) = $V \times I$

$$400 = 220 \times I$$

$$I = \frac{400}{220} = \frac{20}{11}$$

$$\text{Total current} = \frac{75}{11} + \frac{20}{11} = \frac{95}{11} = 8.636 \text{ A}$$

= 8.64 A

7. Power of electric bulb = 60 W

Power of 4 bulbs = 4 × 60 = 240 W

8. Power of heater = 1000 W

Current = 4 A

$$\text{Voltage} = \frac{1000}{4} = 250 \text{ V}$$

9. a. Resistance of toaster = 50 W

Current drawn = 5 A

Voltage = IR = 50 × 5 = 250 V

Power = $V \times I$ = 250 × 5 = 1250 W

b. Potential difference is 250 V.

10. Power of electric heater (P) = 1470 W

Resistance (R) = 30 Ω

a. $P = V \times I$

$V = IR$

Now $P = I^2 \times R$

$$1470 \text{ W} = I^2 \times 30 \ \Omega$$

$$I^2 = \frac{1470 \text{ W}}{30 \ \Omega} = 49 \text{ A}$$

I = 7 A

b. $P = V \times I$

We know, $I = \frac{V}{R}$

$$P = V \times \frac{V}{R}$$

$$1470 = \frac{V^2}{30}$$

$$V^2 = 30 \times 1470 = 44100$$

$$V = \sqrt{44100} = 210 \text{ V}$$

11. a. Power of electric motor = 1.5 kW = 1500 W

Potential difference = 250 V

Current flowing = ?

$$P = V \times I$$

$$1500 = 250 \times I$$

$$I = \frac{1500}{250} = 6 \text{ A}$$

b. Energy consumed per second

$= P \times t$

$= 1500 \times 1 = 1500$ J

c. Time taken to consume 90 kWh of energy at the rate of 1500 J/s

$$= \frac{90000 \times 3600}{1500} = 60 \times 3600 \text{ s} = 60 \text{ h}$$

12. Resistance of electric oven = 20 Ω

Current = 10 A

Working duration per day = 3 h

Working duration per month = 3 × 30
= 90 h

Power = I^2Rt

$= (10)^2 \times 20 \times 90 = 180000$ Wh $= 180$ kWh

Cost of 1 kWh = ₹ 4

∴ Cost of 180 kWh = 180 × 4 = ₹ 720

13. Power of electric heater = 2.2 kW = 2200 W

Potential difference = 220 V

a. Current = ?

$$P = V \times I$$

$$2200 = 220 \times I$$

$$I = 10 \text{ A}$$

b. Resistance of the heater = $R = \frac{V}{I}$

$$R = \frac{220}{10} = 22\ \Omega$$

c. Energy consumed in 2 hours = $P \times t$
= 2.2 kW × 2 = 4.4 kWh.

d. 1 kWh is priced at ₹ 5

∴ Cost of 4.4 kWh = 4.4 × ₹ 5 = ₹ 22

14. Number of tubelights = 6

Power of each tubelight = 40 W

Power of six tubelights = 6 × 40 = 240 W

Time = 10 hours/day

= 10 × 30 = 300 h

Energy consumed = $P \times t$

= 240 × 300 = 72000 Wh = 72 kWh

Number of fans = 4

Power of each fan = 100 W

Power of four fans = 4 × 100 = 400 W

Time = 10 hours per day
= 10 × 30
= 300 hours per month

Energy consumed = 400 × 300 = 120000 Wh
= 120 kWh

Total energy consumed = 72 + 120 = 192 kWh

Cost per unit = ₹ 3

Cost of 192 units = 3 × 192 = ₹ 576.

P. 53 Higher Order Thinking Skills (HOTS) Questions

A. Multiple-choice Questions

1. a **2.** d **3.** c **4.** c **5.** b

B. Very Short Answer Type Questions

1. Alloys have higher resistivity.

2. (d) and (f)

C. Short Answer Type-I Questions

1. Thin wire because $R = \rho\frac{l}{A}$. That means the resistance is inversely proportional to area of cross section, i.e., to the thickness. Hence, the thinner the wire the greater the resistance.

2. Resistance of one resistor $R_1 = 5\ \Omega$

Resistance of second resistor $R_2 = 10\ \Omega$

Let the potential difference be V

Current flowing through $R_1 = I_1 = \frac{V}{R_1} = \frac{V}{5}$

Current flowing through $R_2 = I_2 = \frac{V}{R_2} = \frac{V}{10}$

$$\frac{I_1}{I_2} = \frac{V}{R_1} \div \frac{V}{R_2}$$

$$= \frac{V}{5} \div \frac{V}{10} = \frac{V}{5} \times \frac{10}{V} = \frac{2}{1}$$

Therefore the ratio = 2 : 1.

3. The resistivity will get reduced by one-fourth.

4. Let the length of longer wire be l_1

Let the resistivity be R_1

Let the length of short wire be l_2

Let the resistivity be R_2

$$R_1 = \frac{\rho l_1}{A}$$

$$R_2 = \frac{\rho l_2}{A}$$

$$\frac{R_1}{R_2} = \frac{\rho l_1}{A} \div \frac{\rho l_2}{A}$$

$$= \frac{\rho l_1}{A} \times \frac{A}{\rho l_2} = \frac{l_1}{l_2} = 3 : 1$$

Since resistance is directly proportional to length, the ratio of the resistances will also be in the ratio 3 : 1.

5. We know $R = \frac{\rho l}{A}$, $\rho = \frac{RA}{l}$. Since the resistivity is inversely proportional to length, if the length increases by three times, the resistivity will get reduced by one third.

6. By separating positive and negative charges.

7. Resistance is the action of opposing flow of electric current whereas a resistor is an electrical device that resists the flow of electrical current.

8. The wire is bent to form a closed circle. So, the two parts are connected in parallel (because different amount of current will flow through them).

So, equivalent resistance

$$\frac{1}{R} = \frac{1}{20} + \frac{1}{20}$$

$$\frac{1}{R} = \frac{2}{20}$$

$$R = \frac{20}{2} = 10\ \Omega$$

9. Less heat is generated in long electric cable wires because they are good conductor of electricity and allow easy flow of charge. They are generally made of copper or aluminium which have low resistivity but the filament of the bulb is made of tungsten which has high resistivity and does not allow easy flow of charge and gets heated quickly.

10. 25 W bulb, twice that of 50 W because $P = \frac{V^2}{R}$

11. If ammeter is a low resistance device. If it is connected in parallel, it will burn out because of the large amount of current flowing.

12. It gets split up between each row depending on its resistance.

13. Potential difference.

D. Short Answer Type-II Questions

1. Resistance of wire A, $R = \frac{\rho l}{A} = \frac{\rho l}{\pi r^2}, \frac{1}{R} = \frac{\pi r^2}{\rho l}$

Resistance of wire B

$$= \frac{\rho 2l}{A} = \frac{\rho 2l}{\pi(2r)^2} = \frac{\rho l}{2\pi r^2}, \frac{1}{R} = \frac{4\pi r^2}{\rho l}$$

Since they are connected in parallel,

$$\frac{1}{R_P} = \frac{\pi r^2}{\rho l} + \frac{4\pi r^2}{\rho l} = \frac{5\pi r^2}{\rho l},\ R_P = \frac{\rho l}{5\pi r^2}$$

Ratio of total resistance to resistance of A

$$= \frac{R_P}{R} = \frac{\rho l}{5\pi r^2} \div \frac{\rho l}{\pi r^2} = 1 : 5.$$

2. When the physical conditions are constant.

3. Their resistances will be different because $R = \frac{\rho l}{A}$, it depends on the length and area of cross section.

4. No

5. T_1 is at higher temperature because the $\frac{V}{I}$ value which is equal to the resistance is higher for T_1 and we know that resistance of a metal increases with increase in temperature.

6. **a** is correctly labelled because the parallel combination always yield less resistance than series. The $\frac{V}{I}$ value (i.e. resistance) for parallel combination in **a** is less than that for series. But in **b**, the series combination is labelled to have less resistance than that of parallel which is incorrect.

P. 54-60 Exercises

A. Objective type Questions

I. Multiple-choice Questions

1. a	**2.** b	**3.** a	**4.** d	**5.** b
6. a	**7.** c	**8.** b	**9.** d	**10.** a

II. Fill in the blanks

1. voltage, electrical power

2. External resistance, internal resistance

3. rating

4. Ammeter

5. electrical cell

III. Assertion–Reasoning Type Questions

1. a	**2.** c	**3.** b	**4.** d	**5.** a
6. c	**7.** a	**8.** b	**9.** d	**10.** c

IV. Very Short Answer Type Questions

1. The coulomb is the SI derived unit of electric charge. It is defined as the charge transported by a steady current of one ampere in one second.

2. Volt.

3. Scalar

4. Coulomb

5. That means one joule of work is done to move a charge of one coulomb from A to B.

6. The potential difference is measured by means of an instrument called the voltmeter.

The voltmeter is always connected in parallel across the points between which the potential difference is to be measured

7. The resistance of a voltmeter should be high because voltmeter is always connected in parallel across a device.

8. The only condition required for a current to flow in conductor is the presence of potential difference.

9. Resistivity of a material is the resistance offered by 1 m length of the wire of the material having an area of cross section of 1 m^2.

10. Silver

11. Because tungsten has high resistivity.

12. Nichrome.

13. 100 W filament bulb

14. It has low resistance.

15. Bulb

16. Both will have same diameter.

17. Resistivity will become half.

18. Electrons

19. Watt

20. Kilowatt-hour (kWh)

B. Short Answer Type-I Questions

1. Ohm's law is not obeyed if the physical conditions like temperature, pressure, etc. do not remain constant.

2. Power = 1 kW = 1000 W

Potential difference = 220 V

Current (I) = ?

$$P = V \times I$$

$$I = \frac{P}{V}$$

$$= \frac{1000}{220} = 4.55 \text{ A}$$

3. Current = 5 A

Resistance = 44 Ω

Time 5 min = 300 s

Power = I^2Rt

$= (5)^2 \times 44 \times 300 = 330000 \text{ J} = 330 \text{ kJ}$

4. 60 W bulb will have higher resistance because power is inversely proportional to resistance.

5. Power of bulb = 200 W

Time = 2 h

Energy = $P \times t = 200 \times 2 = 400 \text{ Wh} = 0.4 \text{ kWh}$

6. Energy = $P \times t$

Units consumed = 60 (that is the energy)

Therefore, $E = 60$ kWh

Time = 120 min = 2 hours per day = 2×30 hours per month = 60 h

$$E = P \times t$$

$$60 = P \times 60$$

$$P = 1 \text{ kW}$$

7. Silver because it has higher resistance.

8. Given: Length of wire (l) = 5 m

Cross-sectional area, $A = 0.01 \text{ mm}^2$

$$= 0.01 \times 10^{-6} \text{ m}^2$$

Resistivity (ρ) $= 50 \times 10^{-8}$ Ω m

Using formula

$$R = \frac{\rho \times l}{A}$$

$$= \frac{50 \times 10^{-8} \Omega \text{ m} \times 0.5 \text{ m}}{0.01 \times 10^{-6} \text{ m}^2}$$

$$= 250 \ \Omega$$

C. Short Answer Type-II Questions

1. Current flowing in the circuit

Total resistance = 5 Ω + 8 Ω + 12 Ω = 25 Ω

Potential difference $V = 6$ V, Current I = ?

$$\frac{V}{I} = R$$

$$\frac{6}{I} = 25 \ \Omega,$$

Therefore, $I = \frac{6}{25} = 0.24$ A

The ammeter will show the reading of 0.24 A.

Potential difference across 12 Ω resistor:

$I = 0.24$ A, $R = 12$ Ω, V = ?

$V = IR = 0.24 \times 12 = 2.88$ V

The voltmeter will show the reading of 2.88 V.

2. The electric current I flowing through a conductor is directly proportional to the potential difference V across its ends, provided the physical conditions remain constant. (see Fig. 1.17, P-16 of textbook for diagram).

3. $V = IR$. **a.** SI unit of resistance is Ω, **b.** SI unit of resistivity is Ω m. Refer pages 18–19 for activity.

4. Given: Cross-sectional area (A) $= 4 \times 10^{-6}$ m^2

Resistivity (ρ) $= 1.6 \times 10^{-8}$ Ω m

Resistance (R) = 10 Ω

Length (l) = ?

Using formula

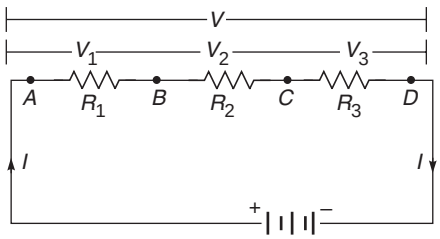
$$l = \frac{R \times A}{\rho}$$

$$= \frac{10\ \Omega \times 4 \times 10^{-6}\ m^2}{1.6 \times 10^{-8}\ \Omega\ m}$$

$$= 2500\ m$$

If diameter is doubled, then radius will be doubled, so resistance will be doubled.

5.



Determination of equivalent resistance ($R_s = R_1 + R_2 + R_3 + ...$)

Consider three resistors of resistance R_1, R_2 and R_3 respectively connected in series. Let I be the current flowing through each resistor and V be the potential difference across the series combination. If V_1, V_2 and V_3 be the potential differences across the resistors R_1, R_2 and R_3 respectively, then

$$V = V_1 + V_2 + V_3 \quad ... (1)$$

By Ohm's law, $V_1 = IR_1$, $V_2 = IR_2$ and $V_3 = IR_3$ or

$$V = I(R_1 + R_2 + R_3) \quad ... (2)$$

If R_s be the effective or equivalent resistance of the series combination, then

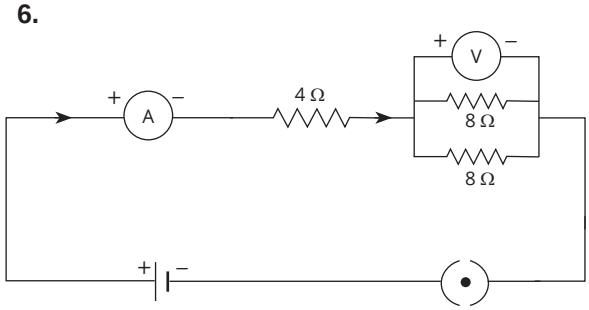
$$V = IR_s \quad ... (3)$$

From equations (2) and (3), we get

$$IR_s = I(R_1 + R_2 + R_3)$$

$$R_s = R_1 + R_2 + R_3.$$

6.



We know that $P = I^2R$

$$I^2 = \frac{P}{R}$$

Maximum current through 4 Ω resistor

$$I = \sqrt{\frac{P}{R}} = \sqrt{\frac{16}{4}} = 2\ A$$

$$I = \frac{V}{R}$$

Maximum current through each of the 8 Ω resistor = $\frac{1}{2} \times 2 = 1$ A

7. Power of electric bulb = 100 W

Potential difference = 230 V

Time = 20 min = 20 × 60 = 1200 s

$E = P \times t = 100 \times 1200 = 120000 = 1.2 \times 10^5$ J.

8. Number of lamps = 10

Power of each lamp = 60 W

Power of 10 lamps = 60 × 10 = 600 W

Time in a month = 5 hours per day = 5 × 30

= 150 h

$E = P \times t$

= 600 W × 150 h

= 90,000 W

= 90 kWh

9. Electrical resistivity is the opposite of electrical conductivity. It is the measure of a material's ability to oppose the flow of current

For the figure (a.), we have been provided with the following information:

Length of the cylinder L

Cross sectional area of the cylinder = A

Now we will simply put these values in the formula to find out resistance

So, we get $R_a = \frac{\rho L}{A}$

For the figure (b.), we have been provided with the following information:

Length of the cylinder = $3L$

Cross sectional area of the cylinder = $\frac{A}{3}$

Now we will simply put these values in the formula to find out resistance

So, we get $R_b = \frac{\rho 3L}{A/3} = \rho \frac{L}{A}$

For the figure (c.), we have been provided with the following information:

Length of the cylinder = $\frac{L}{3}$

Cross sectional area of the cylinder = $3A$

Now we will simply put these values in the formula to find out resistance

So, we get $R_c = \rho\frac{L}{3} \times 3A = \rho LA$

Therefore, we can arrange the resistances in the following order

$$R_b > R_a > R_c$$

10. When connected in series

$$R_1 + R_2 = 16 \quad \text{... (1)}$$

When connected in parallel

$$\frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{3}$$

$$\frac{R_2 + R_1}{R_1 R_2} = \frac{1}{3}$$

Substituting the values of $(R_1 + R_2)$ in the above equation $\frac{16}{R_1 R_2} = \frac{1}{3}$

$$48 = R_1 R_2$$

From equation (1), $R_2 = 16 - R_1$

Therefore, $48 = R_1 \times (16 - R_1)$

$$48 = 16 R_1 - R_1^2$$

$$R_1^2 - 16R_1 + 48 = 0$$

$$R_1 = \frac{(-16) \pm \sqrt{(16)^2 - 4 \times 1 \times 48}}{2 \times 1}$$

$$= \frac{-16 \pm \sqrt{256 - 192}}{2}$$

$$= \frac{-16 \pm \sqrt{64}}{2} = \frac{16 - 8}{2} = \frac{8}{2} = 4$$

$R_1 = 4\ \Omega$

$R_2 = 16 - 4 = 12\ \Omega$.

11. Power of the bulb = 100 W

Potential difference = 200 V

$$P = V \times I$$

$$100 = 200 \times I$$

$$I = \frac{100}{200} = 0.5 \text{ A}$$

$$V = IR$$

$$200 = 0.5 \times R$$

$$R = \frac{200}{0.5} = 400\ \Omega$$

Power of 5 such bulbs = 5 × 100 = 500 W

Time = 4 h

Energy = 500 × 4 = 2000 Wh

Cost per unit = ₹ 5

Cost for 2 kWh = 2 × ₹ 5 = ₹ 10.

12. Resistance of each resistor = 2 Ω

When connected in series,

Total resistance = 2 + 2 = 4 Ω

Potential difference V = 12 V

We know $V = IR$

Therefore, current $I = \frac{V}{R} = \frac{12}{4} = 3$ A

Power $P = V \times I = 12 \times 3 = 36$ W

When connected in parallel, $\frac{1}{R} + \frac{1}{R} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2}$

$= 1,$

$R = 1\ \Omega$

Potential difference V = 12 V

We know $V = IR$

Therefore, current $I = \frac{V}{R} = \frac{12}{1} = 12$ A

Power $P = V \times I = 12 \times 12 = 144$ W

Ratio of power in series to parallel

= 36 : 144 = 1 : 4

13. Given: Power of electric oven (P) = 1.5 kW

Potential difference (V) = 220 V

Current (I) = 5 A

We have, $P = V \times I$

or, $I = \frac{P}{V}$

$= \frac{1500 \text{ W}}{220 \text{ V}} = 6.8$ A

Here, current drawn by the electric oven is 6.8 A which is more than 5 A. Therefore, electric fuse will melt and break the circuit.

14. From Joule's Law of heating, $P = \frac{V^2}{R}$

For first lamp, $R_1 = \frac{220^2}{100} = 484\ \Omega$

For second lamp, $R_2 = \frac{220^2}{200} = 242\ \Omega$

a. When they are connected in series,

When lamps are connected in series , equivalent resistance = 484 + 242 = 726 Ω

Hence current drawn by lamps that are

connected in series = $\frac{220}{726}$ = 0.3 A

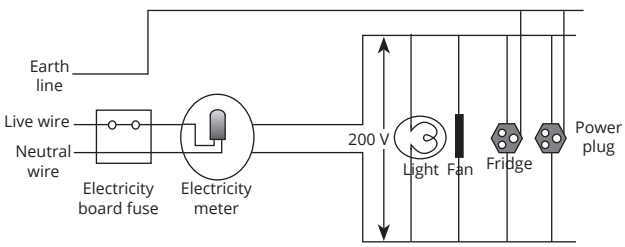
b. When lamps are connected in parallel, each lamp draws current independently as per its wattage.

Current drawn by 100 W lamp = $\frac{100}{220}$ = 0.45 A

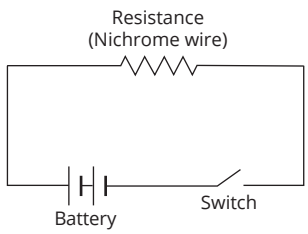
Current drawn by 200 W lamp = $\frac{200}{220}$ = 0.91 A

Hence total current drawn by lamps when they are connected in parallel = 0.45 + 0.91 = 1.36 A

15.



16. The *V*–*I* graph for a nichrome wire shows a straight line, which means the resistance of the wire remains constant when the current supply is changed (the slope of the graph represents the resistance).



Also, we can conclude that the current flowing through the wire is directly proportional to the potential difference *V* across it.

The resistance of the wire can be calculated as

$$R = \frac{V}{I} = \frac{0.4}{0.1} = 4\ \Omega$$

Thus, the nichrome wire has a constant resistance of 4 Ω, and it follows the Ohm's law, therefore, it is considered an ohmic conductor.

17. Mathematical expression for Joule's law of heating is : $H = I^2RT$

Charge (Q) = 96000 C,

Time (t) = 2 h = 2 × 60 × 60 = 7200 s

Potential difference (V) = 40 V , Current (I) = ?

$$I = \frac{Q}{T} = \frac{96000}{7200} = \frac{80}{6}\ \text{A}$$

Let us calculate the quantity of heat generated by using the formula

$$H = V \times I \times t = 40 \times \frac{80}{6} \times 7200$$

H = 3840000 J

Therefore, the heat generated is 3840000 J.

D. Long Answer Type Questions

1. a. Refer Figure 1.30 of the book page no. 31.

The three resistors of resistance R_1, R_2, and R_3 respectively connected in parallel.

Let V be the potential difference across each resistor. The current I drawn from the cell divides into three parts (i.e. I_1, I_2 and I_3) at junction point A. Let the current I_1, I_2 and I_3 flow through the resistors R_1, R_2 and R_3 respectively.

$\therefore \quad I = I_1 + I_2 + I_3$

Since the potential difference between the two ends A and B is V, therefore by Ohm's law,

Current in R_1 is $I_1 = \frac{V}{R_1}$

Current in R_2 is $I_2 = \frac{V}{R_2}$

Current in R_3 is $I_3 = \frac{V}{R_3}$

Now, $I = I_1 + I_2 + I_3$

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3} \qquad ...(1)$$

If the equivalent resistance of the combination between the points A and B is R_P

then $$I = \frac{V}{R_P} \qquad ...(2)$$

From equations (1) and (2) we get

$$\frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$= V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$\frac{1}{R_P} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

b. Equivalent Resistance $\frac{1}{R} = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

$$\frac{1}{R} = \left(\frac{1}{12} + \frac{1}{12}\right) = \frac{2}{12} = \frac{1}{6}$$

$R = 6\ \Omega$

Therefore, current $I = \frac{V}{R} = \frac{6}{6} = 1$ A

OR

Given $R_1 = 20\ \Omega \quad R_2 = 4\ \Omega, \quad V = 6$V

a. The total resistance of the circuit

$= R_1 + R_2 = 20\ \Omega + 4\ \Omega = 24\ \Omega$

b. The current through the circuit,

$$I = \frac{V}{R} = \frac{6}{24} = 0.25 \text{ A}$$

c. Potential difference across the (i) electric lamp $= V = IR = 0.25 \times 20 = 0.5$ V

Potential difference across the (ii) conductor $= V = IR = 0.25 \times 4 = 1$V

d. Power of the lamp. $P = I^2 \times R = (0.25)^2 \times 20 = 1.25$ W

2. a. When we change the position of ammeter to anywhere in between the resistor and note the reading of ammeter each time, the ammeter reading will remain same every time. Therefore the same current flows through every part of the circuit containing three resistors in the series.

b. The total resistance of the circuit $= R_1 + R_2 + R_3 = 5\ \Omega + 10\ \Omega + 15\ \Omega = 30\ \Omega$

$V = 30$ V

Current flowing in the circuit

$$= I = \frac{V}{R} = \frac{30}{30} = 1 \text{ amp}$$

Potential difference across the 15 Ω resistor

$= V = IR = 1 \times 15 = 15$ V

OR

a. Refer Figure 1.30 of the book page no. 31.

b. $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{20} + \frac{1}{20} = \frac{2}{20} = \frac{1}{10}$

$R_p = 10\ \Omega$

Equivalent resistance $= 10\ \Omega + 10\ \Omega = 20\ \Omega$

3. a. In series $R_S = R_1 + R_2 + R_3$

In parallel $= \frac{1}{R_P} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$

b. Minimum resistance $= \frac{12 \times 12}{12 + 12} = 6\ \Omega$

Power $P_1 = \frac{V^2}{R} = \frac{3 \times 3}{6} = 1.5$ W

Maximum resistance $= 12 + 12 = 24\ \Omega$

Power $P_2 = \frac{V^2}{R} = \frac{3 \times 3}{24} = 0.375$ W

Ratio of $\frac{P_1}{P_2} = \frac{1.5\,\text{W}}{0.375\,\text{W}} = 4$

OR

a. $R = \rho \frac{I}{A}$

Unit of resistivity $(\rho) = \frac{\text{ohm} \times (\text{metre})^2}{\text{metre}}$

$= \text{ohm} \times \text{metre}\ (\Omega\ \text{m})$

Thus, the SI unit of resistivity is ohm-metre which is written in symbol as Ω m.

b. $\text{R} = \rho \frac{I}{A}$

$100 = \rho \times \frac{5}{3 \times 10^{-7}}$

$\rho = \frac{100 \times 3 \times 10^{-7}}{5} = 6 \times 10^{-6}\ \Omega$ m.

4. a. When we change the position of ammeter to anywhere in between the resistor and note the reading of ammeter each time, the ammeter reading will remain same every time. Therefore the same current flows through every part of the circuit containing three resistors in the series.

b. Equivalent resistance $= \frac{24 \times 24}{24 + 24} + 12 = 24\ \Omega$

The current through 12 Ω resistor $= I = \frac{V}{R} = \frac{6}{24}$

$= 0.25$ A

The difference in the readings of the two resistors = 0 as they are connected in series.

OR

a. Electric power (P) can be defined as the rate of doing electrical work, or the rate at which electrical energy is consumed in an electric circuit.

i.e. Electric power $(P) = \frac{\text{Electrical work done}}{\text{Time taken}}$

or $P = \frac{E}{T}$

or $P = V \times I$

So, electric power is also defined as the product of the applied voltage and the current flowing through the circuit.

Electric power in terms of I and R

We know, $V = I \times R$ (from Ohm's law)

Substituting the value of V in the equation

$$P = V \times I$$

$$P = (I \times R) \times I = I^2R$$

b. For Bulb-1 Power = P = 100 W, Voltage = V = 220 V, Resistance = R

$$P = \frac{V^2}{R}$$

$$100 = \frac{220 \times 220}{R}$$

$$R = \frac{220 \times 220}{100} = 484\ \Omega$$

For Bulb-2

Power = P = 60 W, Voltage = V = 220 V, Resistance = R

$$P = \frac{V^2}{R}$$

$$60 = \frac{220 \times 220}{R}$$

$$R = \frac{220 \times 220}{60} = 806.7\ \Omega$$

As the resistors are connected in parallel, total resistance = $\frac{1}{R} = \frac{1}{484} + \frac{1}{806.7}$

R = 302.5 ohms

We know that $V = IR$

$$220 = I \times 302.5$$

$$I = \frac{220}{302.5} = 0.73$$

The current drawn is 0.73 A

5. A. 6 V battery in series with 1 ohm and 2 ohm resistors

Potential difference (V) = 6 V

The equivalent resistance of the circuit,

$$R = 1 + 2 = 3 \text{ Ohm}$$

According to Ohm's law, $V = IR$, $I = \frac{6}{3} = 2$ A

This current will flow through each component of the circuit because there is no division of current in series circuits. Hence, the current flowing through the 2 ohm resistor is 2 A.

Power is given by the expression,

$$P = I^2R = 2^2 \times 2 = 8 \text{ W}$$

B. 4 V battery in parallel with 12 ohm and 2 ohm resistors

Potential difference (V) = 4 V

The voltage across each component of a parallel circuit remains the same. Hence, the voltage across 2 ohm resistor will be 4 V.

Power consumed by 2 ohm resistor is given by

$$P = \frac{V^2}{R} = \frac{4^2}{2} = 8 \text{ W}$$

Therefore, the power used by 2 Ohm resistor is 8 W.

OR

Given P = 40 watts, V = 220 volt

$$P = VI \text{ and } I = \frac{P}{V} = \frac{40}{220} = 0.18 \text{ A}$$

$$R = \frac{V}{I} = \frac{220}{0.18} = 1222.2 \text{ ohms}$$

Yes, there will be change in current and resistance once replaced by a bulb having rating of 25 watt .

6. Refer to page 29 of the textbook.

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_P} = \frac{1}{1\ \Omega} + \frac{1}{6\ \Omega} + \frac{1}{4\ \Omega}$$

$$\frac{1}{R_P} = \frac{12\ \Omega + 2\ \Omega + 3\ \Omega}{12}$$

$$\frac{1}{R_P} = \frac{17\ \Omega}{12}$$

$$\therefore \quad R_P = \frac{12}{17}\ \Omega = 0.7\ \Omega$$

7. a. Resistance in series = 10 + 20 = 30 Ω

= 5 + 25 = 30 Ω

Total resistance in parallel $\frac{1}{R} = \frac{1}{30} + \frac{1}{30} = \frac{2}{30}$

R = 15 Ω

b. Potential difference = 12 V

Resistance = 15 Ω

Current I = ?

$V = IR$

$$I = \frac{V}{R} = \frac{12}{15} = 0.8 \text{ A}$$

8. a. Total resistance in series = 3 + 2 = 5 Ω

Total resistance = $\frac{1}{5} + \frac{1}{5} = \frac{2}{5}$

$$R = \frac{5}{2} = 2.5\ \Omega$$

b. Total resistance = 2.5 Ω

Potential difference = 2.5 V

Current I = ?

$$I = \frac{V}{R} = \frac{2.5}{2.5} = 1 \text{ A}$$

9. Power of electric bulb = 60 W

Time = 15 hours per day = 15 × 30 = 450 hours per month

Energy consumed = 60 × 450 = 27000 Wh

Power of electric heater = 750 W

Time = 10 hours per day = 10 × 30 = 300 hours per month

Energy consumed = 750 × 300 = 225000 Wh

Total energy consumed = 27000 + 225000

= 252000 Wh = 252 kWh

Cost per unit = ₹ 2

Cost for 252 units = 252 × 4 = ₹ 1008.

10. a. Potential difference = 5 V

Current = 500 mA = 0.5 A

Power = $V \times I = 5 \times 0.5 = 2.5$ W

Resistance = ?

$V = IR$

$5 = 0.5 \times R$

$R = 5/0.5 = 10\ \Omega$

b. Time = 4 h = 4 × 3600 s = 14400 s

Energy consumed = $P \times t$

= 2.5 × 14400 = 36000 J = 36 kJ.

11. a. Potential difference remains same when resistance R_1 and R_2 are connected in parallel. Current through R_1 and R_2 remains same, when they are connected in series.

b. i. Given that

$R_1 = 7\ \Omega, \quad R_2 = 5\ \Omega, \quad R_3 = 10\ \Omega$

R_2 and R_3 are in parallel connection.

So, $\frac{1}{R_P} = \frac{1}{R_2} + \frac{1}{R_3}$

$= \frac{1}{5\ \Omega} + \frac{1}{10\ \Omega}$

$= \frac{2+1}{10\ \Omega} = \frac{3}{10\ \Omega}$

$\therefore \quad R_P = \frac{10}{3}\ \Omega$

Resultant resistance = $R_1 + R_P$

$= 7\ \Omega + \frac{10}{3}\ \Omega$

$= \frac{21+10}{3} = \frac{31}{3}\ \Omega = 10.33\ \Omega$

ii. $R = 10.33\ \Omega$, $V = 6$ V, I = ?

Using Ohm's law

$$I = \frac{V}{R} = \frac{6 \text{ V}}{10.33\ \Omega} = 0.58 \text{ A}$$

iii. Given: $I = 0.58$ A

$R = 7\ \Omega$

V = ?

Using Ohm's law

$R = \frac{V}{I}$

$7\ \Omega = \frac{V}{0.58 \text{ A}}$

$V = 7\ \Omega \times 0.58$ A

= 4.06 V

12. a. The electrical resistance of a conductor depends on the following factors:

i. length of the conductor

ii. area of cross section of the conductor

iii. temperature of the conductor

iv. nature of material of the conductor

b. Given: $P = 4$ kW = 4000 W

$V = 220$ V

i. Electric current I = ?

Using formula, $P = V \times I$

$$I = \frac{P}{V} = \frac{4000 \text{ W}}{220 \text{ V}} = 18.18 \text{ A}$$

ii. Resistance (R) = ?

Using formula, $R = \frac{V}{I}$

$= \frac{220 \text{ V}}{18.18 \text{ A}} = 12.1\ \Omega$

iii. Electric energy consumed in 2 hours = ?

Using formula, $E = P \times t$

$E = 4000 \text{ W} \times 2 \text{ h}$

= 8000 Wh

= 8 kWh

13. Refer to page 41 of the textbook.

More heat will be produced when resistors are connected in series. As we know that heat produced in a conductor is directly proportional to the resistance of the conductor for a given current and time.

14. Refer to page 31 of the textbook.

More heat will be produced when resistors are connected in series. As we know that heat

produced in a conductor is directly proportional to the resistance of the conductor for a given current and time.

a. R_5 and R_1 are connected in series.

b. R_2 and R_3 are connected in parallel.

c. $2\ \Omega + 2\ \Omega + \frac{1}{2}\ \Omega + \frac{1}{2}\ \Omega + 2\ \Omega = 7\ \Omega$

F. Source-based/Case-based/Passage-based/ Integrated Assessment Questions

1. a. iii. 120 V, 60 Hz.

b. i. 220 V, 50 Hz.

c. iii. rheostat.

d. ii. 1 joule/1 coulomb.

e. ii. one-fourth (because $\pi = v^2/R$.)

2. a. iii. American Wire Gauge.

b. iii. 6.

c. ii. ohm-metre.

d. i. length or thickness.

e. iv. nichrome.

G. Value-Based Questions (Optional)

1. a. We should bear rubber slippers while working with electrical devices to prevent electric shocks. Rubber is an insulator of electric current.

b. Care for friend, scientific temperament, helpfulness.

2. a. As all the bulbs were connected in series.

b. LEDs consume less amount of energy in comparison to traditional bulbs.

3. a. Due to the heating effect of electric current, the bulb gets hot.

b. Care for others, use of scientific knowledge.

4. a. MCBs drip down themselves in the case of short-circuit or overload.

b. Scientific temperament, care for others, decision-making

5. a. LEDs consume less energy than filament bulbs.

b. Use of scientific knowledge, energy conservation, value for money, etc.

CHAPTER-2

MAGNETIC EFFECTS OF CURRENT

P. 66 Check Your Progress 1

A. Multiple-choice Questions

1. a **2**. d **3**. b **4**. b **5**. c

B. Very Short Answer Type Questions

1. The term magnetic effect of current means that an electric current flowing in a conductor (for example a wire) produces a magnetic field in the space around it.

2. The region surrounding a magnet, in which the force of a magnet can be detected is called its magnetic field.

3. The curved lines along which the irons filling align themselves represent magnetic field lines or magnetic lines of force.

4. Outside the magnet, the direction of the magnetic field lines is from its north pole to its south pole. Inside the magnet, the direction of the magnetic field lines is from its south pole to its north pole. Hence, the magnetic field lines are closed curves.

5. Yes.

6. Hans Christian Oersted.

7. A magnetic compass is an instrument having a small bar magnet which can turn freely on a pivot (or pin).

8. When a bar magnet is brought near a compass, it exerts a force on the poles of the compass needle (due to the magnetic field of the bar magnet) due to which the compass needle turns. The poles of the compass needle are either attracted or repelled from the bar magnet.

9. Iron filling method, compass needle method

10. Yes. Magnetic field lines have a definite direction and magnitude.

C. Short Answer Type-I Questions

1. a. A freely suspended magnet always points in the north – south direction (directive property).

b. A magnet attracts substances like iron, steel, nickel and cobalt by inducing magnetism in them (attractive property).

2. a. Each magnetic field line forms a closed curve.

b. The relative strength (magnitude) of the magnetic field is shown by the degree of closeness of the field lines.

c. The magnetic field lines emerge (come out) from north pole and merge at south pole.

d. Although magnetic field lines are not real yet represent a magnetic field which is real.

3. If two magnetic field lines intersect or cross each other, there would be two directions of magnetic field lines at that point of intersection which is not possible.

D. Short Answer Type-II Questions

1. a. Take a drawing board and fix a smooth white sheet of paper on it with the help of drawing pins.

b. Place a bar magnet in the middle of the white sheet.

c. Sprinkle fine powder of iron (iron filings) on it, such that it is spread evenly on the paper. A salt sprinkler can be used for this purpose.

d. Tap the drawing board gently. The iron filings rearrange themselves in the form of curves. These curves represent the magnetic lines of force. (Refer to fig. 2.4 P-64 of book)

2. a. Take a drawing board and fix a white sheet paper on it. Place a magnet on the white sheet and draw its boundary.

b. Now place a small compass needle close to the north pole of the magnet. The south pole of the compass needle points towards the north pole of the magnet. Then north pole of the compass needle is deflected away from the north pole of the magnet. Mark two dots exactly at the two ends of the needle. Mark the points as 1 and 2.

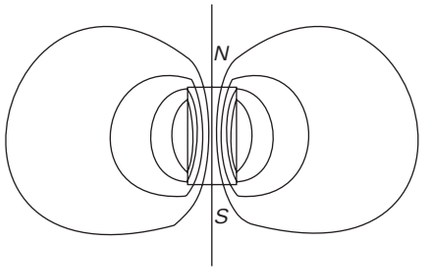
c. Now lift the compass and place it in such a way that its south pole occupies the position previously occupied by its north pole (point 2). Now mark the new end as point 3.

d. Repeat the process of moving the compass needle till the other end of the bar magnet is reached and you obtain points 4, 5, 6, 7, etc. Join the points to get a continuous curve. Thus one magnetic field line is traced.

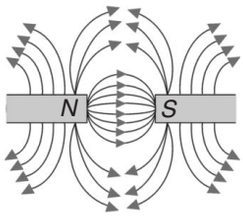
e. Repeat the process from the north pole of the magnet starting from a different point and trace another field line. These represent the magnetic field around the magnet. (Refer to fig 2.5, P-64 of the book)

3. To show how an electric current heated a wire, Oersted connected the wire to the terminals of a big battery. To his surprise, the needle of the compass which was placed near the wire swung around – only to swung back again to its normal position pointing north when the wire was disconnected.

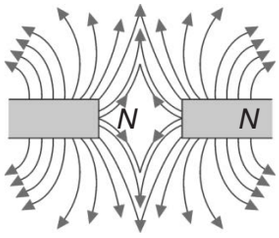
4. a.



b.



c.



P. 71-72 Check Your Progress 2

A. Multiple-choice Questions

1. b **2**. a **3**. b **4**. b **5**. d

B. Very Short Answer Type Questions

1. If a current carrying conductor is imagined to be held in the right hand such that the thumb points in the direction of current, then the tips of the fingers encircling the conductor will give the direction of the magnetic lines of force.

2. Distance from the conductor, radius of circular loop, strength of magnetic field, number of turns on circular loop.

3. By right hand thumb rule.

4. At a point below it, the direction of magnetic field will be south to north and at a point directly above it north to south.

5. By increasing current, increasing number of turns, reducing the radius.

6. a. from its north pole to its south pole

b. from its south pole to north pole

7. On increasing the strength of current in the conducting wire, the number of lines of force around it increases, space between the lines of force decreases (i.e lines of force become closer). Hence, the strength of the magnetic field is directly proportional to the current passing through the conductor.

C. Short Answer Type-I Questions

1. a. A current carrying conductor produces a magnetic field.

b. The larger the value of the current in the conductor, stronger is the magnetic field and vice versa.

c. It the direction of current through a conductor (say copper wire) is reversed, then the direction of magnetic field produced by the electric current is also reversed.

2. Properties of magnetic field lines around a straight current carrying conductor.

a. The magnetic field lines are in form of concentric circles around a straight conducting wire.

b. The plane of magnetic field lines is perpendicular or normal to the straight conductor.

c. When the direction of field is downwards, then the direction of field lines is clockwise.

d. When the direction of current is reversed, i.e. upwards, then the direction of the field lines is anti-clockwise.

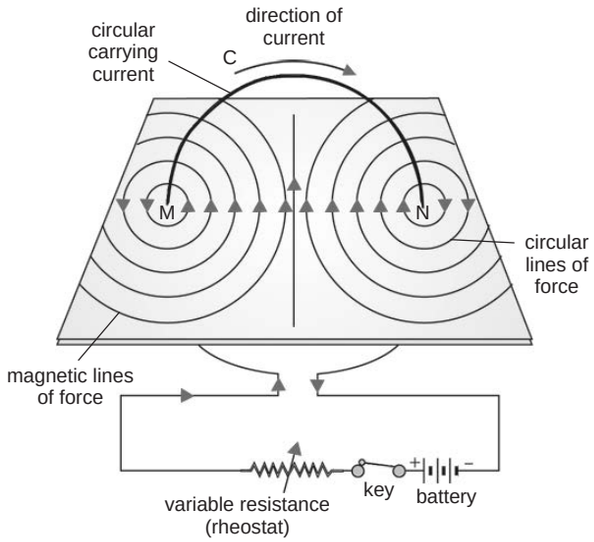
e. The strength of magnetic field lines around a straight current carrying conductor increases.

i. If strength of current (I) is increased, i.e. $B \propto I$.

iii. If distance from the conductor is reduced, i.e. $B \propto \frac{1}{r}$

3. The magnetic field lines are nearly circular near the wire. (i.e. near the points M and N)

a. The lines of force are in the same direction, i.e. in the upward direction within the space enclosed by the wire.



b. Near the centre of loop, the magnetic field lines are nearly parallel and straight and the magnetic field may be assumed to be practically uniform.

c. At the centre of the coil, the plane of magnetic lines of force is perpendicular to the plane of the circular coil.

4. Strength of current, number of turns in the circular coil and radius of the coil

D. Short Answer Type-II Questions

1. a. Magnetic field lines.

b. By right hand thumb rule and Maxwell corkscrew rule.

c. The direction of magnetic field lines is also reversed.

d. Space between lines decreases.

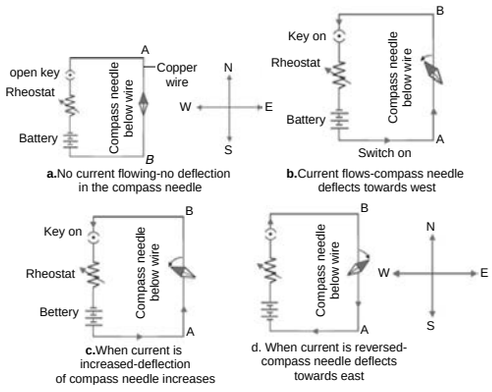
2. a. Take a thin insulated copper wire and fix it in such a way that the portion AB of the wire is in the north – south direction. Two ends of the wire are connected to a battery through a rheostat (to vary current) and plug key to switch the current on and off when required. A magnetic compass is kept directly below the wire AB. When the key is open, no current is flowing in the wire AB, the magnetic needle is parallel to the wire AB and points in the usual north–south direction. There is no deflection in the magnetic needle.

b. When the key is closed, the current flows in the wire in the direction A to B. It is found that the magnetic needle is deflected from its north–south position. The north pole N of the needle deflects towards the west.

c. If the current in the circuit is increased, the deflection of the needle also increases.

d. When the direction of current in the wire is reversed (by means of charging the terminals of the battery), the deflection of the needle is found to be in the opposite direction. The north pole N of the needle deflects towards the east when the current is passing from B to A. (Refer to fig 2.8, P-67)

3.



4. a. Take a sheet of stiff but smooth cardboard and pierce a hole through its centre.

b. Place the cardboard horizontally and pass a long straight thick copper wire vertically straight through the hole.

c. Connect the ends of the wire to an ammeter A (0-5 A), a battery B (12 V), rheostat and a plug key in series.

d. Sprinkle some iron filings uniformly (you may use a salt sprinkler for this purpose) on the cardboard. Close the key and allow the current to pass through the conducting wire. Gently tap the cardboard a few times.

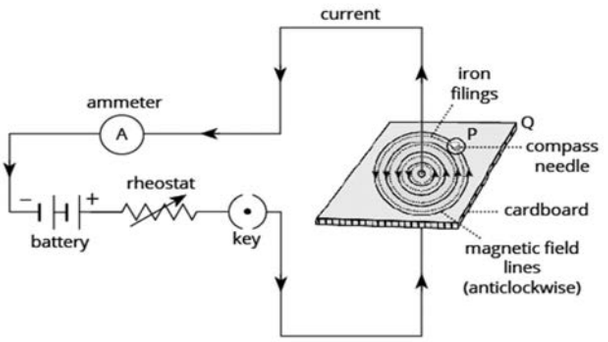
e. It is observed that the iron filings arrange themselves in concentric circles around the copper wire.

f. If a small compass needle is placed on the cardboard near the wire, the direction in which the north pole of the needle points, gives the direction of the magnetic field at that point produced by the electric current through the straight wire at point P. The current in the wire flows in the downward direction, then the direction of lines of magnetic field are in clockwise direction.

g. When the direction of current through the straight copper wire is reversed (by means of changing the terminals of the battery) the current in the wire flows in the upward direction, then the direction of lines of magnetic field are in anticlockwise direction.

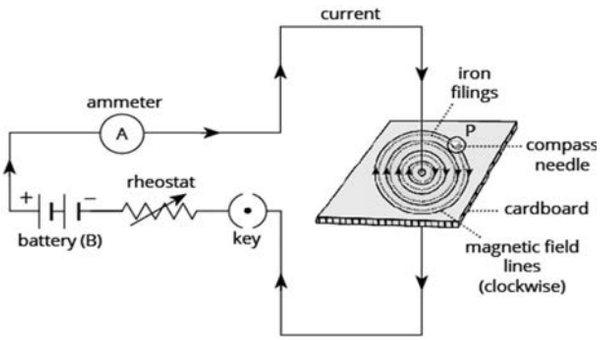
h. If the current in the circuit is increased (by means of a rheostat), the deflection of the needle also increases. It indicates that the magnitude of the magnetic field produced at a given point increases as the current through the wire increases.

i. Now place the magnetic compass at a farther point from the conducting wire. We see that the deflection in the needle decreases. Thus, the strength of magnetic field produced at a given point decreases as the distance of the point from the current carrying conductor increases. It can be noticed that the concentric circles representing the magnetic field around a current – carrying straight wire becomes larger and larger as we move away from it. (Refer to fig. 2.10 P-68 of the text-book)



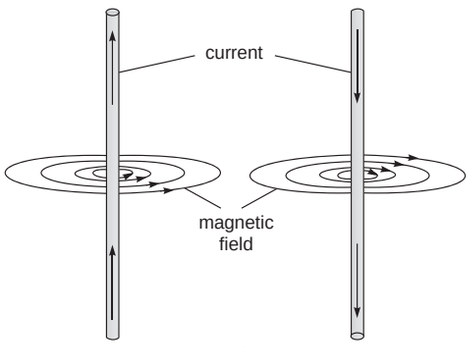
a. Upward direction of current → Anticlockwise direction of magnetic field lines

Magnetic field pattern due to a straight current-carrying wire



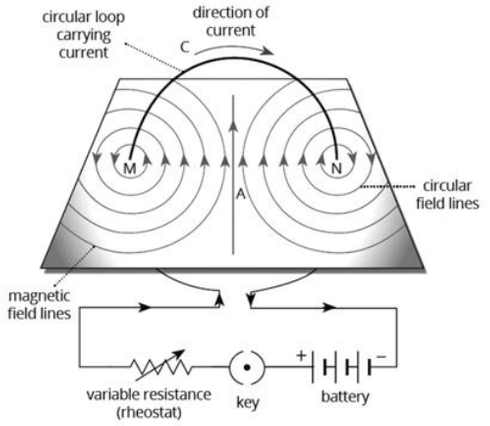
b. Downward direction of current → Clockwise direction of magnetic field lines

6. a.



Field pattern of straight wire

b.



Magnetic field due to current through a circular loop

P. 75-76 Check Your Progress 3

A. Multiple-choice Questions

1. a **2**. c **3**. c **4**. a **5**. d

B.Very Short Answer Type Questions

1. When current is passed through a solenoid, it behaves like a magnet and develops a magnetic field around it.

2. Similar to bar magnet.

3. As poles of magnet.

4. a. Points in north and south direction.

b. Attracts iron filings.

5. Strength of current, number of turns in the coil and nature of core material.

6. Magnetic lines of force inside the solenoid are nearly parallel to each other and parallel to the axis of solenoid.

7. By increasing the strength of current and number of turns.

8. a. An electromagnet gets demagnetised as soon as the current is switched off.

b. The strength of the magnetic field of an electromagnet can be easily changed by changing the strength of the current in the coil or the number of turns in the solenoid.

9. Clock rule states that:

a. If the current at a face facing us flows in clockwise direction, that face of the coil behaves like south pole.

b. If the current at a face facing us flows in anticlockwise direction, that face of the coil behaves like north pole.

c. The polarity of an electromagnet can be changed by reversing the direction of current in the solenoid.

C. Short Answer Type-I Questions

1. Properties of the magnetic field produced by a current carrying solenoid are:

a. A solenoid carrying current behaves like a bar magnet as its two ends act as the two poles of a magnet.

b. The magnetic field is uniform inside the solenoid.

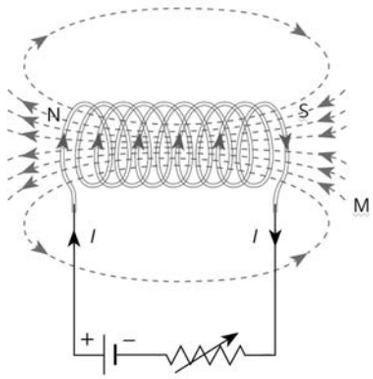
c. The intensity of magnetic field of a current carrying solenoid depends upon the number of turns in the coil and strength of current.

2. Magnetic field inside the solenoid is uniform. The magnetic lines of force inside the solenoid are parallel to each other and parallel to the axis of solenoid.

3. A solenoid behaves like a magnet in the following ways:
   a. The magnetic field produced by a current carrying solenoid is similar to the magnetic field produced by a bar magnet.
   b. If a current-carrying solenoid is suspended freely, it comes to rest pointing north and south like a suspended magnet.
4. a. Electromagnets are used in the construction of a large number of electrical devices like electric bells, loudspeakers, electric motors, electric fans, telephone instruments, etc.
   b. Electromagnets are used to lift and transport heavy loads like big machines, steel girders and scrap iron objects for loading and unloading purposes. Unloading of goods is done by switching off the current in the electromagnet.

D. Short Answer Type-II Questions

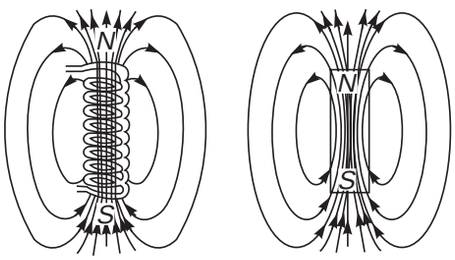
1. A coil of many circular turns of insulated copper wire wound closely in the shape of a cylindrical tube whose diameter is less in comparison to its length is called a solenoid.



Magnetic field inside the solenoid

The pattern of the magnetic field lines of a current carrying solenoid is similar to that of a bar magnet. They originate from north pole and ends at south pole.

2. The magnetic field produced by electric current in a solenoid coil is similar to that of a bar magnet.



3. The magnetic field is the same at all points inside a current carrying solenoid as the magnetic lines of force are parallel to each other and to the axis of the solenoid.
4. The polarity of solenoid can be determined with the help of a bar magnet. A solenoid when suspended moves freely. When we bring the north pole of a bar magnet near it, if the solenoid moves towards the magnet then that end is the south pole of the solenoid and if it moves away from the magnet then that end is the north pole.
5. It is usually prepared by placing a soft iron core in a solenoid, or by winding a large number of turns of an insulated wire (generally insulated copper wire) around a cylindrical soft iron core.
6.

Electromagnet	Permanent magnet
It shows temporary magnetism. It produces the magnetic field as long as current flow in its coil.	It shows permanent magnetism, i.e. it retains magnetism in it even when the current is switched off.
The polarity of an electromagnet can be changed by reversing the direction of the current.	The polarity of a permanent magnet cannot be changed.
The strength of the magnetic field can be increased or decreased by changing the strength of the current or the number of turns in the coil.	The strength of the magnetic field cannot be changed.
An electromagnet can easily be demagnetised by switching off the current in the solenoid.	It cannot be easily demagnetised.
It can produce a strong magnetic field.	It cannot produce a very strong magnetic field.
It is a solenoid with a soft iron core.	It is made of steel

P.82 Check Your Progress 4

A. Multiple-choice Questions

1. c **2**. c, d **3**. c **4**. b **5**. d

B. Very Short Answer Type Questions

1. The length of conductor, current flowing through it and the strength of magnetic field.
2. Fans, refrigerators, washing machines, mixers and grinders.
3. Towards west (Applying Fleming's rule).
4. AC and DC.
5. If a current carrying conductor is suspended in a magnetic field, if experiences a mechanical force, i.e. the conductor starts moving in the direction of force.

6. It experiences a mechanical force because when current flows through the conductor, it produces a magnetic field around it.

7. Stretch of forefinger, central finger and the thumb of your left hand mutually perpendicular to each other. If the forefinger indicates the direction of magnetic field and the central finger indicates the direction of current, then the thumb gives the direction of the force acting on the conductor.

8. Two appliances which use electric motor are:

   a. washing machines

   b. refrigerators

C. Short Answer Type-I Questions

1. Armature: An electric motor consists of a rectangular coil ABCD of insulated copper wire wound on a soft iron core known as armature. The main function of armature is to rotate the shaft to which it is attached.

2. The function of split ring is to reverse the direction of current flowing through the coil every time. Carbon brushes are connected to the battery which supply current. Brush B_1 is negative and B_2 is positive.

3. The speed of rotation of the coil of an electrical motor (power of the motor) can be increased in the following ways:

   a. By increasing the current flowing in the coil

   b. By increasing the number of turns in the coil

   c. By increasing the area of cross section of the coil

   d. By increasing the strength of radial magnetic field

   e. By laminating the soft iron core.

   f. By using a powerful electromagnet in place of a permanent magnet.

4. **a.** DC motors are used to run machinery in factories.

   b. DC motors are used in electric locomotives, trolly-buses, etc.

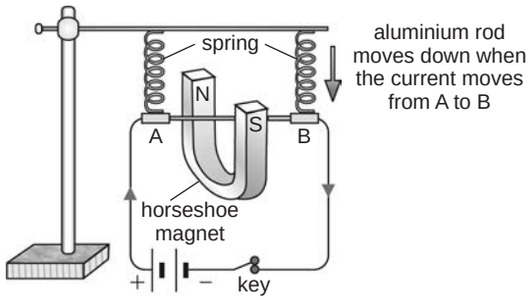
D. Short Answer Type-II Questions

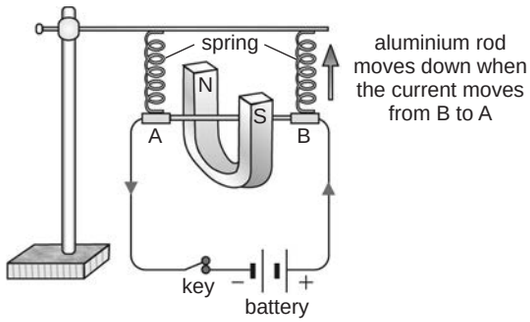
1. Charged particle is a proton

2. **a.** A small aluminium rod AB (1 mm diameter, 4–5 cm length) is suspended horizontally by means of two connecting light springs from a stand.

   b. A strong horseshoe magnet is now placed in such a way that the rod lies between the two poles with the field directed upwards. The aluminium rod AB is connected to a battery through a press key in series.

   c. When the key is pressed, electric current passes from A to B and it is observed that the aluminium wire is pulled down and the springs get stretched. If the magnet is removed now, the aluminium wire returns back to its original position.





   d. If the experiment is repeated by reversing the direction of the current (now the current is made to flow from B to A) or by reversing the polarity of the magnetic field. It is observed that the aluminium rod moves and the springs get compressed.

3. If the above experiment is repeated by reversing the direction of the current (now the current is made to flow from B to A) or by reversing the polarity of the magnetic field. It is observed that the aluminium rod moves and the springs get compressed. This proves that the direction of force depends upon the direction of the current.

4. **For Construction and Working:** Refer to Pages 80-81 of the textbook.

P. 89-90 Check Your Progress 5

A. Multiple-choice Questions

1. c **2**. c **3**. b **4**. c **5**. b

B. Very Short Answer Type Questions

1. Michael Faraday.

2. Induced current.

3. A galvanometer is essentially a detecting instrument which is used for finding whether a current is flowing in a circuit or not.

4. **a.** The galvanometer shows deflection which indicates the presence of current in solenoid.

   b. The galvanometer shows deflection but in the opposite direction compared to when the magnet is moved towards the solenoid.

   c. The deflection in the galvanometer becomes zero. This phenomena is known as electromagnetic induction.

5. The process by which a changing magnetic field in a conductor induces a current in another conductor, is called electromagnetic induction.

6. Strength of induced current depends on the strength of magnetic field, number of turns of wire in the coil and relative speed between the coil and the magnet.

7. Generator and transformer.

8. An electrical machine that produces electricity by converting mechanical energy into electrical energy for use in home and industry is an electric generator or a dynamo.

9. The two types of generators are AC generator and DC generator.

10. **a.** Alternating current can be transmitted over long distances with negligible loss of energy. Since the power wastage in AC transmission is almost negligible, the cost of AC transmission is low.

    b. AC at any desired voltage can be obtained using transformers.

    c. The magnitude of AC can be reduced using a choke coil, without involving loss of energy. When required, AC can be changed into DC.

11. **a.** It is dangerous to work with AC at high voltage. If the insulation is faulty, one gets a severe shock.

    b. The shock of AC is attractive, whereas that of DC is repulsive. An AC shock attracts the person towards it, whereas a DC shock pushes the person away.

    c. The AC is transmitted more from the surface of the conductor than from inside. Therefore, several fine insulated wires (and not a single thick wire) are required for the transmission of AC.

    d. AC cannot be used for electroplating, electrotyping and other such electrolytic processes, etc. In such cases DC is used.

C. Short Answer Type-I Questions

1. The galvanometer will show deflection as long as the coil is moving.

2. Differences between alternating current and direct current

S. No.	Parameter	Alternating Current	Direct Current
1.	Direction	An electric current which changes its direction after a certain fixed interval of time is called alternating current.	An electric current which always flows in the same direction is called direct current.
2.	Polarity	The positive and negative polarity of an alternating current are not fixed.	The polarities of a direct current are fixed.
3.	Sources	The powerhouse generators, bicycle dynamos, car alternators produce an alternating current.	The current produced by a cell or battery is direct current.

3. Fleming's right-hand rule: According to this rule, stretch out the forefinger, middle finger and thumb of your right hand so that they are at right angles to one another. If the forefinger points in the direction of magnetic field, thumb in the direction of motion of the conductor, then the middle finger will point in the direction of the induced current.

   This rule is suitable to find the direction of induced current when the conductor moves at right angles to a stationery magnetic field.

   Consider a conductor AB moving upwards at right angles to a uniform magnetic field. Applying Fleming's right-hand rule, it is clear that the direction of induced current is from B to A. If the motion of the conductor AB is downwards, keeping the direction of magnetic field unchanged, then the direction of induced current will be from A to B.

4. A DC generator is a device which is used for producing direct current energy from mechanical energy.

D. Short Answer Type-II Questions

1. A coil of insulated copper wire is wound on a non-conducting thick paper cylindrical roll to form a solenoid. The two ends of the coil are connected to a sensitive centre zero galvanometer. A bar magnet is placed along the axis of the coil. When the magnet is stationary, there is no

deflection in galvanometer. When the north pole of the magnet is brought near the solenoid, a small deflection is seen in the galvanometer. That shows the flow of current in the solenoid. If the motion of magnet is stopped, the deflection becomes zero. When the magnet is moved away from the solenoid, again deflection is seen in the galvanometer. If the south pole of the magnet is brought near the magnet, the galvanometer shows deflection. If the magnet is kept stationary and the coil is moved towards or away from the magnet the galvanometer shows deflection.

2. The different ways to induce current in a coil are:

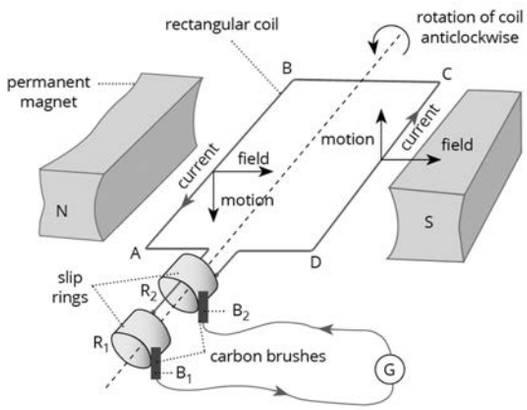
a. By moving the coil in a magnetic field

b. By changing the magnetic field around the coil.

3. Construction of an AC generator. The main parts of an AC generator are –

a. Armature is a rectangular coil (ABCD) as shown in the figure, having a large number of turns of insulated copper wire wound over a laminated soft iron core. The coil can be rotated about the central axis, as shown by the dotted line.

b. Field magnet is a strong permanent magnet or an electromagnet whose poles are made concave to increase the strength of magnetic field passing through the coil. The armature is rotated between the two poles of the magnet so that the axis of rotation is at right angles to the direction of magnetic lines of force.



AC generator

c. Slip rings: Two ends of the armature coil are connected to two metallic rings R1 and R2 respectively, which help to provide movable contact and that is why they are called slip rings, which rotate with the rotation of the coil about the same axis.

d. Brushes: There are two flexible metal plates on carbon rods, B1 and B2, as shown in the figure. They are fixed and are pressed against the slip rings R1 and R2 respectively. The purpose of the brushes is to convey the current produced in the armature coil to the external load resistance *R*.

Working of AC Generator: Refer to pages 87-88 of the textbook.

4. a. Armature: Armature coil consists of large numbers of turns of insulated copper wire wound over a soft iron core. It generates electromotive force.

b. Slip rings: They provide a means for connecting the rotating armature to an internal circuit.

c. Brushes: The function of brushes is to make contact with the rotating rings and through them to supply current to the coil.

5. The essential parts of DC generator are also the same as those of AC generator except the slip – ring arrangement. The slip rings are replaced by split rings or commutators. R_1 and R_2 are the two halves of the same metallic ring. The ends of the armature coils (A and D) are connected to these half rings which rotate along with the armature coil. With this arrangement, one brush is at all times in contact with the arm moving up in the field unlike the other is in contact with the arm moving down. As the armature rotates, alternating voltage is generated in the coil. The split rings convert alternating voltage into direct voltage across the brushes. The direction of the induced current does not change in the external circuit, it always flow in the same direction. This is because brush B_2 always has the same polarity (+*ve*) brush B_1 always remains –*ve*. The generator is thus called a DC generator.

6. a. Galvanometer shows no deflection,

b. pointer of galvanometer jumps to one side and just returns to zero,

c. galvanometer shows no deflection,

d. pointer of galvanometer moves to the opposite side and quickly returns to zero.

7.

DC Generator	Electric Generator
DC generator is used for producing direct current from mechanical energy.	Electric motor converts electrical energy into mechanical energy.
The direction of current is given by Fleming's right-hand rule.	The direction of motion of conductor is given by Fleming's left-hand rule.

P. 93 Check Your Progress 6

A. Multiple-choice Questions

1. b **2**. a **3**. a **4**. c **5**. c

B. Very Short Answer Type Questions

1. The strength of induced current in an electrical device by increasing the strength of magnetic field, i.e. by using a high power magnet, by increasing the number of turns in a wire and by increasing the relative speed between the coil and the magnet.

2. When the magnetic field is strongest.

3. Electric generator works on the principle of electromagnetic induction, i.e. when a coil is rotated in a uniform magnetic field, then current is induced in it.

4. An electric current which always flows in the same direction is called direct current.

5. Sources of direct current are battery or cell.

6. **a.** Live wire

b. Neutral wire

c. Earth wire.

The live wire (L) is at a high voltage (220 V) and brings in the current. If we touch the live wire accidentally, we may get an electric shock. Another wire with black insulation cover is called neutral wire. Neutral wire (N) provides a return path for the current and is kept at zero potential by connecting it to the earth at the power station itself. Thus, the potential difference (voltage) between the live and neutral wires is 220 Volts (220 V – 0 V = 220 V) in India. There is no harm if we touch the neutral wire.

The wire with green insulation cover is called the earth wire (E, no charge).

7. The main supply of electric power is done to our homes using a three core cable. The three cables are:

a. Live wire (L)

b. Neutral wire (N)

c. Earth wire (E)

A wire with red insulation cover is called a live.

8. Tree system and ring system

9. 220 V.

10. Connecting the metallic body of an electrical appliance to the earth by a conducting wire to prevent electric shock is called the earthing of an appliance. Earthing of an electrical appliance is done to protect the user from any accidental electrical shock. Earthing also saves the appliances from being damaged in case of short circuit and overloading.

11. If the household appliances are connected in series, same current flows through all the appliances and if one device or resistors fails, the current in all the devices ceases to flow. The disadvantages are that, all devices have to be operated simultaneously as all have the same switch and also only small amount of current flows through each device.

C. Short Answer Type-I Questions

1. In a house, the local earthing is made near the electrical meter. Earthing is done by connecting a metal plate to a thick copper wire surrounded by a hollow insulating pipe. The metal plate is buried deep (about 5 metres) into the earth, where it is surrounded by a mixture of charcoal and salt for making good earth connection. Through the insulating pipe, water is supplied to the earth periodically, since water forms a conducting medium between the plate and the ground.

2. Earthing saves the appliances from being damaged in case of short circuit and overloading. The earth can be regarded as an electric sink since excess current flows through the earthing to the earth.

3. Overloading is flow of extremely large current in circuit due to excessive use of electrical appliances at the same time. Short circuiting is the touching of live wire and neural wire.

4. A fuse wire should have high resistance and since resistance is inversely proportional to area of cross section, i.e. thickness of the wire $\left(R = \rho \frac{1}{A}\right)$ we use a thin wire for fuse.

5. A fuse must have a low melting point and a copper wire has high melting point. Hence it will not melt even if a very large current flows through it and the circuit will not break leading to damage of the home appliances.

D. Short Answer Type-II Questions

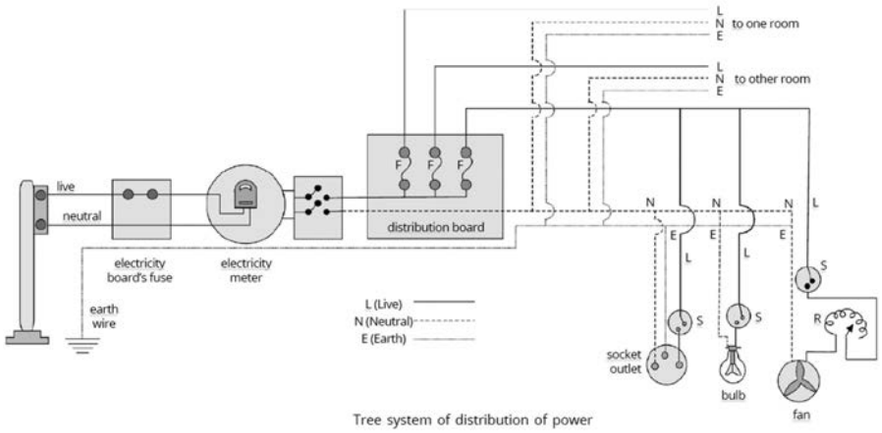
1. Electric power is usually generated at places which are far away from the places where it is consumed. At the generating station, the electric power is generated at 11,000 volts. This voltage alternates at a frequency of 50 Hz. The power is transmitted over long distances at high voltage to minimise the loss of energy in the transmission.

Domestic Wiring

- The electric power line enters our house through three wires – namely the live wire, the neutral wire and the earth wire. To avoid confusion we follow a colour code for insulating these wires. The red wire is the live wire, and the black wire is neutral. The earth wire is given in green plastic insulation.
- The live wire has a high potential of 220 volts whereas the neutral wire has zero potential. Thus, the potential difference between the live wire and the neutral wire is 220 – 0 = 220 volts.

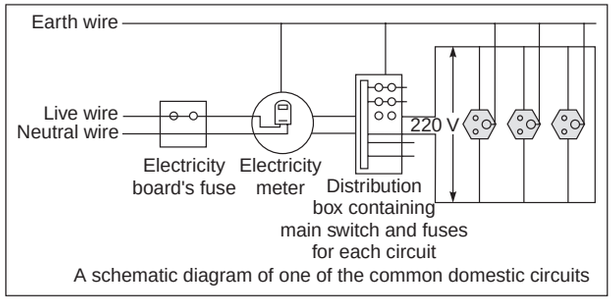
  The earth wire is much thicker in size and is made of copper. One end of it is connected to a copper plate buried deep under the earth. The earth connection is made to the electric meter and then to the main switch.
- In our homes, we receive supply of electric power through a main supply (mains), either supported through overhead electric poles or by underground cables.
- The live wire and neutral wire, coming from the electric pole, enter a box fitted just outside our house which has a main fuse F. The fuse is connected in series with the live wire. This is done so because it is only the live wire which has a high potential of 220 volts unlike the neutral wire which carries zero potential. The fuse F has a high rating of about 50 amperes. Thus, it prevents any damage such as fire to the entire electrical wiring entering the house due to short-circuit or overloading.
- The two wires then enter the electricity meter which records the electrical power consumed by us in kilowatt-hour (kWh). This meter is installed by the Electric Supply Department of our city.
- These two wires coming out of the meter are then connected to a main switch which is placed in a distribution box. Another fuse F is placed in series with the live wire in this box for the sake of consumer safety.
- There are two separate circuits in a house namely lighting circuit and power circuit. The lighting circuit with a 5 A fuse is used for running electric bulbs, fan, radio, TV, tube lights, etc. and the power circuit with a 15 A fuse is used for running electric heater, electric iron, geyser, refrigerator, etc. as it draws more current.
- The distribution circuits are always connected in parallel combination. In a parallel circuit even if there is a fault or short-circuiting in any one line, the corresponding fuse blows off leaving the other circuits and appliances intact and prevents damage to the entire house.
- In case short-circuit occurs in the power circuit, then the power-fuse will blow off but our lights will continue to burn as the lighting circuit remains unaffected.
- A constant voltage of the main line is available for all other electrical appliances.
- Along with the two wires, a third wire called the earth wire also enters our house as shown in the fig. The earth connection is first made to the electric meter and then to the main switch. This wire then goes into the rooms along with the live and neutral wires.

2. An electric fuse is a safety device consisting of a piece of thin wire of material (generally an alloy of tin and copper) having a low melting point and a high resistance, which melts and breaks the circuit if the current exceeds a safe value, hence, preventing the electrical appliances in the circuit from getting damaged.



Tree system of distribution of power

3. The disadvantages are that it requires plugs and sockets of different current values for different appliances and when fuse in one distribution circuit melts, it disconnects all appliances in that distribution circuit.
4. To avoid the overloading of domestic electric circuits the following precautions must be taken:
   a. Too many appliances should not be connected to a single socket.
   b. Wires should be properly insulated.
5. While handling electrical appliances, they should be held by their handles made of insulating material and electrical appliances should never be operated with wet hands.
6.



A schematic diagram of one of the common domestic circuits

P. 94-96 Higher Order Thinking Skills (Hots) Questions

A. Multiple-choice Questions

1. c **2**. a **3**. c **4**.c **5**. b

B. Very Short Answer Type Questions

1. When a bar magnet is brought near a compass, it exerts a force on the poles of the compass needle (due to the magnetic field of the bar magnet) due to which the compass needle turns. The poles of the compass needle are either attracted or repelled from the bar magnet.
2. North pole
3. Velocity, momentum
4. From its south pole to its north pole.
5. If two magnetic field lines intersect or cross each other, there would be two directions of magnetic field lines of that point of intersection which is not possible.
6. Force experienced will be maximum.
7. When it is placed at right angles to the direction of magnetic field.
8. It behaves as an electromagnet.
9. It will in downward direction.
10. As the frequency is 50 Hz, so AC completes 50 cycles in 1 second. In other words, it reverses its direction 100 times in one second.
11. Yes. It is called mutual inductance.
12. North pole
13. Because soft iron loses its magnetism easily.
14. By changing the direction of current flowing through the conductor and by changing the direction of magnetic field.
15. When the current carrying conductor is placed along the direction of a magnetic field.
16. The speed of rotation of an electric motor can be increased by increasing the current flowing in the coil and by increasing the number of turns in the coil.
17. Applying Fleming's rule, the direction of magnetic field is upwards.
18. Magnetic field produced by a solenoid is stronger than that produced by a bar magnet because a solenoid produces a magnetic field under the influence of current and it is further influenced by the number of turns in the coil.
19. By changing the direction of current flowing through the conductor and by changing the direction of magnetic field.
20. By passing current through a solenoid.
21. Current carrying solenoid are used in the construction of electric bells, electric motors, electric fans, etc.

C. Short Answer Type-I Questions

1. A current carrying solenoid behaves as magnet and hence exhibits the directional property of aligning along a particular direction when freely suspended.
2. i. a $\rightarrow$ Direct Current (DC) b $\rightarrow$ Alternating Current (AC)
   ii. Sources of DC are battery or cell and source of AC is an AC generator.
   iii. Frequency of current in India is 50 Hz.

D. Short Answer Type-II Questions

1. The first observation is wrong as the deflection of the north pole gets reversed when the terminals of the battery are interchanged.
2. a. As a bar magnet is pushed into the coil, a momentary deflection is observed in the galvanometer indicating the production of momentary current in it.
   b. When the bar magnet is withdrawn from inside the coil, a momentary deflection is observed in the galvanometer indicating the production of momentary current in it.

c. When the bar magnet is held stationary inside the coil, no deflection is observed in the galvanometer indicating no current is flowing in the coil.

P.96-101 Exercises

A. Objective Type Questions

I. Multiple-choice Questions

1. d **2**. d **3**. a **4**. c **5**. a

6. a **7**. d

II. Fill in the blanks

1. north-south **2**. current

3. Magnetic field **4**. motion

5. Michael Faraday

III. Assertion–Reasoning Type Questions

1. c **2**. d **3**. a **4**. d **5**. a

6. c **7**. d **8**. b **9**. a **10**. c

IV. Very Short Answer Type Questions

1. If we place a compass needle near current carrying wire and it gets deflected, it will show that there is a magnetic field around the wire.

2. a. magnetic south

b. magnetic north

3. $B \alpha I$

4. The steel bar can be magnetised by keeping it inside a solenoid. The magnetic domains of a steel bar would align along the direction of the magnetic field it is kept in, thereby magnetising it.

5. Suppose a current carrying conductor held in your right hand such that the thumb points in the direction of current. Then the curl of your fingers encircling the conductor will give the direction of magnetic field lines around the conductor.

6. The space around a magnet or current carrying conductor within which its influence can be felt by a magnetic substance like iron is called magnetic field.

7. Minimum force or no force acts on the charge particle if it is aligned along the magnetic field.

8. If a current carrying conductor is imagined to be held in the right hand such that the thumb points towards the direction of current, then the direction in which your fingers curl around the conductor will give the direction of magnetic field.

9. According to this rule, stretch out the forefinger, middle finger and thumb of your right hand so that they are at right angles to one another. If the forefinger points in the direction of magnetic field, thumb in the direction of motion of the conductor, then the middle finger will point in the direction of the induced current.

10. As the frequency is 50 Hz, so AC completes 50 cycles in 1 second. In other words, it reverses its direction 100 times in one second.

11. Since AC changes its direction after every 0·01 s, it completes one cycle in $2 \times 0{\cdot}01 = 0{\cdot}02$ s. As is obvious, it completes 50 cycles in 1s, thus, its frequency is 50 Hz.

12. Clockwise

13. Anticlockwise

14. According to Lenz law, if any conductor is kept in a varying magnetic field then EMF is induced in the conductor and when the loop is close the current will follow through the conductor. The phenomena in which it occurs is known as Electromagnetic induction.

15. The earth wire is used for providing a low resistance conducting path for the current. It ensures that any leakage of current to the metallic body of the appliance keeps its potential to that of the earth, and the user may not get an electric shock.

16. When the live wire and the neutral wire come in direct contact, i.e. touch each other, short circuiting takes place. It can happen accidently or if the insulation on these wire melts. When short circuiting occurs, the resistance of the circuit becomes very small and hence a huge amount of current flows through it, which produces a large amount of heat which raises the temperature of the circuit to very high value, and the circuit catches fire.

B. Short Answer Type-I Questions

1. a. When the charge is perpendicular to magnetic field.

b. When the charge is parallel to the magnetic field.

2. When the live wire and the neutral wire come in direct contact, i.e. touch each other, short circuiting takes place. It can happen accidentally or if the insulation on these wire melts. When short circuiting occurs, the resistance of the circuit becomes very small and hence a huge amount of current flows through it, which produces a large amount of heat which raises the temperature of the circuit to very high value, and the circuit catches fire. Overloading means flow of large amount of current in the circuit

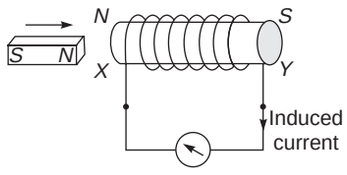
beyond the permissible value of current. It occurs when many electrical appliances of high power rating like geyser, heater, motor, etc. are switched on simultaneously. It also causes fire. It can be avoided by not connecting many appliances in the circuit.

A fuse is a thin wire of low melting point and high resistance which melts when extremely large current flows through the circuit and breaks the circuit thereby preventing the appliances form damage.

3. Differences between alternating current and direct current

S. No.	Parameter	Alternating current	Direct current
1.	Direction	An electric current which changes its direction after a certain fixed interval of time is called alternating current.	An electric current which always flows in the same direction is called direct current.
2.	Polarity	The positive and negative polarity of an alternating current are not fixed.	The polarities of a direct current are fixed.
3.	Sources	The powerhouse generators, bicycle dynamos, car alternators produce an alternating current.	The current produced by a cell or battery is direct current.

4. A coil of insulated copper wire is wound on a non conducting thick paper cylindrical roll to form a solenoid. The two ends of the coil are connected to sensitive centre zero galvanometer. A bar magnet is placed along the axis of the coil. Movement of magnet towards the solenoid will induce current and deflection can be seen in the galvanometer.



5. Magnetic field lines are the curved paths along which the iron filings arrange themselves in a magnetic field due to force exerted on them by the magnetic field.

Properties:

a. Magnetic field lines are closed and continuous curves.

b. Magnetic field lines never intersect each other.

6. In domestic circuits, series arrangement is not used because of the following reasons:

a. The total potential difference available, i.e. 220 volts, is divided between various appliances in the circuit as per their resistances as the current flowing through all the appliances is the same, due to which each appliance will not get the required potential difference for it to operate properly.

b. If we switch off any one of the appliances, the circuit is broken and all the appliances will stop working.

c. Moreover, if one of the appliances is out of order, the circuit will break and all the appliances in the circuit will stop working.

d. As all the appliances work simultaneously even if we do not need one or more of them at a time, a lot of power wastage occurs.

7. a. The magnitude of magnetic field produced in a given point increases.

b. The strength of magnetic field decreases.

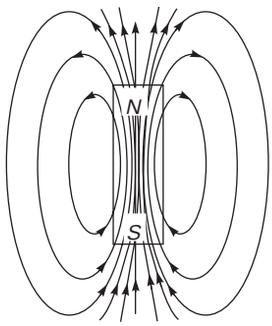
C. Short Answer Type-II Questions

1. a. The strength of magnetic field increases if the radius of the circular coil is decreased, i.e. $B \propto 1/r$.

b. The strength of magnetic field increases if the number of turns in the coil is increased.

c. The strength of magnetic field increases if the strength of current in the coil is increased, i.e. $B \propto I$.

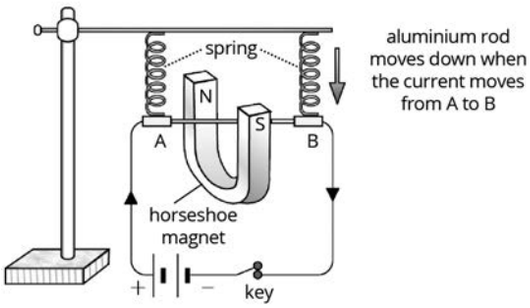
2. They travel from the North to the South Pole of a magnet outside the magnet and from South to the North Pole inside the magnet. They are continuous closed curves.



3. Magnetic field can be produced by a current carrying conductor without using a bar magnet.

a. A small aluminium rod AB is suspended horizontally by means of springs.

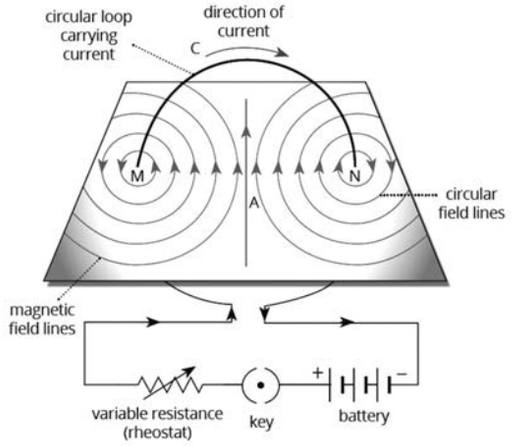
b. A horseshoe magnet is placed in such a way that the two poles of the magnet are on either side of the rod.



c. When key is pressed, electric current passes from A to B, it is observed aluminium rod goes down and the spring stretches.

d. If the direction of current is reversed, the aluminium rod moves upwards, the springs contract.

4.

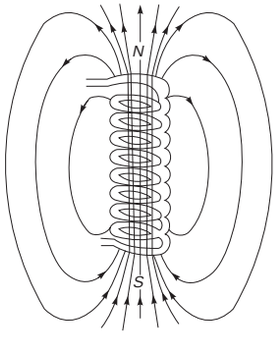


Magnetic field due to current through a circular loop

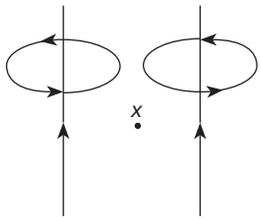
a. If the strength of current is doubled the magnetic field also becomes double.

b. The magnetic field becomes double if radius is reduced to one half since $B \propto 1$

5.



6. The point x is at equal distance from the two parallel straight conductors. The magnitude of magnetic field will be zero since the magnetic fields caused by the two conductors are in the opposite direction and cancel each other.



7. a. When current in P is changed, the field associated with Q will vary causing an induced current in Q.

b. If both the coils are moved in the same direction with same speed, there will not be any change in the field associated with Q. Hence no current will be induced in Q .

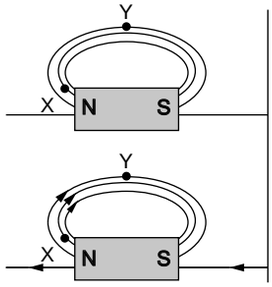
8. When a coil of insulated copper wire is connected to a galvanometer, following observations will take place for each option:

a. When a bar magnet is pushed into the coil, current is induced in the coil momentarily as a result the galvanometer deflects in a particular direction momentarily.

b. When the bar magnet is withdrawn from inside the coil, current is induced momentarily but in the opposite direction and the galvanometer deflects in the opposite direction momentarily.

c. When the bar magnet is held stationary inside the coil, no current will be induced as a result there will be no deflection in the galvanometer.

9. The relative strength of the magnetic field is shown by the degree of closeness of the field lines. The degree of closeness is more at X than at Y. Therefore, the field is stronger at X where the field lines are crowded.

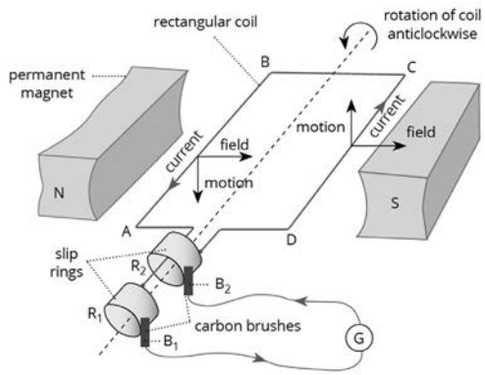


10. Right-hand thumb rule: If a current-carrying conductor is imagined to be held in right hand such that the thumb points in the direction of current, then the direction in which your fingers curl around the conductor will give the direction of the magnetic field lines.

If we apply the right hand thumb rule to the left side of the loop then the direction of magnetic field lines inside the loop will go into the table while outside the loop they come out of the table. If we apply the right hand thumb rule to the right side of the loop then the direction of magnetic field lines inside the loop again go into the table while outside the loop they are coming out of the table.

11. A machine that produces electricity by converting mechanical energy into electrical energy (electricity) for use in home and industry is known as generator.

Principle: It works on the principle of electro-magnetic induction, i.e. when a coil is rotated in a uniform magnetic field, then current is induced in it. In other words, mechanical energy is used to rotate a conductor in a magnetic field to produce



AC generator

electricity. An AC generator produces alternating current, which changes direction after equal intervals of time. It is also known as alternator.

12. a. The metallic body of electric appliances is earthed by means of earth wire. Any leakage of electric wire is transferred to the ground by means of earth wire. This prevents the user of the electric appliance from getting electric shocks. This is the reason why it is important for the metallic appliances to be earthed.

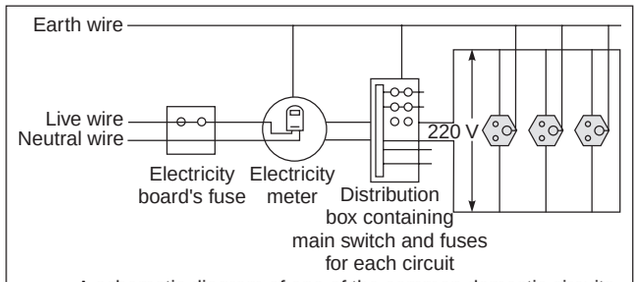
b. An electric short circuit occurs when live (positive) wire and neutral (negative) wire come in direct contact with each other. This short circuiting occurs when

i. the insulation of wires is damaged,

ii. there is a fault in the electrical appliance.

c. 5A, 15A

13.



A schematic diagram of one of the common domestic circuits

D. Long Answer Type Questions

1. a. The magnetic field around a magnet can be visualised by drawing hypothetical lines originating from the magnet's north pole and ending at the magnet's south pole. They basically tell the direction of the magnetic field at a point.

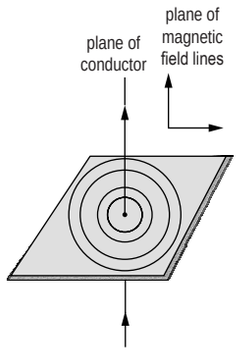
The direction of the magnetic field at a point can be determined using magnetic field lines. The lines are directed from north pole to the south pole outside the magnet while they are directed from south pole to north pole inside the magnet. A tangent drawn on a magnetic field line gives the direction of the magnetic field at that point. The direction can also be determined by using a magnetic compass. When a magnetic compass is placed on a magnetic field line, then it always points in the direction of the magnetic field at that point.

b. When the current in coil X changes, the magnetic field associated with it also changes. As a result the magnetic field around coil Y undergoes change. The change in the magnetic field of coil Y induces current in it.

c. Fleming's right-hand rule: Stretch the forefinger, middle finger and thumb of your right hand so that they are at right angles to one another. If the forefinger points in the direction of magnetic field, thumb in the direction of motion of the conductor, the middle finger will point in the direction of induced current.

2. The magnetic field lines are in the form of **concentric circles** around a straight conducting wire. The pattern of magnetic field generated by a current-carrying conductor depends on its shape. Current-carrying conductors having different shapes produce different magnetic field patterns. **For detailed activity refer to Experiment-2 P-68.**

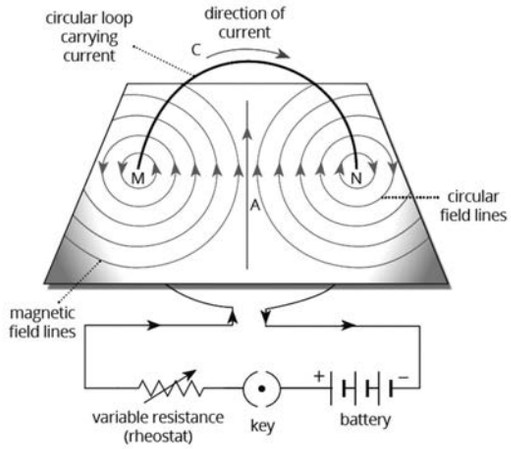
a. Right-hand thumb rule: If a current-carrying conductor is imagined to be held in the right hand such that the thumb points towards the direction of current, then the direction in which your fingers curl around the conductor will give the direction of the field lines of the magnetic field



b. i. Alpha particles being positively charged constitute a current in the direction of motion, therefore magnetic field will be produced around a thin beam of moving alpha particles.

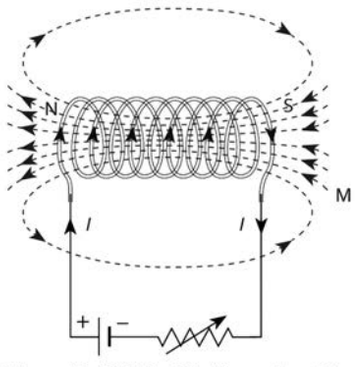
ii. The neutrons being electrically neutral constitute no current, so no magnetic field will be produced around a thin beam of moving neutrons.

3. a. Magnetic field due to current through a circular loop



Magnetic field due to current through a circular loop

b. Magnetic field inside the solenoid



Magnetic field inside the solenoid

4. According to this rule, stretch out the forefinger, middle finger and thumb of your right hand so that they are at right angles to one another. If the forefingerpoints in the direction of magnetic field, thumb in the direction of motion of the conductor, then the middle finger will point in the direction of the induced current. **Construction of an AC generator:** Refer to Page 87 of textbook.

Working: Refer to Pages 87-88 of textbook.

5. a. For showing the method of inducing electric current in a coil with a moving magnet, **refer to Activity- 3 Page 83-84** of the Textbook.

The direction of induced current produced in a straight conductor moving in a magnetic field is given by Fleming's right-hand rule.

According to this rule, stretch out the forefinger, middle finger and thumb of your right hand so that they are at right angles to one another. If the forefinger points in the direction of magnetic field, thumb in the direction of motion of the conductor, then the middle finger will point in the direction of the induced current.

b. When the current in coil A changes, the magnetic field associated with it also changes. As a result the magnetic field around coil B undergoes change. The change in the magnetic field of coil B induces current in it.

OR

AC generator is the device which converts mechanical energy into electrical energy. For the underlying principle and working of this device and its labelled diagram **Refer to P 87-88 of the textbook.**

6. Principle: An electric motor works on the principle of magnetic effect of current,

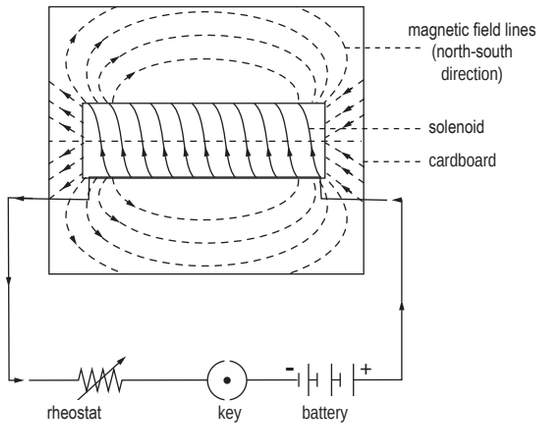
i.e. when a current carrying conductor is kept normally in a magnetic field, it experiences a force as a result of which the conductor begins to move. The direction of the force is determined by Fleming's left-hand rule.

Working: Refer to Page 81 of textbook. Refer to Question 4, Page 82, Check Your Progress-4

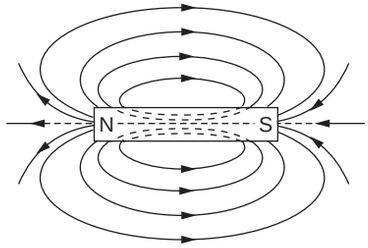
The function of split ring commutator is to reverse the direction of current flowing through the coil every time the coil just passes the vertical position during a rotation.

7. A coil of many circular turns of insulated copper wire wound closely in the shape of a cylindrical tube, whose diameter is less in comparison to

its length is called a **solenoid.** When current is passed through a solenoid, it behaves like a magnet and develops a magnetic field around it.



Magnetic field lines due to a current-carrying solenoid

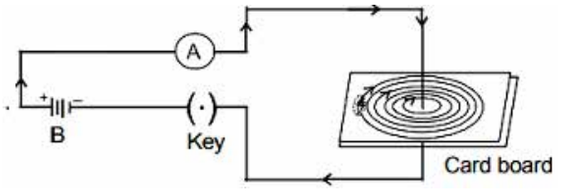


Magnetic field lines around a bar magnet

Two distinguishing features between the two fields.

1. The magnetic field of the solenoid can be varied as per the requirement just by changing the current or core of the solenoid whereas the magnetic field of the bar magnet is fixed.
2. The magnetic field outside the solenoid is negligible as compared to the bar magnet.

8. a.



The **right-hand thumb rule** is used to find the direction of the magnetic field lines. According to this rule if we place our right-hand thumb along the direction of the current flowing in a current-carrying wire, the direction in which the fingers wrap the wire represents the direction of the magnetic field.

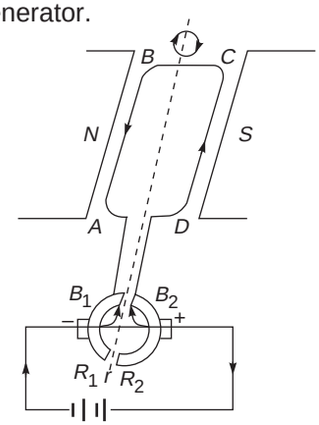
b. When we move away from the straight wire carrying constant current, the deflection of the needle decreases which implies the magnetic field decreases as $B \alpha \frac{1}{r}$.

9. a. Fleming's left-hand rule is applicable for the force experienced by a current-carrying straight conductor placed in a magnetic field which is perpendicular to it. Whenever a current-carrying conductor comes under a magnetic field, there is a force acting on the conductor. The direction of the force is found by using Fleming's Left-hand Rule.

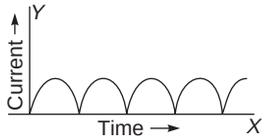
b. Refer to **Figure 2.34 Page-80 of the textbook** for the labelled diagram of a DC Motor

10. A DC generator is based on the principle of electromagnetic induction.

Construction: Similar to an AC generator, but in DC generator, we use 'split ring commutator instead of slip ring commutator which is used in AC generator.



Working: An nduced e.m.f. is set up across the end of the coil due to the change in the magnetic flux in the rotating coil. With the help of split ring commutator, one carbon brush is at all times in contact with the arm moving up while the other is in contact with the arm moving down. The current in the external circuit flows in the same direction due to this arrangement, although induced e.m.f. in the coil is reversed after every half rotation. In this way, a unidirectional current is produced.



If several coils inclined at equal angles to one another and a commutator with corresponding number of segments in it are used, we get

almost steady current.

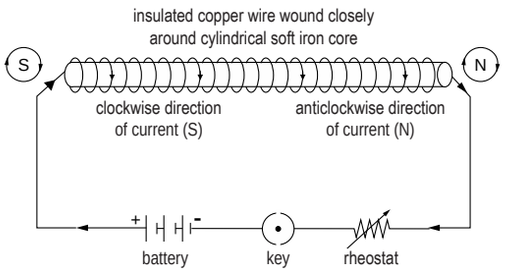
11. a. An electromagnet is a solenoid with a soft iron core usually prepared by placing a soft iron core in a solenoid, or by winding a large number of turns of an insulated wire around a cylindrical, soft iron core. An electromagnet shows magnetic properties only as long as electric current flows through the solenoid. It loses the magnetic properties when the current is switched off.

Uses:

1. Electromagnets are used in the construction of a large number of electrical devices like electric bells, loudspeakers, electric motors, electric fans and telephone instruments.

2. Electromagnets are used to lift and transport heavy loads like big machines, steel girders and scrap iron objects for loading and unloading purposes. Unloading of goods is done by switching off the current in the electromagnet.

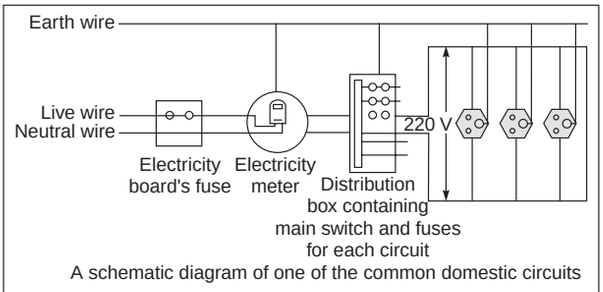
b.



c. Soft iron core is used because it has less retentivity. Retentivity is referred to as the capacity of a material to retain the magnetic property in itself. The iron core of the solenoid produces magnetic field as iron gets magnetised due to magnetic induction.

d. The strength of the magnetic field of an electromagnet can be easily changed by changing the strength of the current in the coil or the number of turns in the solenoid.

12. Earthing of an electrical appliance is done to protect the user from any accidental electrical shock. Earthing also saves the appliances from being damaged in case of short circuit and overloading.



A schematic diagram of one of the common domestic circuits

E. Source-Based/Case-Based/Passage-Based/ Integrated Assessment Questions

1. a. iv. all of these.

b. ii. copper

c. iv. nickel.

d. i. by placing it inside a coil carrying current.

e. iii. soft iron.

2. a. i. electromagnetic induction.

b. iii. e.m.f.

c. i. mechanical energy to electrical energy.

d. ii. length of rotating wire.

e. ii. less than that in the primary coil

F. Value-Based Questions (Optional)

1. a. A magnetic compass is an instrument having a small bar magnet in the form of needle which can turn freely on a pivot. It points in north-south direction and can help to find a direction.

b. This shows that Radhika is very helpful and has a good knowledge of magnetic compass. She is aware of the fact that magnetic compass can be used to find the direction.

2. a. The blackish material must be a metal like Iron, nickel, etc.

b. The blackish material sticked to the magnet because it could experience the magnetic pull (force) of the bar magnet when brought closes to it.

c. Seema's act displayed that she is a brave girl who has a good knowledge about magnets. She is very helpful and kind.

3. a. Ramesh advised his father to use electromagnet because it will help him to separate iron articles from the rest of scrap. Iron articles would get attracted to the magnet and will stick on to it. This will reduce his father's manual work.

b. Ramesh's advice shows that he is a very good son who wants to help his father.

He is caring and wants to reduce his father's work load by introducing as basic concept of physics in daily life.

4. a. If too many appliances draw power from the same socket, it can overheating and catch fire. This is called overloading.

b. Jame's mother is a very active who is aware of what is going around in her surrounding. She has a good knowledge of electricity which makes her prevent from any mishappening.

5. a. Battery cells provide electrical energy to the electric motor which is converted to mechanical energy for the use.

b. William's actions show that he is a very caring brother who wants to see her sister happy. He has a good knowledge about batteries. He showed presence of mind and changed the batteries.

6. a. Earth wire (E)

b. An earth wire connects the metallic body of any appliance to the ground by conducting wires to prevent electric shock. This is called earthing.

c. We learn that we should be aware about the problems related to electrical appliances and we should know how to rectify these problems, so that no one gets harmed due to these problems.

7. a. An electric heating rod uses electricity to heat the water. Tap water is a good conductor of electricity, so if someone puts his hands in a bucket filled with water with an electric rod dipped in it, can get an electric shock.

b. The precautions to be taken to avoid electric shock are:

i. Make sure to keep the rods away from kids and children

ii. Do not switch on the rod before placing it inside the water

iii. Hang the immersion rod in-between with the help of clothes hanger or some support.

c. This shows that Mayank has a good presence of mind. He has a good knowledge of electricity. He is very caring and protects his brother from an accident.

8. a. A watch is totally mechanical, it may be affected by strong magnetic fields. If the balance wheel gets magnetised that will add friction and bias to the system and the watch will likely slow down or stop.

b. Rohan is aware of what is going on in his surroundings. He has a good presence of mind. He has a good knowledge of magnets and watches.

9. a. Overloading is a situation when too many appliances are connected in the same circuit such that the overall current exceeds the current carrying capacity of the connecting wires. The wires cannot withstand such a high current and melt and may cause fire.

Overloading can be avoided in the following ways:

i. Do not use too many appliances at the same time.

ii. Use the appliances within the safe limit of electric circuit.

iii. Do not connect too many appliances in a single socket.

b. This shows that Meenakshi is very caring and wants to avoid any mishappening. She has a good presence of mind. She is very helpful as she tells her parents about the consequences of overloading.

CHAPTER-3

SOURCES OF ENERGY

P. 106-107 Check Your Progress 1

A. Multiple-choice Questions

1. b **2**. d **3**. c **4**. d **5**. a

B. Very Short Answer Type Questions

1. We need energy to work, to grow and to sustain life.

2. No, some usable energy gets converted into unusable energy.

3. Chemical energy.

4. Fossil fuels take hundreds of millions of years to form under the Earth's surface. Hence, they cannot be replaced in short intervals of time. So essentially, all fossil fuels are considered non-renewable.

5. The sources of energy which are extensively used by man due to their easy availability and also meet a major portion of man's energy requirement are called conventional sources of energy. For example, fossil fuels (coal, petroleum, natural gas), hydro energy (energy of flowing water in rivers), energy from biomass (firewood, animal dung, biodegradable waste), wind energy.

6. a. coal and cowdung cakes,

b. kerosene and petrol,

c. Natural gas and methane.

7. a. Chemical to heat and light,

b. Potential to kinetic,

c. Electrical to heat and light.

8. No, because some usable energy gets converted into unusable energy which does not perform any work and gets lost to the environment.

9. Renewable and non-renewable.

10. Solar energy is considered a renewable source because it is inexhaustible.

11. Conventional and non-conventional.

12. The sources of energy which are not used extensively by man and meet man's energy requirement on a limited scale are called non-conventional sources of energy. For example, solar energy, geothermal energy, nuclear energy, etc.

13. A combustible substance which on burning in air produces a large amount of heat energy is called a fuel. Coal and Petrol.

C. Short Answer Type-I Questions

1. Characteristics of a good source of energy:

a. Large amount of work done per unit volume or mass: A good source of energy would be a large amount of work per unit mass or per unit volume. LPG is better cooking source of energy as compared to kerosene because LPG would be able to do large amount of work per unit volume as compared to kerosene.

b. Safe and convenient to use: A good source of energy should be safe and convenient to use. For example, cooking gas (LPG is a safe source of energy in a house hold kitchen). But nuclear energy is not safe source of energy to be used in homes.

c. Easy to transport: A good source of energy should be easy to transport. For example, coal, petrol, diesel, LPG, etc. can be transported by trucks, tanks and even pipes from the place of their production to the consumers.

d. Easy to store: A good source of energy should be easy to store. For example,huge storage tanks are used to store petrol, diesel, LPG, etc.

e. Cheap and easily available: A good source of energy should be cheap(economical) and easily available. For example, it is economical to use cooking gas (LPG). Nowadays, CNG is used in cars as it is more economical than petrol. On the other hand, commercial LPG is also economical but not easily available, so few people prefer to run cars on LPG available in petrol pumps.

f. Environmental pollution: A good source of energy should not cause any environmental pollution. LPG is preferred over wood in household kitchens as it does not cause any environmental pollution.

2. Fuel is called a source of energy because it produces large amount of energy on burning which can be used to do useful work.

3. CNG is a better fuel than kerosene because it does not produce pollutants. It is a clean fuel.

4. LPG is preferred over wood because it does not cause environmental pollution and also it is economical.

D. Short Answer Type-II Questions

1. The sources of energy which are exhaustible, i.e. which cannot be renewed or replaced in

short intervals of time are called non-renewable sources of energy. For example, coal and petroleum.

2. Those sources of energy which are inexhaustible, i.e. which can be renewed at short intervals of time are called renewable sources of energy. Renewable sources of energy will be available continuously. For example, wood, water, wind, solar energy are renewable sources of energy.

3. Differences between conventional and non-conventional sources:

S.No.	Parameter	Conventional Sources	Non-conventional Sources
1.	Usage	These sources of energy are extensively used by human beings.	These sources of energy are not extensively used by human beings.
2.	Energy requirement	They provide major portion of man's energy requirement.	They meet man's energy requirement on a small scale.
3.	Future prospect	Most of the conventional sources of energy are going to be exhausted in near future.	Most of the non-conventional sources of energy are going to be continuously available on the earth.
4.	Example	Fossil fuel, hydro energy, energy from biomass, wind energy.	Solar energy, ocean energy, geothermal energy, nuclear energy.

4.

Renewable sources of energy	Non-renewable sources of energy
The sources of energy which are inexhaustible and can be renewed after a short period of time are called renewable sources of energy.	The sources of energy which are exhaustible and cannot be renewed are called non-renewable sources of energy.
They are inexhaustible.	They will be exhausted one day.
They are quickly replaced after being used.	They cannot be quickly replaced after being used.
They take short period for their formation.	They take millions of years for their formation.
These sources do not cause any environmental pollution.	These sources are a major cause of environmental pollution.
We need not to conserve renewable sources of energy.	We need to conserve non-renewable sources of energy.
Solar energy, wind energy, water energy, energy from biomass, geothermal energy.	Coal, petroleum, natural gas.

5. Coal is formed from trees but its formation takes millions of years. Wood is a renewable source because trees can be planted and grown easily.

6. LPG is preferred over wood because it does not cause environmental pollution and it is economical too.

7. Fuel B is better because its ignition temperature is high, so it will not burn spontaneously and also it does not produce toxic pollutants.

P. 109-110 Check Your Progress 2

A. Multiple-choice Questions

1. c **2**. b **3**. d **4**. c **5**. d

B. Very Short Answer Type Questions

1. The fuels formed from the prehistoric remains of dead plants and animals buried deep under the earth's crust under special conditions are called fossil fuels.

2. Fossil fuels contain sulphur, which produces sulphur dioxide on burning. Besides being a poisonous gas, it dissolves in atmospheric water to form sulphuric acid which falls on the earth along with the rain.

3. SO_2, CO, CO_2, NO_2. C_2

4. Scrubbers and electrostatic precipitation.

C. Short Answer Type-I Questions

1. Fossil fuels take hundreds of millions of years to form under the Earth's surface. Hence, they cannot be replaced in short intervals of time. So essentially, all fossil fuels are considered non-renewable.

2. Burning of fossil fuels leads to production of gases such as carbon dioxide and sulphur dioxide. Burning in an insufficient supply of air leads to the formation of carbon monoxide which is poisonous. The oxides of sulphur and nitrogen lead to formation of acid rain. In this way burning of fossil fuels causes air pollution.

3. The combustion of fossil fuels produces carbon dioxide which is released in the atmosphere. Carbon dioxide has the tendency to absorb infrared radiations radiated by earth's crust resulting in warming of earth's atmosphere. Large concentration of carbon dioxide will increase the greenhouse effect.

D. Short Answer Type-II Questions

1. Air pollution caused by fossil fuels can be reduced by using efficient internal combustion engines in vehicles, by installing catalytic converter and using scrubbers and electrostatic precipitators in industries to remove suspended particulate matter.

2. The vehicles are fitted with catalytic converters which converts harmful gases coming out of the vehicles into harmless ones. For example, the catalytic converter converts harmful poisonous gas carbon monoxide into non-poisonous carbon dioxide which is relatively less harmful.

P. 113 Check Your Progress 3

A. Multiple-choice Questions

1. a **2.** c **3.** c **4.** b **5.** c

B. Very Short Answer Type Questions

1. A power plant in which a fossil fuel (coal or petroleum) is burnt to produce heat energy which is converted into electrical energy is called a thermal power plant.

2. Thermal power plants are set-up near the coal and oil fields because coal and oil are its basic source of energy and also to lessen the cost of production.

3. Energy of flowing water has been traditionally used for transporting heavy logs of wood from one place to another, driving watermills to grind wheat to make flour and to drive looms which weave cloth and to run pumps for pumping water out form ground.

4. The power station where electricity is produced by using the energy of flowing water to drive generators is called hydro power plant (or hydro electric power station). The electricity produced in a hydroelectric power station is called hydroelectricity or hydroelectric power.

5. Because water is renewable.

C. Short Answer Type-I Questions

1. In a thermal power plant, large amount of fossil fuels are burnt continuously to heat up water. Water when heated to a high temperature produces steam. This steam is made to run the turbine. When the turbine rotates, its shaft also rotates and drives the generator. The generator generates electricity. Thus, electricity is produced in a thermal power plant.

2. In a thermal power plant, chemical energy of fossil fuels is converted into heat energy. This heat energy rotates the turbines and electricity is produced.

3. Potential energy of stored water in a dam → kinetic energy of flowing water → Kinetic energy of turbines → Electrical energy in generator

D. Short Answer Type-II Questions

1. Basic principle of producing hydroelectricity in a hydroelectric plant:

a. A high dam is constructed on a high altitude river (i.e. river flowing in a hilly area) to obstruct the flowing of running water. Due to this, the water is collected in a large reservoir or man-made lake behind the dam (like Gobind Sagar Lake which collects water for Bhakra Nangal Dam). In this process the kinetic energy of the flowing water gets transformed into potential energy of water stored behind the dam. The stored water in the reservoir possesses very large amount of potential energy due to its height above the ground.

b. The dam has sluice gates at a high level. The opening and the closing of the sluice gate is done by a control valve. The water stored in the reservoir behind the dam can pass through the sluice gate when it opens.

c. On opening the sluice gate, water from the high level of the dam is carried through pipes to the turbine at the bottom of the dam. Since the water falls from a high level of the dam, it flows at a very high speed. Here, the potential energy of the water gets converted into the kinetic energy of the flowing water. This kinetic energy of the flowing water rotates the blades of the turbine. Here, the kinetic energy of the flowing water is converted into mechanical energy of the turbine.

d. The turbine is connected with the generator through a shaft. When the turbine rotates, its shaft also rotates and makes the armature of the generator to rotate rapidly. The moving armature of the generator in the magnetic field generates electricity. Here, the mechanical energy of the turbine is converted into electrical energy in the generator.

e. The hydroelectricity so produced is fed to step-up transformer and then supplied to homes and industries through transmission lines.

2. Advantages of dams are:

a. It is used to store water.

b. It is used in hydroelectric power generation.

c. It is used in irrigation purposes.

d. It prevents flooding in lower course.

3. Hydropower plants constructed to generate hydroelectricity are multipurpose projects. They help in controlling floods, enable us to use water for irrigation,develop recreational sites, etc.

4. Due to the construction of the dam, there are no annual floods in the river. The soil in the downstream becomes poor in quality (less fertile) because there are no annual floods to deposit nutrient-rich slit on the banks of the rivers. The crop yield also decreases in these areas.

P. 117-118 Check Your Progress 4

A. Multiple-choice Questions

1. c **2**. c **3**. c **4**. b **5**. c

B. Very Short Answer Type Questions

1. Energy from biomass is energy derived from the remains of living organisms and from the excreta of animals. For example, dry leaves, wood shavings, agriculturalwaste like bagasse.

2. Wood is a renewable source of energy to some extent if we can ensure that enough trees are planted.

3. Charcoal is prepared by the strong heating of wood in closed vessels in a limited supply of air (oxygen).

4. Biogas is obtained by anaerobic fermentation of animal dung in presence of water.

5. Wood when used as a fuel is called firewood.

6. Disadvantages of burning animal dung directly as a fuel:

a. Cow dung or animal dung contains important nutrients like nitrogen and phosphorus which are required by the soil for proper growth and development of the crops growing in that soil. So, burning of animal dung as a fuel destroys the useful nutrients which otherwise could be used as a manure in agriculture.

b. Animal dung cakes have low calorific value. So, we need a large amount of animal dung cakes to obtain required heat.

c. Animal dung cakes do not burn completely, they produce a lot of ash as residue.

d. Animal dung cakes produce a lot of smoke and harmful gases on burning which cause air pollution.

7. Disadvantages of burning cow dung cake are:

a. It has a very low calorific value.

b. It produces a lot of smoke and hence causes air pollution.

c. It does not burn completely and leaves a lot of residue on burning.

d. The vital nutrients get destroyed on burning cow-dung cakes, so it cannot be used by farmers as manure.

8. Biomass has a low calorific value and it gives out smoke when burnt. Hence, has a poor efficiency as fuel.

9. Biogas is an ideal fuel for domestic purposes because the energy produced is low which is sufficient for cooking food, illumination purpose and driving engines of water pumps. It cannot be used for generating electricity on a large scale.

10. Charcoal is obtained by removing the volatile material from wood by destructive distillation. 1 kg of wood produces only 250 g of charcoal. Hence, it is very expensive.

11. The spent slurry is rich in nitrogen and phosphorus compounds. So, it is taken in the fields and used as manure.

12. The main constituent of biogas is methane (55–70%). Biomass is broken down into smaller molecules by chemicals and microorganisms. Upon completion of the anaerobic digestion process, the biomass is converted into biogas.

Advantages of using biogas are:

a. Biogas does not produce any smoke and hence, causes no air pollution.

b. On burning, it leaves no residue

C. Short Answer Type-I Questions

1. The calorific value of wood is low, being only 17 kJ/g. Thus, to produce sufficient amount of heat, we need to burn a large quantity of wood.

2. Using wood as fuel leads to cutting down of trees in the forests (deforestation). This affects our ecosystem and our environment.

3. Charcoal is a better fuel than wood because it has high calorific value, it does not produce smoke on burning, does not produce any residue and it is a compact fuel, i.e. easy to handle and convenient to use.

4. Uses of biogas:

a. Biogas is used as a fuel for cooking food.

b. Biogas is used for illumination purposes.

c. Biogas can be used for driving engines of water pumping sets used for irrigation.

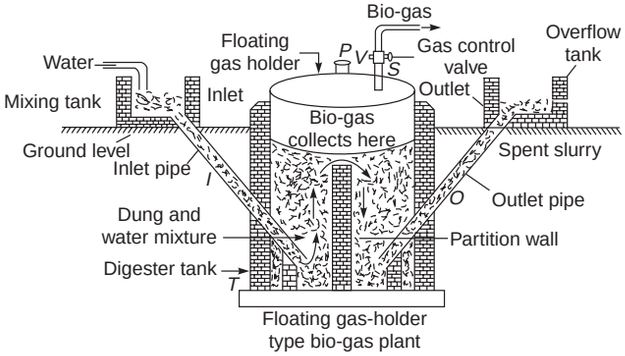
D. Short Answer Type-II Questions

1. Animal dung is renewable source of energy because it will not get easily exhausted and can be easily replaced.

2. Biogas is obtained by anaerobic fermentation of animal dung in presence of water. Biogas is a mixture of methane, carbon dioxide, hydrogen and traces of hydrogen sulphide.

Cattle dung and water are mixed in equal proportions in a mixing tank to prepare a semi-fluid mixed slurry. The slurry so prepared is passed on the underground digester tank through an inlet chamber. The digester tank is a sealed chamber in which there is no oxygen. It is in the digester tank where the slurry is decomposed in about 50 – 60 days by anaerobic bacteria to produce biogas. Thus, biogas produced get collected in the gas tank. As biogas keeps collecting in the dome, it exerts pressure on the spent collecting in the dome, it exerts pressure on the spent slurry in the digester tank. This pressure forces the spent slurry to flow into the overflow tank through the outlet chamber. The spent slurry is gradually removed from the overflow tanks. The spent slurry is rich in nitrogen and phosphorus compounds, so it is taken in the field and used as manure. The biogas which has collected in the gas tank is taken out through the biogas outlet pipe and used as required. To get continuous supply of biogas, fresh dung slurry is added to the digester tank periodically to replace the spent slurry.

3. The slurry left behind in biogas plants is rich in nitrogen and phosphoru compounds, so it is taken in fields and used as manure.



The fixed dome type biogas plant consists of a digester tank, a mixing tank and an overflow tank.
Digester tank: It is well-shaped underground tank. The roof of the digester tank is made in the form of a dome. This dome-shaped structure called gas tank acts as a storage tank for the biogas. There is a biogas outlet pipe at the top of dome having a gas valve.

Mixing tank: On the left side of the digester tank is the mixing tank lying above the ground. The bottom of the mixing tank is connected to the digester tank through the inlet chamber.

Overflow tank: On the right side of the digester tank is the overflow tank lying below the ground. The bottom of the overflow is connected to the base of the digester tank through the outlet chamber.

4.

Biogas	Animal dung cake
The calorific value of the biogas is very high as compared to the animal dung cakes.	It has a very low calorific value.
Biogas does not produce any smoke and hence causes no air pollution.	It produces a lot of smoke and hence causes air pollution.
Biogas on burning leaves behind no residue so it is a clean fuel.	It does not burn completely. It leaves a lot of residue on burning.
Biogas can be used for illumination purposes and for driving engines of water pump sets used for irrigation.	Animal dung cakes cannot be used for these purposes.
There is no storage problem for biogas as it is supplied by pipes directly from the biogas plant when required.	A lot of space is required to store dry animal dung cakes.

5.

Biomass	Hydroelectricity
Renewable source of energy only if we plant trees in a planned manner.	Renewable source of energy.
The energy from biomass can be obtained by using a chullah (on burning wood or animal-dung cakes) or a biomass plant (by producing biogas).	Production of hydroelectricity requires construction of dams on rivers.
The devices used for using biomass (Chullahs, biogas plants) can be installed at all places even at remote village.	The plants for obtaining hydroelectricity can be installed only at few places where dams can be built on high altitude river.
It requires very little investment to install devices for producing energy from biomass.	It requires a huge investment in constructing dam to produce hydroelectricity.

The use of biomass (wood and dry animal dung cakes) as fuels produces lot of smoke on burning, hence causing air pollution. Biomass provides pollution-free energy only when wood is converted into charcoal and animal dung is converted into biogas using technological innovation.	Hydroelectricity is totally pollution-free. It does not cause any air pollution.
It has a limited usage. It can be used for cooking food, illumination purpose, driving the engines of water pumps, etc. It cannot be used for generating electricity on a large scale.	It has unlimited uses as it produces electricity to run all types of electrical appliances.

6. Biogas is considered to be a boon for the farmers because:

a. It is a renewable source of energy.

b. It is very economical.

c. It is prepared itself by wastes.

P. 120-121 Check Your Progress 5

A. Multiple-choice Questions

1. c **2**. b **3**. b **4**. b **5**. d

B. Very Short Answer Type Questions

1. Unequal heating of the land mass and water bodies by solar radiation generates air movement and causes wind to blow.

2. In a water lifting pump, the rotatory motion of windmill's blade is utilised to lift water from a well. In a flour mill, the rotatory motion of the blades of the windmill is utilised to rotate the millstone to grind the grains like wheat and corn into flour.

3. Wind energy has been derived from the sun's energy.

4. Traditional use of wind energy has been modified by the formation (establishment) of wind energy farms which generates electricity.

5. In a water lifting pump, the rotatory motion of windmill's blade is utilised to lift water from a well. In a flour mill, the rotatory motion of the blades of the windmill is utilised to rotate the millstone to grind the grains like wheat and corn into flour.

C. Short Answer Type-I Questions

1. With the increasing population the non-renewable sources of energy are coming to an exhaustion and wind is a clean, cheap and convenient form of energy.

2. The tower and blades of the wind turbine generators are exposed to the vagaries of nature like rain, storm and cyclones, etc. They need a high level of maintenance. So, the cost incurred in its maintenance is high.

3. The advantages of using wind energy for generating electricity are as follows:

a. Wind energy is an environment-friendly and efficient source of energy. It does not cause any environment pollution.

b. Wind energy is a renewable source of energy. It is inexhaustible as long as the sun keeps shining because we know the sun's energy powers the wind on the earth. Wind energy has been derived from the sun's energy.

c. Wind energy is available free of cost. It requires no recurring expenses for the production of electricity through wind energy. So, it is one of the cheapest sources of energy.

4. Limitations of harnessing energy from the wind:

a. The wind energy farms cannot be established everywhere: Wind energy can be established only at those places where wind blows for the greater part of the year and that too blows at a high speed of more than 20 km/h to maintain the required speed of the turbine.

b. The wind energy farms need back-up facilities: Even where the wind energy farms are established, the wind does not blow all the days of the year at desired speed and in desired direction. So, there should be some back-up facilities (like storage cells) to take care of the energy needs during a period when there is no wind.

c. The wind energy farms need large area: Establishment of wind energy farms requires large area of land. This area should be vacant land area free from forest and human settlements. For a one MW generator, the wind energy farm needs about two hectares of land.

d. The wind energy farms incur high cost of maintenance: The tower and blades of the wind turbine generators are exposed to the vagaries of nature like rain, storm and cyclones, etc. They need a high level of maintenance. So, the cost incurred in its maintenance is high.

e. Setting up a wind energy farm is highly expensive.

D. Short Answer Type-II Questions

1. **Construction of a wind turbine generator:** A wind turbine generator is a technologically modified windmill. It consists of a rotator to which large sized blades are fixed. The arrangement of the rotator and its blades is called wind turbine. The wind turbine is fixed over the top of a tall tower in such a way that the rotator and its blades are free to rotate. The shaft of the wind turbine is connected to the armature of an electric generator.

2. **Working of a wind turbine generator:** When the fast moving wind (having a speed of more than 20 km/h) strikes the blades of the wind turbine, it exerts a force on its blades. The blades of the wind turbine start rotating continuously. The shaft of the wind turbine also starts rotating. The rotating shaft of the wind turbine rotates the armature of the generator and electricity is produced. The electricity so produced is fed to step-up transformer and then supplied to homes and industries through transmission lines.

3. The electricity produced by a single windmill is quite less and cannot be used for commercial purposes.

4. **Wind energy farm:** The electricity produced by a single windmill is quite less and cannot be used for commercial purposes. Therefore, a large number of wind turbine generators (modified windmills) are installed over a large area. A cluster of wind turbine generators installed over a large area is called a wind energy farm.

   The energy produced by large number of wind turbine generators produce large quantity of energy which is used for co commercial purposes.

P. 127-128 Check Your Progress 6

A. Multiple-choice Questions

1. c **2**. c **3**. b **4**. b **5**. b

B. Very Short Answer Type Questions

1. Industrialisation, modern lifestyle and improved standard of living, extensive use of machines and increase in population has resulted in an increase in our demand for energy.

2. The sun is providing us heat and light energy free of cost for nearly 5 billion years and will continue radiating at that rate for about 5 billion years more.

3. **a.** Solar energy has been used for drying clothes.

   b. Solar energy has been used for the preservation of fruits, vegetables and fish, etc. by the process of sun drying.

   c. Solar energy has been used for obtaining salt from the sea water.

4. A solar cooker is a device that utilises solar energy for cooking food.

5. It is an improvised type of solar cooker in which large spherical mirror reflector is used in place of a plane mirror reflector. The sunlight falling on the surface of a concave spherical or parabolic reflector gets concentrated at its focus. The cooking utensil is kept at the place where the sun rays get focussed.

6. Solar water heaters are used for supplying hot water in big hotels, hospitals, industries requiring hot water, cooperative housing societies, etc.

7. **a.** Develop technology to use the conventional sources of energy more efficiently.

   b. Shift our preference to renewable sources of energy.

   c. Shift our preference to use latest sources of energy which are non-conventional sources of energy, like solar energy, energy from the sea, geothermal energy, nuclear energy, etc.

8. In order to make use of solar energy for heating purposes, we have to first collect and concentrate it. Scientists have developed special devices which are being used to convert the solar energy into its usable form. Some of them are solar cooker, solar heaters, solar furnaces, etc.

9. Solar cookers, solar heaters.

10. The solar cooker cannot be used for frying, baking or making chapattis. It can be used to cook rice, soup, egg, etc.

11. Solar cell.

C. Short Answer Type-I Questions

1. Solar constant is the amount of solar energy received per second by one square metre area at outer edge of the earth's atmosphere exposed perpendicularly to the rays of the sun at the average distance between the sun and the earth. The approximate value of solar constant is 1.4 kW/m^2.

2. **Advantages of solar cooker:**

   a. The use of solar cooker for cooking food saves fuel as it requires no fuel or electric supply.

b. The use of solar cooker does not produce smoke. Hence, it does not cause any environmental pollution.

c. The food is cooked at a comparatively low temperature in a solar cooker. So, the vitamins contained in the food are not destroyed and the nutritional value of the food is preserved.

d. The solar cooker has a very low installation and maintenance cost.

e. The solar cooker can cook one to four dishes simultaneously at the same time.

3. The group of solar cells connected in specific pattern to produce desired potential difference and magnitude of current (electric power) is called solar cell panel.

4. Solar cells have no moving parts, are easy to construct, and require little maintenance, can be installed in remote and very less populated areas in which laying a power transmission line may be expensive and not commercially viable; solar cell and solar cell panel are renewable sources of energy; they do not cause pollution of environment, and use of solar cells saves fossil fuels.

5. Expensive manufacturing: The entire process of manufacturing is expensive because of use of expensive components.

a. Special grade silicon required for making solar cells is limited in nature. So, it is very expensive.

b. Silver used for interconnecting various cells in a solar cell panel is also expensive.

c. It is costly to store electricity in storage batteries.

6. A solar panel is mounted on a tall supporting pole or insulated on specially designed inclined roof tops so that more solar energy is incident over it. The solar energy falling on the solar cells of the solar cell panel gets converted into electricity. The electricity so produced flows to storage battery, where the electricity is stored in the form of chemical energy.

7. The electricity produced in the solar cell panel is direct current (DC) which is stored in DC batteries. Only DC devices can be operated by DC batteries. Now most of our electrical appliances operate on alternating current (AC). To operate any AC device, we need to convert DC stored in the batteries into AC by using inverters.

D. Short Answer Type-II Questions

1. Materials required: Take two identical beakers, black and white paints, thermometers.

Procedure:

a. Take two identical beakers, paint one of them white and the other black.

b. Pour equal volumes of water in the two beakers. Insert a laboratory thermometer in each beaker.

c. Place both the beakers in the sun for about an hour.

d. Read the temperature of water in both the beakers.

Result: Water in black beaker is found to be warmer than that in white beaker.

Conclusion: A black surface absorbs more heat as compared to a white surface. In other words, the black bodies are better heat absorbers than the white bodies under identical conditions.

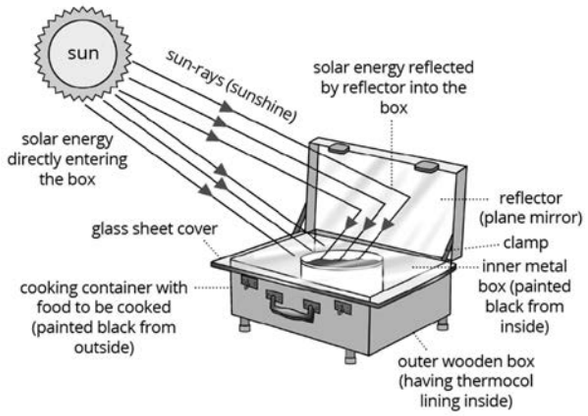
The practical applications of the above finding could be used in our daily life. Some of them are:

a. The bottom part of cooking utensils is blackened to absorb the heat of the flame quickly.

b. We wear dark coloured clothes during winters. This is because black or dark coloured clothes absorb more heat and keep us warm during winters.

2. Construction of a solar cooker:

A solar cooker is a device that utilises solar energy for cooking food. It consists of the following.



a. Wooden box: A solar cooker consists of a rectangular wooden box, which is lined from inside with some insulating material such as thermocol or glass wool. The insulating material prevents heat losses due to

conduction, convention or radiation. Within the wooden box is placed a tight fitting metallic box, whose inner surface is painted black, as black surfaces are good absorbers of heat energy.

b. Glass sheet cover: The top of the box is covered by a lid which consists of an aluminium frame, to which a plane glass sheet is fixed.

c. Plane mirror reflector: A plane mirror reflector fixed in a frame is attached to the upper side of the box with the help of clamps. The plane mirror reflector can be adjusted to any angle so that the reflected sunlight falls on the glass sheet cover of the box.

d. Cooking containers: The cooking containers having lids are made of aluminium and blackened from outside are kept in the wooden box. These cooling containers are also pointed black because surfaces absorb more heat.

3. Working of a solar cooker:

a. In order to cook food in the solar cooker, the food materials such as rice, dal, etc.are placed in the containers with appropriate amount of water and lids are fixed on them.

b. The cooking containers are then placed inside the wooden box and the glass sheet cover of the box is closed.

c. The solar cooker is then placed in the open turned towards the sun. The angle of the plane mirror reflector is so adjusted that the more of the reflected sunlight falls on the glass cover sheet.

d. The sun rays passing through the glass sheet cover get absorbed by the black surfaces inside the box. This heats up the box. As a result, the hot inner surface starts radiating infrared radiation of longer wave length.

e. The glass sheet cover does not allow these infrared radiations to escape. The trapping of infrared radiation by the glass sheet cover is called greenhouse effect.

4. a. Wooden box: A solar cooker consists of a rectangular wooden box, which is lined from inside with some insulating material such as thermocol or glass wool.
The insulating material prevents heat losses due to conduction, convention or radiation. Within the wooden box is placed a tight fitting metallic box, whose inner surface is painted black, as black surfaces are good absorbers of heat energy.

b. Glass sheet cover: The top of the box is covered by a lid which consists of an aluminium fame, to which a plain glass sheet is fixed.

c. Plane mirror reflector: A plane mirror reflector fixed in a frame is attached to the upper side of the box with the help of clamps. The plane mirror reflector can be adjusted to any angle so that the reflected sunlight falls on the glass sheet cover of the box.

5. a. The solar cooker cannot be used to cook the food during night time.

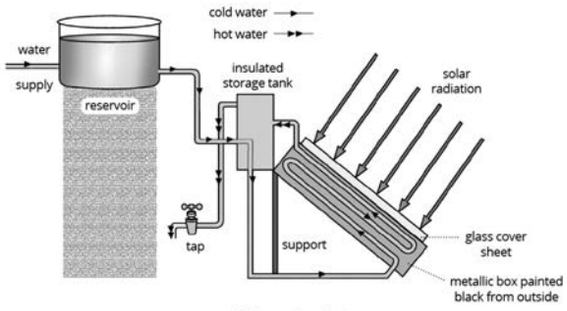
b. The solar cooker cannot be used to cook the food when the sky is cloudy during daytime.

c. The direction of the plane mirror reflector of the solar cooker has to be changed frequently from time to time, so that it always faces the sun.

d. The solar cooker cannot be used for frying, baking or making chapattis.

e. It takes a longer time to cook the food especially during winters. The efficiency of the solar cooker is much lower as compared to the devices working on coal or LPG or electricity.

6. A solar water heater is a device used to heat water with the help of solar energy. A solar water heater works on the same principle as that of a solar cooker. A solar water heater consists of two main parts.



Solar water heater

a. A flat plate collector: It consists of a rectangular, insulated metallic box which is painted black from both the sides. The box contains copper tubes bent in the form of a coil. This is done to increase the surface area for absorbing heat. The copper tube is blackened from outside. The blackening of the box and copper pipes is done so as to absorb radiant heat energy of the sun

effectively. The metallic box is provided with glass cover sheet to provide greenhouse effect.

b. An insulated storage tank: It is connected with the reservoir containing cold water (and the free end of the copper tubes contained in the collector. One free end of the copper tube of the collector is connected to the bottom of the storage tank serving as an inlet for the cold water. The other free end of the copper tube of the collector is connected to the middle of the storage tank serving as an outlet for the hot water.

Working of a solar water heater:

The solar water heaters are placed in the open space generally on the terrace of the buildings. When the sun shines, the solar radiations enter the metallic box through glass lid and are absorbed by water present in copper tubes. Water on getting hot expands and pushed itself into the insulated storage tank through outlet end. To take the place of hot water, the fresh cold water from the water supply enters from below into the inlet end of the copper tube. Thus, a convection current sets up and the hot water circulates from the water supply to the storage tank. Whenever hot water is required, it is taken out from the storage tank through the tap. Solar water heaters are used for supplying hot water in big hotels, hospitals, industries, requiring hot water, cooperative housing societies, etc.

7. a. Metallic box is painted black from both sides so as to absorb radiant heat energy of sun effectively.

b. Copper tubes are bent in the form of a coil to increase the surface area for absorbing heat.

c. The metallic box is provided with a glass cover sheet to provide greenhouse effect.

8. A solar cell consists of a 4 cm^2 of semiconductor silicon, in fact, it consists of a very thin sandwich of n-type and p-type wafer of silicon in which is placed a U- shaped metal grid. When exposed to sunlight, the solar radiation falls on the solar cell, the n-type wafer produces a large number of electrons. These electrons drift towards p-type wafer thereby generating an electric potential.

9. Refer to question 8.

10. Solar cell panels are being used to produce electricity for the purposes of street lighting, operating water pumps for domestic and agricultural works in remote/rural areas.

11. Uses of solar cell panel: In spite of the high cost, low efficiency and conversion problem, solar cells are used for many scientific and technological appliances. Some of them are:

a. Artificial satellites and space probes, like Mars orbiters, use solar cell panel as the main source of energy.

b. Radio broadcasting or TV relay stations in remote areas use solar cell panel for its transmission. This is because in remote areas, we may not find power transmission line as it is expensive and not commercially viable.

c. Traffic signals, electric watches, calculators and many toys are fitted with solar cells.

d. Solar cell panels are being used to produce electricity for the purposes of street lighting, operating water pumps for domestic and agricultural works in remote/rural areas.

12.

Sun as the direct source of energy	Fossil fuels
The sun is a renewable source of energy, so, it is inexhaustible.	Fossil fuels are non-renewable sources of energy. There are limited reserves of fossil fuels, so, it is exhaustible.
The solar energy does not cause any kind of environmental pollution.	Burning of fossil fuels produces lot of smoke, so, it causes air pollution.
The solar energy is available only during the daytime when the sun shines and when the clouds are not around.	Fossils fuels can provide energy at any time
Special devices like solar cell or solar cooker are needed to utilise solar energy.	No special devices are needed to use fossil fuels.
The sun's energy is available in a diffused form (scattered form).	Fossil fuels provide energy in concentrated form.
It has lower heat generation efficiency.	Fossils fuels have comparatively higher heat generation efficiency than solar energy.
It is a non-conventional source of energy.	Fossil fuels are traditional and conventional sources of energy.

P. 132 Check Your Progress 7

A. Multiple-choice Questions

1. c **2**. b **3**. b **4**. b **5**. c

B. Very Short Answer Type Questions

1. Kinetic energy (tidal energy)
2. Limitations of tidal energy:
   a. **Limited scope:** Tidal dams cannot be established everywhere. There are very few sites around the world which are suitable for building tidal dams to harness tidal energy.
   b. **Small scale power generation:** The rise and fall of sea water during tides is not enough to generate electricity on a large scale.
   c. **High maintenance cost:** The sluice gates and blades of the turbines are exposed to salty sea water, so they need a high level of maintenance, so the cost incurred in its maintenance is high.
   d. **Valuable output:** There is variation in the tides during the daytime so the power generation is also affected.
3. Due to geological changes, molten rocks called magma formed in deeper hot regions of earth's core, get pushed upwards and trapped in certain regions called hot spots.
4. The heat inside the earth that can be utilised as a source of energy under favourable conditions is called geothermal energy.
5. New Zealand and United States of America
6. The alternate rise and fall in the water level of oceans and sea is known as tides. The rise of the ocean water called high tide, while the fall of the ocean water is called low tide.
7. The energy available due to the difference in the temperature between the water at the surface and water as depths is called ocean thermal energy (OTE).
8. Geothermal
9. At some places, steam and hot water trapped inside layers of rocks sometimes force their way to surface through cracks in the rocks. They gush out in the form of high fountains called geysers.

C. Short Answer Type-I Questions

1. The energy obtained from tidal waves is known as tidal energy.

   A tidal power plant has a dam built across a day having the narrow opening to the sea. A turbine connected to the generator through a shaft is fixed at the opening of the dam. The dam has sluice gates. The operating and closing of the sluice gates is done by a control valve. During high tides, the sluice gates are opened, water from the sea is allowed to fall on the turbine. The kinetic energy of the incoming flowing water rotates the blades of the turbine. When the turbine rotates, its shaft also rotates and makes the armature of the generator to rotate rapidly. Thus, electricity is produced.

2. **Advantages of tidal energy:**
   a. It is an inexhaustible and renewable sources of energy.
   b. It does not cause any environmental pollution.
   c. It is not affected due to uncertainty of rainfall (as we have seen in case of hydroelectricity, less rainfall lowers hydropower generation.
   d. It does not produce any harmful waste (as we have seen in case of burning of fossil fuels which produces ash).
   e. It saves our valuable fossil fuels as it does not require any fuel for its production. Once the tidal power plant is established, it has low maintenance cost.
3. The energy associated with the sea wave is called sea wave energy. A wide variety of devices have been developed to trap wave energy to rotate the blades of the turbine. The shaft of rotating turbine rotates the armature of the generator and electricity is produced.
4. Steam trapped inside layers of rocks is brought to the earth's surface by sinking pipes through holes drilled up to the hot spots. The steam which comes out at high pressure through holes is utilised to turn the turbines of an electric generator to produce electricity.

D. Short Answer Type-II Questions

1. The water at the sea gets heated by the heat of the sunrays falling on it and attains a higher temperature. The water in the deeper sections in the sea is not heated to the same extent and so is relatively colder. So, there is always a temperature difference between the water at the upper surface and at deeper level of the sea.
2. In can be operational when the temperature difference between the water at the surface and water at depths up to 2 km is 20 °C or more. The warm water of the sea is used to

boil a liquid like ammonia or chlorofluorocarbon (CFC) in the evaporator of OTEC plant to obtain its vapour. The resulting vapours of the ammonia liquid are used to rotate the blades of the turbine. The rotating turbine rotates the armature of the generator to generate electricity. The cold water from the depth of the ocean is pumped up to the condenser of the OTEC power plant. This cold water is used to condense ammonia vapour into liquid ammonia. The liquid ammonia is again taken back to the evaporator and the process is repeated again and again.

3. The limitations of the energy that can be obtained from the oceans are:

a. Limited sites: There are very few sites in the world which are suitable for harnessing energy from the oceans. Tidal dams to derive energy from tidal energy cannot be established everywhere as the rise and fall of sea – water during high and low tides is not enough to generate electricity. Oceans wave energy can be obtained only at place where waves are very strong. Ocean thermal energy can be obtained only when temperature difference between water at the surface and water at depth up to 2 km is 20 °C or more.

b. Huge investment: The devices and technologies needed to trap ocean energy are very expensive.

c. Small scale power generation: The power generated from energy obtained from the oceans is very small in amount. The efficiency of power generation is very low. It is of variable nature.

d. High maintenance cost: The sluice gates and blades of the turbines are exposed to salty sea water, so they need a high level of maintenance, so the cost incurred in its maintenance is high.

4. a. Geothermal energy is a renewable source of energy. Since the interior of the earth is going to remain hot for millions of years, geothermal energy is an inexhaustible source of energy.

b. It is clean source of energy as it does not cause any environmental pollution.

c. The cost of production of electricity is not much, i.e. the electricity produced is inexpensive and economical.

d. It enables us to save our fossil fuels as it requires no fuels for its production.

5. Limitations of geothermal energy:

a. Geothermal hot spots are scattered and not found everywhere. There are very few commercially viable sites where such energy can be harnessed.

b. Deep drilling in the earth to take out steam coming from hot spots is very expensive.

P. 139 Check Your Progress 8

A. Multiple-choice Questions

1. b **2**. a **3**. b **4**. b **5**. d

B. Very Short Answer Type Questions

1. The energy released by either splitting up of a heavy unstable nucleus or by fusion of two or more light nuclei is called nuclear energy.

2. The difference between the actual mass of the original nucleus and the sum of the masses of the individual product nucleons is called mass defect.

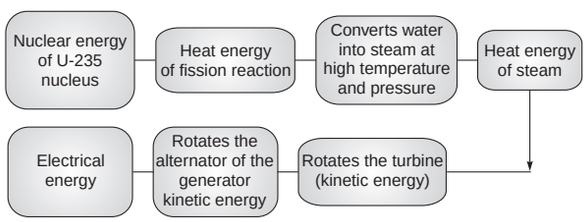
3. When uranium-235 atoms are bombarded with slow moving neutrons, the heavy uranium breaks up to produce two medium-weight atoms, barium-139 and krypton-94 with the emission of three neutrons. A large amount of energy is produced during the reaction.

$$^{235}_{92}U + {}^{1}_{0}n \xrightarrow[fission]{Nuclear} \underbrace{{}^{139}_{56}Ba + {}^{94}_{36}Kr}_{\text{Two medium weight fission product}} + 3\,{}^{1}_{0}n + \text{large amount of energy}$$

4. A kind of reaction where the particle which initiates (starts) the reaction is also produced during the reaction and carries on the reaction further and further to make it self-propagating and continuous is called a chain reaction.

5. The set-up used for generating electricity from the heat energy released in a controlled nuclear fission chain reaction is called a nuclear power plant.

6. The heat produced in a controlled nuclear fission is used for producing steam. The steam so produced runs the turbine. The rotatory motion of the turbine rotates the alternator of the generator and electricity is produced. Thus, in a nuclear power plant, the energy transforms in the following sequence.



7. The process in which two lighter nuclei fuse to form a stable heavier nucleus with the liberation of enormous amount of energy is called nuclear fusion. For example, two deuterium atoms (heavy hydrogen atoms with mass number 2) combine to form a heavy nucleus of helium and a neutron is emitted. A large amount of energy is also produced during the reaction.

$$\underset{\text{Deuterium}}{{}^{2}_{1}\text{H} + {}^{2}_{1}\text{H}} \xrightarrow[\text{fusion}]{\text{Nuclear}} {}^{3}_{2}\text{He} + {}^{1}_{0}n + \textbf{large amount of energy}$$

8. The nuclear energy can be obtained by two ways (a) nuclear fission (b) nuclear fusion.

9. The nuclear power plant produces radioactive nuclear waste. Improper waste storage and disposal leads to contamination. These nuclear radiations can cause serious damage to plants, animals (including human beings) and the environment.

10. Production of heat in a controlled fashion.

11. $E = \Delta mc^2$ where Δm = mass defect or loss in mass, c = speed of light in vacuum (i.e. 3×10^8 ms^{-1}).

12.

Nuclear fission	Nuclear fusion
A heavy unstable nucleus breaks down into two or more lighter nuclei. Examples: ^{235}U, ^{239} Pu, etc.	Two (or more) lighter nuclei combine to form a heavier nucleus. Examples: Deuterium, tritium, etc.
Limited, expensive	Unlimited, cheap
It is accompanied by emission of nuclear radiation and hence causes nuclear pollution.	It is not accompanied by emission of nuclear radiation and hence causes no nuclear pollution
It is possible in fission reactions.	It is not possible.
Amount of energy released is very large.	Amount of energy released is much larger than that released in fission.
Very acute since the waste produced is radioactive and causes pollution.	Not acute since waste produced in fusion reaction is not radioactive

13. Use of each and every source disturbs the environment in some way or the other. These are called environmental consequences of using that source of energy.

C. Short Answer Type-I Questions

1. The process of splitting of the nucleus of a heavy atom such as $^{235}_{92}U$ (by bombarding with slow neutrons) into two or more lighter nuclei with the liberation of enormous amount of energy is called nuclear fission.

2.

Uncontrolled Chain Reaction	Controlled Chain Reaction
A chain reaction in which all the neutrons produced during the fission reaction are deliberately allowed to go out of control by causing further fissions leading to an explosion.	A chain reaction in which the neutrons produced during the fission reaction causes just one further fission reaction and the extra neutrons are removed by control rods.
10^{20} Uranium-235 atoms undergo fission in just one minute.	Only 60 Uranium-235 atoms undergo fission in one minute.
Energy is produced in unmanageable amount	Energy is produced at a slow, steady and manageable rate.
Released energy cannot be used for useful purpose.	Released energy can be used for useful purposes like generation of electricity, etc.
It is used for destructive purpose, i.e. making a nuclear bomb (or atom bomb).	It is used constructive purpose like generation of electricity.

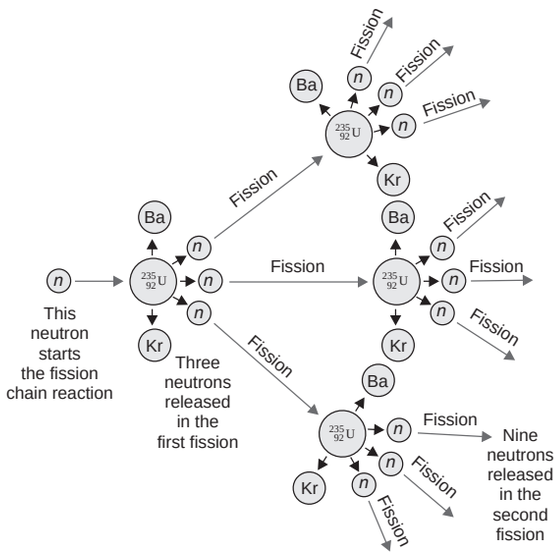
3. Electron volt is unit of nuclear energy. 1 eV = 1.602×10^{-19} J.

4. CNG also causes pollution. It releases CO_2 on burning.

5. The actual operation of a device like solar cell may be pollution-free, but the assembly of the device causes some environmental damage.

D. Short Answer Type-II Questions

1.



2. The advantages of nuclear energy are:

   a. **Tremendous amount of energy produced:** The fission of an atom of uranium produces 10 million times the energy produced by the combustion of an atom of carbon from coal.

b. Energy supply: The nuclear power plant can go on producing electricity for a long span of time once its reactor is loaded with nuclear fuel like uranium.

c. Polluting gases: Unlike fossil fuels, it does not produce carbon dioxide, so it does not contribute to the greenhouse effect. It does not produce sulphur dioxide, so it does not cause acid rain.

3. The energy produced by fission of one atom of uranium is 10 million times the energy produced by the combustion of on atom of carbon from coal.

4. Disadvantages of nuclear energy:

a. Expensive installation: The cost of installation of a nuclear power plant is very high. Hence, the cost of electricity generated in a nuclear power plant is more than the cost of electricity produced in hydrothermal power plant or thermal power plant stations.

b. High risk of environmental contaminations: The waste materials produced during the various steps of the nuclear energy production in a nuclear power plant are harmful because they contain radioactive substances (like barium-139 and krypton-94) which emit nuclear radiations. There is a great problem of disposal of nuclear wastes. Improper nuclear waste storage and disposal results in environmental contamination.

c. Risk of accidental leakage: Any damage caused to a perfectly working nuclear power plant can cause leakage of nuclear radiations. The leakage of nuclear radiations from a nuclear reactor of the nuclear power plant can be due to:

i. Some fault in the construction of the nuclear reactor.

ii. Natural calamity like earthquake, volcano or some other accident at the site of the nuclear reactor. Accidental leakage of large scale nuclear radiations took place from the nuclear power plant at 'Three Mile Island' (USA) and from the nuclear power plant at Chernobyl (former Soviet Union). These radiations can cause serious damages to the plants, animals (including human beings) and the environment.

5. Environmental consequences of various sources of energy:

a. i. The combustion of fossil fuel produces carbon dioxide which is a greenhouse gas. Increasing amount of carbon dioxide would increase the greenhouse effect in the atmosphere leading to global warming.

ii. Fossil fuels contain sulphur which produces sulphur dioxide on burning. The sulphur dioxide gas dissolves in atmospheric water to form sulphuric acid which falls on the earth along with the rains. This rain, known as acid rain damages crops, affects our water and soil resources, etc.

iii. The combustion of fossil fuels produces poisonous gases like carbon monoxide, oxides of nitrogen, suspended particulate, etc., which pollute air. This polluted air affects the plant life and animal life (including human beings).

b. For obtaining firewood, we need to cut down trees from a forest (deforestation). This causes soil erosion and disturbs the wildlife ecosystem. This affects our environment.

c. The construction of hydroelectric power plant (dam) disturbs the environment of the site of production of energy. Many plants and trees are destroyed when submerged in the water of reservoir formed by the dam. Human beings and animals have to migrate from this place as they are rendered homeless.

d. The continuous moving of the blades of a large number of windmills in a wind energy farm affects the routes of migratory birds.

e. The devices and technologies used to exploit energy from the oceans like tidal dams, oscillating water column, OTEC power plants, etc. affect the marine life.

f. The nuclear power plant produces radioactive nuclear waste. Improper waste storage and disposal leads to contamination. These nuclear radiations can cause serious damage to plants, animals (including human beings) and the environment.

6. The various factors which we should keep in mind while choosing a source of energy are:

a. The ease of extracting energy from the source.

b. The cost of extracting energy from the source.

c. The efficiency of the technology available to extract energy from that source, and

d. The damages to environment which will be caused by using that source.

P. 141 Higher Order Thinking Skills (HOTS) Questions

A. Multiple-choice Questions

1. c **2**. a **3**. c **4**. b **5**. b

B. Very Short Answer Type Questions

1. Hydro power is generated from water and water is a renewable source of energy. Hence, hydro power is a renewable source.

2. Use of wind as a source of energy does not produce any toxic gases hence, it is pollution free.

3. Plane mirror because it reflects most of the light falling on it.

4. Tidal energy and geothermal energy.

5. Chemical energy of the fuel → converts water into steam having heat energy → rotates the turbine → rotates the armature of the generator → production of electricity.

6. Biomass plant material is a renewable energy source because the energy it contains comes from the sun. Through the process of photosynthesis, plants capture the sun's energy. When the plants are burnt, they release the sun's energy they contain. In this way, biomass functions as a sort of natural battery for storing solar energy.

C. Short Answer Type-I Questions

1. Thermal power plants are set-up near the coal and oil fields because coal and oil are its basic source of energy and also to lessen the cost of production.

2. CNG is considered an environment friendly fuel as it gives no polluting gases or particulate matter as by-products on burning.

3. **a.** Falling water, and,

b. Ocean tides run turbines to produce electricity.

P. 142-145 Exercises

A. Objective Type Questions

I. Multiple-choice Questions

1. c **2**. c **3**. d **4**. c **5**. b

II. Fill in the blanks

1. Ocean Thermal Energy Conversion

2. Natural gas

3. 33 kJ/g

4. The Sun

5. fossil fuels

III. Assertion–Reasoning Type Questions

1. b **2**. d **3**. a **4**. b **5**. d

6. c **7**. a **8**. d **9**. c **10**. b

IV. Very Short Answer Type Questions

1. Methane, carbon dioxide

2. Biogas is a mixture of methane, carbon dioxide, hydrogen and traces of hydrogen sulphide. The chief constituent of biogas is methane (up to 75% by volume).

3. Nitrogen and phosphorus

4. Oil is better than coal because coal produces more carbon than oil and hence pollutes the environment.

5. The slurry is rich in nitrogen and phosphorus and hence, it is used as manure.

6. In this process, the kinetic energy of flowing water gets transformed into potential energy of water stored behind the dam.

7. We should use LPG for heating our food because it burns without giving out any harmful gases.

8. B is safe because it will not burn spontaneously as A would.

9. Methanol and charcoal.

10. Mechanical energy

11. CNG is considered an environment-friendly fuel as it gives no polluting gases or particulate matter as by-products on burning.

12. Solar cells and solar cell panels do not cause any environmental pollution.

Use of solar cells enables us to save usage of fossil fuels as solar cells require no fuel.

13. Silicon and gallium.

14. No. The farther away from the sun, the lesser will be the efficiency of solar cell panel.

15. Nuclear fusion.

16. Problem of nuclear waste disposal

B. Short Answer Type-I Questions

1. The fuels which are obtained from the remains of plants and animals are called fossil fuels. Coal, petroleum and natural gas are examples of fossil fuels.

2. The calorific value of wood is very low and burning of wood produces a lot of smoke thereby polluting the environment.

3. Four gases commonly present in biogas are:

a. Methane

b. Carbon dioxide

c. Hydrogen sulphide

d. Hydrogen

Advantages of biogas over fossil fuels are:

i. biogas does not produce any smoke and hence, cause no air pollution.

ii. biogas on burning leaves no residue.

4. a. Advantages: Windmills are environment-friendly as they do not cause pollution and they are also cheap.

b. Disadvantages: Windmills are tall and they stand on places where the terrain is very open and free. Therefore, there is also free outlook to the windmills. If the wind speed has reached its maximum the mill is forced to reduce speed to not hurt the mills' machinery. It is a disadvantage that the windmills don't have an engine with a greater capacity.

5. Advantages: It is a renewable source of energy and it does not contribute to pollution of environment.

Disadvantages: It cannot be used at night and during cloudy weather and the energy efficiency is very low.

6. The waste produced in nuclear power plants are harmful because they contain radioactive substances which emit nuclear radiations. Improper nuclear waste storage and disposal results in environmental contamination.

7. The waste materials produced during various steps of the nuclear energy production in a nuclear power plant is the nuclear waste. These materials are harmful because they contain radioactive substances like barium-139 and krypton-94 which emit nuclear radiations. Their disposal is a serious problem because improper disposal results in environmental contamination.

C. Short Answer Type-II Questions

1. a. It should be economical and easily available.

b. It should burn at a moderate and steady rate, i.e. it should not burn either too fast or too slow.

c. It should not produce any poisonous and irritating fumes or smoke during burning.

2. Renewable energy is energy that is produced from natural processes and continuously replenished. Solar energy and wind energy are two such renewable sources.

These sources are unlimited and they are never going to diminish.

These sources are naturally replenishing.

These sources do not cause pollution

They do not release any harmful substance

3. Three reasons for the need to harness non-conventional sources of energy are as follows:

a. Conventional sources are going to be exhausted in near future.

b. Burning of fossil fuels causes environmental pollution.

c. Rising prices of oil and gas has badly affected the foreign exchange.

4. Biogas is obtained by anaerobic decomposition of cow-dung in the presence of water. Biogas is a mixture of methane, carbon dioxide, hydrogen and traces of hydrogen sulphide. The chief constituent of biogas is methane (up to 75 % by volume).

The steps involved in obtaining biogas.

i. Cow-dung and water are mixed in equal proportions in a mixing tank to prepare a semi-fluid mixture called **slurry**.

ii. The slurry so prepared is passed on the underground digester tank through an inlet chamber. The digester tank is a sealed chamber in which there is no oxygen. It is in the digester tank where the slurry is decomposed in about 50–60 days by anaerobic bacteria to produce biogas. This biogas produced gets collected in the gas tank.

iii. As biogas keeps collecting in the dome, it exerts pressure on the spent slurry in the digester tank. This pressure forces the spent slurry to flow into the overflow tank through the outlet chamber.

iv. The spent slurry is gradually removed from the overflow tank. It is rich in nitrogen and phosphorus compounds, so it is taken in fields and used as manure.

v. The biogas which gets collected in the gas tank is taken out through the biogas outlet pipe and used as required.

vi. To get a continuous supply of biogas, fresh slurry is added to the digester tank periodically to replace the spent slurry.

The biogas so obtained is a better fuel than the dry cow-dung cakes.

5. The calorific value of biogas is very high as compared to cow-dung cakes.

Biogas does not produce any smoke and hence causes no air pollution.

Residue Biogas on burning leaves behind no residue, so it is a clean fuel.

Cow-dung contains vital nutrients like nitrogen and phosphorus, which are necessary for the growth and development of the crops in the soil. These nutrients are not destroyed in the biogas plant and hence the spent slurry containing these nutrients can be used as manure

Biogas is a mixture of methane, carbon dioxide, hydrogen and traces of hydrogen sulphide. The chief constituent of biogas is methane (up to 75% by volume).

6. Cow-dung cakes produce a lot of smoke and pollute the environment and cow-dung cakes have low calorific value; they do not burn completely and produce ash. Better way of using cow-dung is to convert it into biogas.

7. Diesel is a fossil fuel and it causes pollution. CNG is a clean fuel and hence does not pollute the environment. It has lesser impurities.

8. Potential energy of stored water in dam $\rightarrow$ kinetic energy of flowing water $\rightarrow$ kinetic energy of turbines $\rightarrow$ electrical energy in generators.

9. A solar cell is a device which directly converts solar energy into electrical energy. In a solar cell, it is the light energy present in solar energy which gets converted into electrical energy. So, a solar cell is also called a **solar photovoltaic** (SPV) cell.

A group of solar cells connected in a specific pattern to produce desired potential difference and magnitude of current (electric power) is called solar cell panel. Solar cells in a solar cell panel are connected by wires made of silver metal. We know silver is the best conductor of electricity, so it increases the efficiency of the solar panel.

A solar panel is mounted on a tall supporting pole or installed on specially designed inclined roof tops so that more solar energy is incident over it. The solar energy falling on the solar cells of the solar cell panel gets converted into electricity. The electricity so produced flows to storage battery, where it is stored in the form of chemical energy. This charged storage battery can supply electricity whenever required.

Advantages of solar cells /solar cell panels

i. Solar cells have no moving parts, are easy to construct and require little maintenance.

ii. Solar cell panels can be installed in remote and very less populated areas in which laying a power transmission line may be expensive and not commercially viable.

10. Nuclear energy is harnessed in nuclear power plants. It contains a nuclear reactor, a boiler and a turbine. The nuclear reactor is the place where nuclear fission is carried out. Nuclear fission produces a huge amount of energy. Energy produced during nuclear fission is utilized to boil water, so that steam can be generated. Steam is utilized to turn the turbines to produce electricity.

Unlike fossil fuels, it does not produce carbon dioxide, so it does not contribute to the greenhouse effect. It does not produce sulphur dioxide, so it does not cause acid rain.

11. Four differences between nuclear fission and nuclear fusion are:

Nuclear fission	Nuclear fusion
A heavy unstable nucleus breaks into two or more lighter nuclei.	Two or more lighter nuclei combine to form a heavier nucleus.
Limited, expensive	Unlimited, cheap
Chain reaction is possible in fission reactions.	Chain reaction is not possible in fusion reactions.
Amount of energy released is very large.	Amount of energy released is much larger than that released in fission.

12. Fossil fuels (coal, petroleum and natural gas) will be depleted some day as these are exhaustible sources of energy. It takes millions of years for their formation, so they cannot be quickly replaced or regenerated when used in large quantities. So, **we cannot depend on fossil fuels as a source of energy for much longer**. We need to conserve our non-renewable sources of energy like fossil fuels (coal, petroleum and natural gas) and also nuclear fuel (like uranium).

On the other hand, renewable sources of energy like geothermal energy, solar energy, ocean energy, wind energy and hydro energy are inexhaustible sources of energy. They are going to remain in our natural environment forever or are stored in such large underground reservoirs that the rate of depletion of the reservoir because of extraction of usable energy is practically negligible, like in case of geothermal energy.

The following steps can be taken to reduce energy consumption and to conserve energy.

i. In offices, schools, hospitals, industries and other establishments, fans, lights, coolers, etc. should be switched off when not in use.

ii. We should use energy efficient appliances. For example, a tube light gives much more light than a light bulb using the same amount of energy.

iii. We should use fuel efficient vehicles and their engines should be tuned properly and maintained timely.

iv. We should close water taps after use and repair all leaking water pipes. Since we use energy to purify water in water treatment plants and pump it to our homes, water saved is energy saved.

D. Long Answer Type Questions

1. Methane, carbon dioxide, hydrogen sulphide and hydrogen. Advantages of biogas over fossil fuels are:

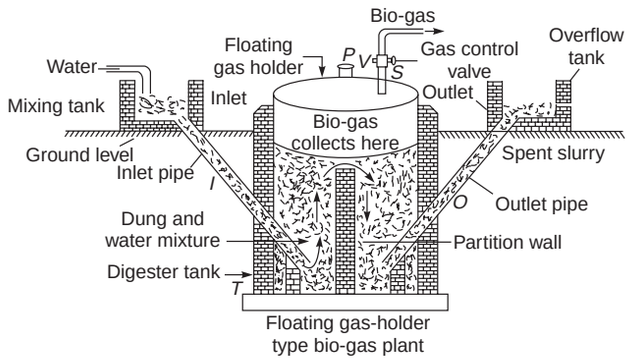
a. Fossil fuels produce smoke while biogas does not.

b. Fossil fuels are non-renewable source of energy while biogas is a renewable source of energy.

c. Fossil fuels produce harmful gas like carbon monoxide in presence of less oxygen while biogas does not produce such gas.

d. Fossil fuels produce SPM in air while biogas does not produce SPM.

2. The fixed dome type biogas plant consists of a digester tank, a mixing tank and an overflow tank.



Digester tank: It is well-shaped underground tank. The roof of the digester tank is made in the form of a dome. This dome-shaped structure called gas tank acts as a storage tank for the biogas. There is a biogas outlet pipe at the top of dome having a gas valve.

Mixing tank: On the left side of the digester tank is the mixing tank lying above the ground. The bottom of the mixing tank is connected to the digester tank through the inlet chamber.

Overflow tank: On the right side of the digester tank is the overflow tank lying below the ground. The bottom of the overflow is connected to the base of the digester tank through the outlet chamber.

3. Paper and vegetable waste.

Advantages: recycling of energy resources, preventing environmental pollution, saving fossil fuels, keeping the environment clean. If these materials are converted into biogas rather than burnt, we see the following advantages:

a. No smoke is produced.

b. The nutrients like nitrogen and phosphorus are not destroyed.

c. Biogas can be used to drive water pump.

d. No storage space is required for biogas.

4. a. Solar heater

b. Solar cell. When fast moving wind strikes the blades of the turbine, it exerts a force on its blades. The blades start rotating continuously. The shaft of the wind turbine also starts rotating. The rotating shaft rotates the armature of the generator and electricity is produced. The electricity so produced is fed to step up transformer and supplied to homes and industries through transmission lines.

5. Four possible mistakes could be

a. The direction of plane mirror reflection is not correct.

b. The lids of cooking container are not blackened.

c. The cooking container is not painted black.

d. The insulating material is not able to prevent heat loss.

It can attain temperature in the range 100–140 °C.

E. Source-Based/Case-Based/Passage-Based/ Integrated Assessment Questions

1. a. i. renewable energy.

b. i. 20 km/h.

c. iii. fifth.

d. i. transformer.

e. ii. Denmark.

2. a. ii. uranium-235.

b. iv. Japan.

c. iii. Cadmium.

d. iii. Tarapur.

e. ii. boron.

F. Value-Based Questions (Optional)

1. a. Yes, Annie did the right thing by switching off the lights and fans. It will save electricity.

b. This shows that Annie knows the importance of saving electricity. She is worried about the future generations and wants to save electricity.

2. a. We should pool cars so as to save the fuel and it will also help in lowering the pollution caused due to vehicles.

b. Kabir's gesture shows that he cares about the environment. He is kind enough to ask everyone to accompany him. He is aware about the current situation of our environment and wants to lower the pollution.

3. a. The advantages of using solar cooker are:

i. It saves fuel as it requires no fuel or electricity.

ii. The use of solar cooker does not produce any smoke. Hence, it does not cause any pollution.

iii. Solar cooker has very low installation and maintenance cost.

iv. Solar cooker can cook one to four dishes simultaneously at the same time.

v. Food is cooked at comparatively low temperature in a solar cooker. So, the vitamins contained in the food are not destroyed and the nutritional value of the food is preserved.

b. It shows that Sharmila is an intelligent girl. She wants to save fuel and being technologically aware, she uses solar cooker to cook food and saves fuel.

4. a. We are looking for alternate sources of energy because fossil fuels will be depleted some day as these are exhaustible sources of energy. It takes millions of years for their formation, so they cannot be quickly replaced or regenerated.

b. It shows that the college principal is very helpful and encourages students to work on such projects which will help us and environment.

5. a. Benefits of having a nuclear power plant in our country are:

i. Nuclear power plant produces tremendous amount of energy from a very small amount of nuclear fuel.

ii. The nuclear power plant can go on producing electricity for a long span of time once its reactor is loaded with nuclear fuel.

iii. Unlike fossil fuels, it does not produce carbon dioxide, so it does not contribute to the greenhouse effect.

b. It shows that the Indian Prime Minister is an ambitious person. He wants to develop the country by meeting the energy requirement of the nature. He wants the development to be environment-friendly.

CHAPTER–4

REFLECTION OF LIGHT

P. 150–151 Check Your Progress 1

A. Multiple-choice Questions

1. c **2**. a **3**. b **4**. c **5**. b

B. Very Short Answer Type Questions

1. Light is a form of energy that produces the sensation of sight.

2. Reflection is the phenomenon in which light rays on striking a polished smooth surface such as mirror are sent back into the same medium.

3. It retraces its path on reflection.

4. The left of the object becomes the right of the image and vice verse. This phenomenon is called lateral inversion.

5. Shadows and eclipses.

6. If we hold a cardboard in front of us, we will not be able to see our face in it. This is because the entire light that falls on the surface is reflected in all directions irregularly, in a scattered manner. Such a reflection is called irregular reflection.

7. a. 40°C **b.** 40°C

8. Right ear is touched by the left hand.

9. When light falls on a smooth reflecting surface, e.g. mirrors, it obeys the following two laws of reflection:

a. The angle of incidence ($\angle i$) is equal to the angle of reflection ($\angle r$), i.e. $\angle i = \angle r$.

b. The incident ray, the normal to the reflecting surface at the point of incidence and the reflected ray, all lie in the same plane.

C. Short Answer Type-I Questions

1. Sun, electric bulb, candle, tube light

2. Characteristics of light:

a. Light is an electromagnetic wave.

b. Light does not require a material medium (like solid, liquid or gas) for its propagation. It can travel through vacuum too. The best example of this is light travelling from the sun to the earth across the space that has no material medium.

3. The phenomenon, due to which a parallel beam of light travelling through a certain medium, on striking a smooth, highly polished surface (such as mirror) bounces back from it as a parallel beam of light in some other direction is called regular reflection whereas the phenomenon, due to which a parallel beam of light travelling through a medium, on striking a rough surface (such as cardboard) gets reflected in various directions in the same medium, is called irregular reflection.

D. Short Answer Type-II Questions

1. 10 cm.

2. Characteristics of an image formed by a plane mirror:

a. The image is formed behind the mirror and has the same size as the object.

b. The image laterally inverted.

c. The image is as far behind the mirror as the object is in front of it.

d. The image is virtual. It cannot be received on a screen.

e. The image is erect.

3. Virtual, erect, laterally inverted and of the same size.

P. 155 Check Your Progress 2

A. Multiple-choice Questions

1. a **2**. a **3**. b **4**. a **5**. c

B. Very Short Answer Type Questions

1. The surface of the spoon curved inwards can be approximated to a concave mirror. The image formed by the surface of the spoon bulged outwards can be approximated to a convex mirror.

2. a. Concave **b.** Convex

3. a. Concave **b.** Convex

4. a. Aperture: The effective width (distance) of the spherical mirror from which reflection of light can take place is called its aperture.

b. Pole: The centre of the reflecting surface of a spherical mirror is called its pole.

c. Centre of curvature: The geometric centre of the hollow sphere of which the spherical mirror is a part is called the centre of curvature of the spherical mirror.

d. The **radius** of the hollow sphere which the reflecting surface of the spherical mirror is a part is called the radius of curvature of the spherical mirror.

e. Principal axis: The straight line passing through the centre of curvature and the pole of a spherical mirror is called its principal axis.

f. Focus of a spherical mirror is a point on its principal axis at which all light rays parallel to principal axis either appear to meet or actually meet after reflection.

C. Short Answer Type-I Questions

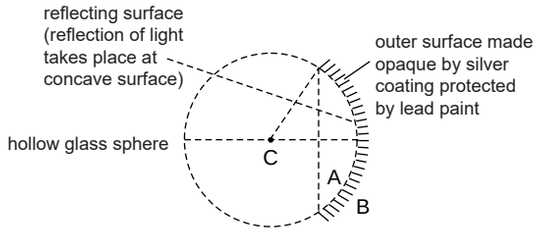
1. A concave mirror has a real focus. The principal focus of a concave mirror is a point on its principal axis at which all the light rays which are parallel and close to the axis, converge after reflection from the concave mirror. So, a concave mirror is called a converging mirror.

2. Distance between the pole and principal focus of a spherical mirror is called the focal length.

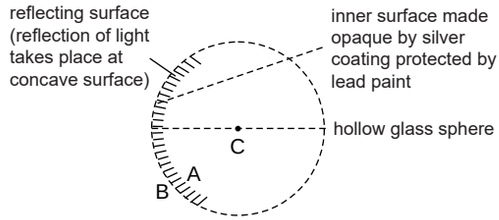
The radius of the hollow sphere which the reflecting surface of the spherical mirror is a part is called the radius of curvature of the spherical mirror.

3. A spherical mirror is obtained by taking a part (thin) of a hollow sphere of glass or any polished metal. The reflecting surface of a spherical mirror may be curved inwards or outwards.

(i) Concave mirror: A spherical mirror whose reflecting surface is curved inwards, i.e. faces towards the centre of the sphere is called a concave mirror.



(ii) Convex mirror: A spherical mirror whose reflecting surface is curved outwards is called a convex mirror.



D. Short Answer Type-II Questions

1.

Concave mirror	Convex mirror
Reflection takes place at the concave surface (or bent – in surface).	Reflection takes place at the convex surface (or bulging out surface).
A parallel beam of light falling on this mirror converges at a point in front of the mirror after reflection.	A parallel beam of light falling on this mirror appears to diverge from a point behind the mirror after reflection.
It is a converging mirror.	It is a diverging mirror.
It has a real focus.	It has a virtual focus.

2. For spherical mirrors of small apertures, the radius of curvature (R) is equal to twice the focal length (f), i.e. $R = 2f$.

3. Procedure used to find the focal length of concave mirror is as follows:

a. A concave mirror is held in such a manner that its reflecting face faces the sun.

b. A sheet of paper is placed near the concave mirror.

c. The mirror is adjusted so that the reflected light falls directly on the sheet of paper placed close to the mirror.

d. The paper is moved forward or backward until a bright sharp spot of light is produced on the sheet of paper. The spot is the inverted image of sun.

e. The distance of the image from the position of mirror gives the approximate value of focal length of the mirror.

4.

Focus of a Concave mirror	Focus of a Convex mirror
It lies in front of the mirror.	It lies behind the mirror.
It is a real focus because the light rays after reflection from a concave mirror actually converge at the focus.	It is a virtual focus because the light rays after reflection from a convex mirror appear to come from the focus.

5.

Real image	Virtual image
A real image is formed when two or more reflected rays intersect each other at a point in front of a mirror.	A virtual image is formed when two or more reflected rays appear to intersect at a point behind a mirror.
It can be obtained on a screen.	It cannot be obtained on a screen.
It is inverted (upside down) with respect to the object	It is erect with respect to the object.

E. Numerical Problems

1. 18 cm

2. 45 cm

3. 50 cm/s

4. a. Radius of curvature $R = 30$ cm

We know $R = 2f$

$30 = 2f$

$f = 15$ cm

b. Focal length, $f = 20$ cm

We know $R = 2f$

$R = 2 \times 20 = 40$ cm

c. According to the question, $f + R = 30$

We know $R = 2f$

Therefore $f + 2f = 30$

$3f = 30$

$f = 10$ cm Hence, focal length is 10 cm.

P. 162–163 Check Your Progress 3

A. Multiple-choice Questions

1. d **2**. b **3**. d **4**. a, c **5**. a

B. Very Short Answer Type Questions

1. Concave mirror is used as shaving mirror because it produces an enlarged erect image.

2. Convex mirrors are used as rear-view mirrors in vehicles like cars, trucks and buses to see the traffic behind. Convex mirrors are used as rear-view mirrors because of the following two reasons:

a. The image formed in a convex mirror is highly diminished due to which a convex mirror gives a wide field of view of the traffic behind the vehicle.

b. A convex mirror always produces an erect image with respect to the object irrespective of the position of the traffic behind.

3. Convex

4. Beyond centre of curvature

5. No

6. Convex

7. Concave

8. Within the focal point

9. Concave mirrors are used by doctors to focus light on some internal body parts. This is possible if a parallel beam of light is incident on a concave mirror which focuses the beam to a point. In this case, the beam is converged to the internal body part to be examined.

10. At the focus

11. Centre of curvature

12. No

C. Short Answer Type-I Questions

1. a. focus of the mirror

b. centre of curvature

2. a. These are used as reflectors, projectors, lighthouses, headlights, search lights, torches, etc. to obtain a parallel beam of light.

b. Concave mirrors are used as shaving mirrors.

3. We can distinguish between these mirrors just by looking into them. Bring each mirror one by one close to your face and observe the image formed on it.

a. If the image is erect, of the same size as the object and it does not change its size and nature on moving the mirror closer or away from the face, the mirror is plane.

b. If the image is magnified, erect and becomes inverted on moving the mirror away from the face, the mirror is concave.

c. If the image is erect, diminished and remains erect on moving the mirror away from the face, the mirror is convex.

4. Concave mirror can produce a magnified image when the object is placed at the

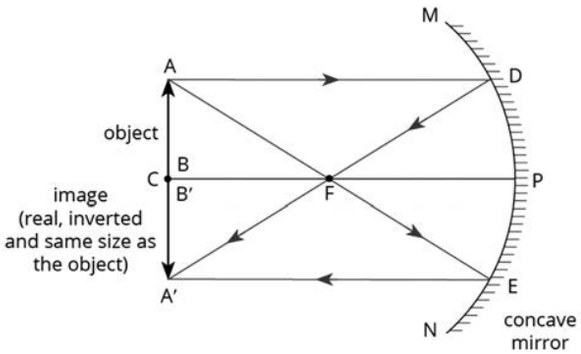
a. focus, and

b. between focus and pole.

There is one difference between the images formed. The image formed when object is at the focus is inverted while the image formed when the object is between pole and focus is erect.

D. Short Answer Type-II Questions

1.



Position of the object: at C

Position: At centre of curvature

Size: Same as the object

Nature: Real and inverted.

2. a. Convex mirrors because

i. the image formed in a convex mirror is highly diminished due to which a convex mirror gives wide field of view of the traffic.

ii. a convex mirror always produces an erect image with respect to the object irrespective of the position of traffic behind.

b. Concave mirrors because

i. they produce an enlarged image of the face.

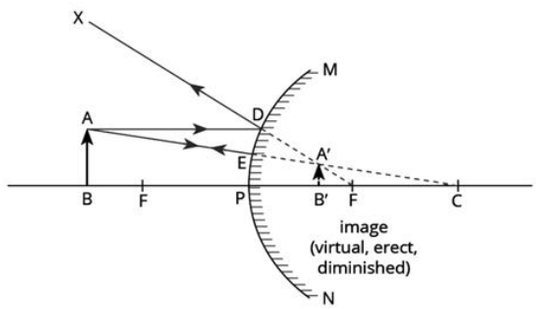
ii. concave mirrors produce an erect image if placed closed to the face.

3. a. Concave mirrors are used in headlights of car because they can give a parallel beam of light when source of light is placed at the focus.

b. Convex mirrors are used in rear view mirrors of car because they form a diminished image due to which it gives a wide field of view and a convex mirror always produces an erect image.

c. Concave mirrors are used in solar furnaces to converge solar radiations at the focus to generate adequate heat.

4.



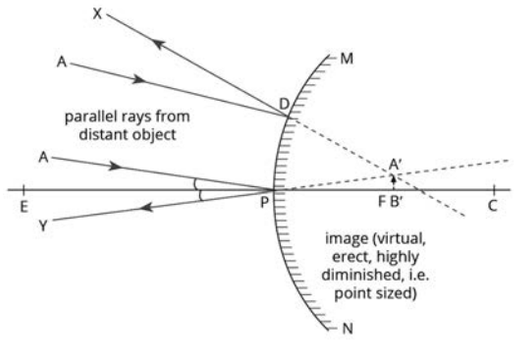
Object between the pole and infinity

Position: Behind mirror between P and F

Size: Diminished

Nature: Virtual and erect

5.



Object at infinity

P. 167–168 Check Your Progress 4

A. Multiple-choice Questions

1. c **2.** d **3.** c **4.** c **5.** a

B. Very Short Answer Type Questions

1. a. + ve **b.** – ve

2. Virtual and erect

3. Magnification is defined as the ratio of the height of the image (h') to the height of the object (h). It is represented by the letter M.

4. When the image is virtual and erect.

5. M = +1

We know Magnification (M) = Height of the image (h') / Height of the object (h)

$$1 = \frac{h'}{h}$$

$$h' = h$$

The size of the image formed by the plane mirror is equal to the size of the object. Since magnification is positive, the image formed by the plane mirror is virtual and erect.

6. a. –ve **b.** +ve

7. Concave

8. When the image is real and inverted.

C. Short Answer Type-I Questions

1. Object distance $u = -10$ cm

Focal length $f = 10$ cm

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

$$\frac{1}{v} + \frac{1}{-10} = \frac{1}{10}$$

$$\frac{1}{v} = \frac{2}{10} = \frac{1}{5}$$

$$v = 5 \text{ cm}$$

So, the image is formed at a distance of 5 cm behind the mirror.

Magnification = $\frac{-v}{u} = \frac{-5}{-10} = 0.5$.

The image is 0.5 times smaller than the object.

2. Focal length = –30 cm

M = + 3 (image is normal)

$$M = \frac{-v}{u}$$

$$3 = \frac{-v}{u}$$

$$v = -3u$$

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

$$\frac{1}{-3u} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{2}{3u} = \frac{-1}{30}$$

$$3u = -60$$

$$u = -20$$

The object must be placed 20 cm from the mirror.

3. Object distance $u = -50$ cm

Image distance $v = 10$ cm

Focal length = ?

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

$$\frac{1}{10} - \frac{1}{50} = \frac{1}{f}$$

$$f = \frac{50}{4} = 12.5 \text{ cm}$$

Since, the focal length is positive, it is a convex mirror.

4. Object distance $u = -10$ cm

Focal length = 15 cm

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

$$\frac{1}{v} + \frac{1}{-10} = \frac{1}{15}$$

$$\frac{1}{v} = \frac{1}{15} + \frac{1}{10}$$

$$v = 6 \text{ cm}$$

$$\text{M} = \frac{-v}{u} = \frac{-V}{11} = \frac{3}{5} = 0.6$$

The image is virtual, erect and diminished.

5. The nature of image is virtual and erect.

D. Short Answer Type-II Questions

1. Object distance u = –15 cm

Focal length $f = -10$ cm

Image distance v = ?

We know

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

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

$$= \frac{1}{-10} - \frac{1}{-15}$$

$$= \frac{-1}{10} + \frac{1}{15}$$

$$= \frac{-3+2}{30} = \frac{-1}{30}$$

$$v = -30 \text{ cm}$$

Therefore, the image distance is 30 cm.

$$h = 5 \text{ cm}$$

$$\frac{h'}{h} = \frac{-v}{u}$$

$$\frac{h'}{5} = -\frac{(-30)}{-15}$$

$$h' = -10 \text{ cm}$$

The size of image is 10 cm.

The image formed is real and inverted.

2. Object distance $u = -30$ cm

Focal length $f = -15$ cm

Image distance v = ?

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

$$\frac{1}{v} = \frac{1}{-15} + \frac{1}{30}$$

$$\frac{1}{v} = \frac{-2+1}{30}$$

$$\frac{1}{v} = \frac{-1}{30}$$

$$v = -30 \text{ cm}$$

Real and inverted, height of the object $h = 5$ cm

$$\frac{h'}{h} = \frac{-v}{u}$$

$$\frac{h'}{5} = \frac{-(-30)}{-30}$$

$$h' = -5$$

$h' = 5$ cm; same size.

3. Radius of curvature = 30 cm

Focal length = 15 cm

Object distance $u = -20$ cm

v = ?

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

$$\frac{1}{v} + \frac{1}{-20} = \frac{1}{15}$$

$$\frac{1}{v} - \frac{1}{20} = \frac{1}{15}$$

$$\frac{1}{v} = \frac{1}{15} + \frac{1}{20}$$

$$\frac{1}{v} = \frac{4+3}{60} = \frac{7}{60}$$

$$v = \frac{60}{7} = 8.57 \text{ cm}$$

The image is virtual and erect.

$h = 5$

h' = ?

$$\frac{h'}{h} = \frac{-v}{u}$$

$$\frac{h'}{5} = \frac{-8.57}{-20}$$

$$h' = \frac{5 \times 8.57}{20} = 2.14 \text{ cm}$$

4. Given:

magnification, $M = \frac{-v}{u}$

$$-1 = \frac{-(-30)}{u}$$

$\therefore$ $u = 30$ cm

Now, $u = -30$ cm, $v = -30$ cm

Using miror formula,

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

$$\frac{1}{f} = \frac{1}{-30} + \frac{1}{-30}$$

$$\frac{1}{f} = \frac{1+1}{-30}$$

$$\frac{1}{f} = \frac{2}{-30}$$

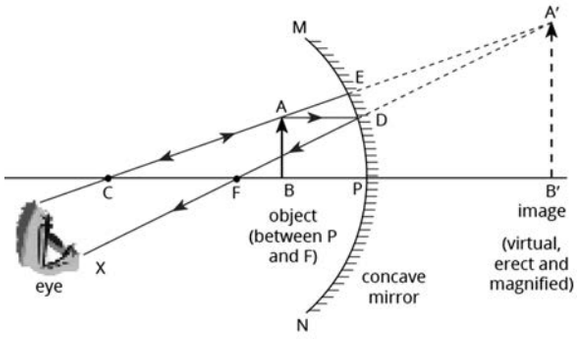
$\therefore$ $f = -15$ cm

Now $u' = -10$ cm and $f = -15$ cm

Using minnor formula

$$\frac{1}{v'} = \frac{1}{f} - \frac{1}{u'}$$

$v' = +30$ cm



5. a. It is a concave mirror.

b. Since magnification is negative, the image must be real and inverted.

$v = -50$ cm

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

$$-1 = \frac{-(-50)}{u}$$

$u = -50$ cm

$\therefore$ The distance of image from object is zero.

c.

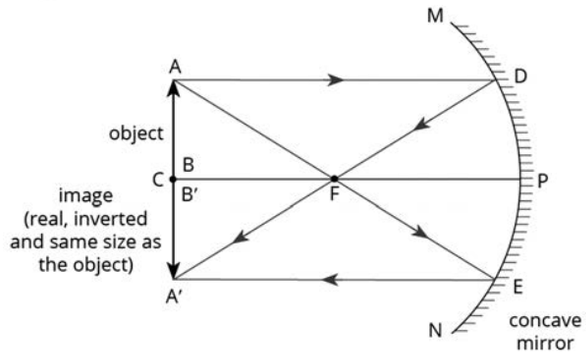
$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$= \frac{1}{-50} + \frac{1}{-50}$$

$$= \frac{2}{-50} = \frac{1}{-25}$$

$f = -25$ cm

d.



Position of the object: at C

6. a. $v = -60$ cm

$u = -15$ cm

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} = \frac{1}{-60} + \frac{1}{-15}$$

$$= \frac{-1-4}{60} = \frac{-5}{60} = \frac{-1}{12}$$

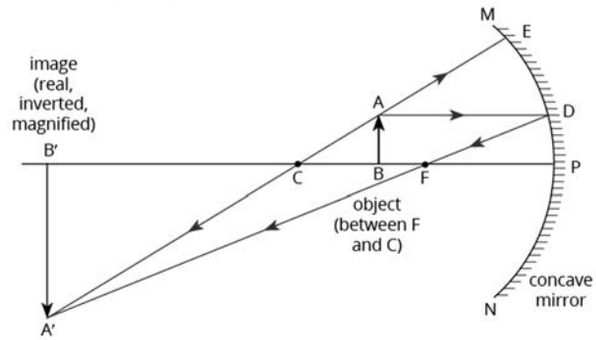
$f = -12$ cm

He should use a concave mirror.

b. $M = \frac{-v}{u} = \frac{-(-60)}{-15} = -4$

c. The distance between image and object is 45 cm.

d. Ray diagram



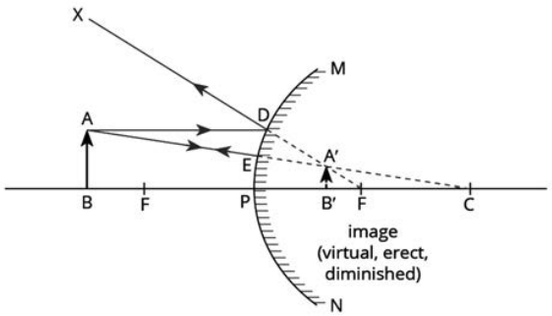
Position of the object: between F and C

7. $M = \frac{+1}{3}$

a. Since the magnification is positive, therefore the image is virtual and erect.

Therefore, it is a convex mirror.

b. The object is placed between pole and infinity.



Object between the pole and infinity

8. $u = -4$ m

Since the image is erect therefore, it is formed behind the mirror.

$$v = 1 \text{ m}$$

$$M = \frac{-v}{u} = \frac{-1}{-4} = \frac{1}{4}$$

Since the magnification is less than 1, therefore the mirror is convex.

P. 169 Higher Order Thinking Skills (HOTS) Questions

A. Multiple-choice Questions

1. a **2**. c **3**. b **4**. b **5**. c

B. Very Short Answer Type Questions

1. Blue

2. **a.** 0 **b.** 0

3. Yes. It will change. It is based on the refractive index of the material of the concave mirror with respect to the medium.

4. Convex

5. Parallel to principal axis.

6. Real

7. Between the pole and focus of the mirror.

8. Plane

9. Focal length

10. 2 Q

11. Black

C. Short Answer Type-I Questions

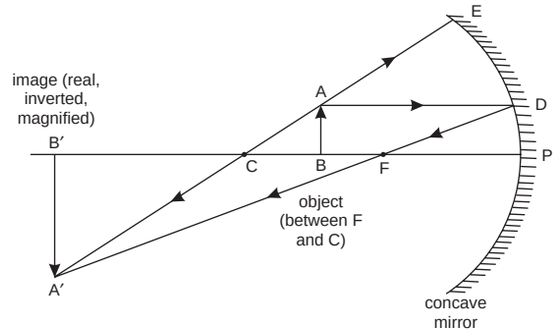
1. When the object is very far from the concave mirror, the image is at the focus and it is a diminished, inverted image. As the object is brought towards the mirror, the image shifts away from the mirror and its size increases. When the object is at centre of curvature of the mirror, the image is also at the centre of curvature and it is of size equal to the size of object. By further bringing the object towards the mirror, the image gets magnified and it moves away from the centre of curvature. When the object is at the focus of mirror, the image is at infinity. If the object is further moved towards the mirror, the image now becomes erect and magnified and it is formed behind the mirror.

2. **a.** Concave **b.** Concave

3. **a.** Convex **b.** Concave

D. Short Answer Type-II Questions

1.



2. Object distance $u = -36$ cm

Focal length $f = -12$ cm (It is a concave mirror)

Image distance v = ?

We know

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

$$\frac{1}{v} + \frac{1}{-36} = \frac{1}{-12}$$

$$\frac{1}{v} = \frac{-2}{36}$$

$$v = -18 \text{ cm}$$

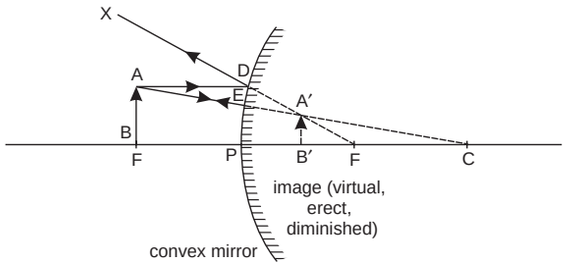
Thus the image is formed at a distance of 18 cm in front of the concave mirror. Since the image is formed in front of the mirror, its nature will be real and inverted.

3. As the object is moved away from a convex mirror, the distance of image (formed behind it) from the mirror increases (between pole and focus), i.e. the image shifts from the pole towards the focus and the size of image gradually decreases. When the object is at infinity (very far), the image is at its focus.

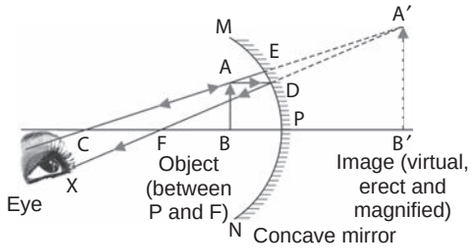
4. No, because reflection takes place in the same medium.

E. Long Answer Type Questions

1. The mirror is convex.



2. The mirror is concave.



P.170–175 Exercises

A. Objective Type Questions

I. Multiple-choice Questions

1. d **2**. d **3**. a **4**. b **5**. d

6. d **7**. c

II. Fill in the blanks

1. real, virtual **2**. centre of curvature

3. converging **4**. parallel

5. convex

III. Assertion–Reasoning Type Questions

1. a. **2**. b. **3**. a. **4**. a. **5**. d.

6. c. **7**. c. **8**. b. **9**. c. **10**. d.

IV. Very Short Answer Type Questions

1. Centre of curvature

2. Between pole and focus.

3. Between focus and centre.

4. Between pole and focus.

5. Convex

6. Concave

7. Convex

8. Infinity

9. Convex mirrors are used as rear-view mirrors in vehicles like cars, trucks and buses to see the traffic behind. Convex mirrors are used as rear view mirrors because of the following two reasons:

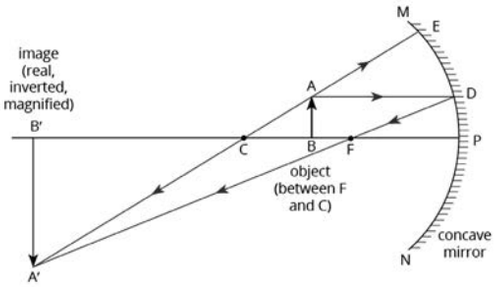
a. The image formed in a convex mirror is highly diminished due to which a convex mirror gives a wide field of view of the traffic behind the vehicle.

b. A convex mirror always produces an erect image with respect to the object irrespective of the position of the traffic behind.

10. Top portion is convex mirror which will bulge out, the middle one is a concave mirror that will have a depression and the bottom part is a plane mirror.

B. Short Answer Type-I Questions

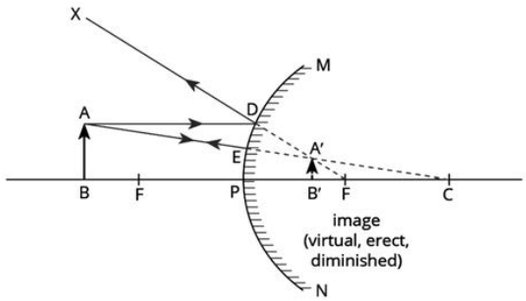
1.



Position of the object: between F and C

2. A ray of light passing through the centre of curvature of a concave or convex mirror, is reflected back along the same path, i.e. such a ray of light retraces its path of reflection because it strikes the mirror normally.

3. If the image is always erect and diminished for all positions of object placed in front of it, then the mirror is convex. We use convex mirrors in following ways:



Object between the pole and infinity

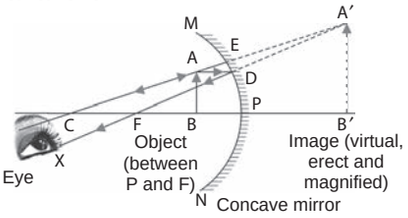
a. As rear-view mirrors because they have a wide field of view and always produce an erect image.

b. As safe view of dangerous corners: Convex mirrors are placed on the staircases to have safe view of dangerous corners while climbing.

c. Convex mirrors are used as vigilance mirrors in big shops and departmental stores as anti-shoplifting devices.

d. Streetlights also use convex mirrors to diverge light over an extended area.

4. 1. a. and **b.**



5. Object distance $u = -12$ cm

Since the image is real

$$M = -4$$

We know $M = \frac{-v}{u}$

$$\frac{v}{u} = 4$$

$$v = 4 \times -12 = -48 \text{ cm}$$

6. To calculate the position of object:

Magnification, M = + 2 (Image is virtual)

We know $M = \frac{-v}{u}$

$$2 = \frac{-v}{u}$$

$$v = -2u$$

Focal length, $f = -20$ cm (it is a concave mirror)

We know the formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

or $\frac{1}{-2u} + \frac{1}{u} = \frac{1}{-20}$

or $\frac{1}{2u} = \frac{1}{-20}$

or $2u = -20$

or $u = -\frac{20}{2} = -10$ cm

Thus, the object should be placed at a distance of 10 cm from the pole of the concave mirror.

C. Short Answer Type-II Questions

1. $h = 3$ cm , $u = -9$ cm , $f = -18$ cm

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

$$\frac{1}{v} + \frac{1}{-9} = \frac{1}{-18}$$

$$\frac{1}{v} = \frac{1}{-18} + \frac{1}{9} = \frac{-1}{18}$$

$$v = -18 \text{ cm}$$

$$\frac{h'}{h} = \frac{-v}{u}$$

$$\frac{h'}{3} = \frac{-18}{-9} = 2$$

$$h' = 6 \text{ cm}$$

The image is virtual, erect and magnified.

2. Object distance $u = -10$ cm

Focal length $f = -20$ cm

We know the formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} + \frac{1}{-10} = \frac{1}{-20}$$

$$\frac{1}{v} = \frac{-1}{20} + \frac{1}{10}$$

$v = 20$ cm, $h = 3$ cm

$$\frac{h'}{h} = \frac{-v}{u}$$

$$\frac{h'}{3} = \frac{-20}{-10} = \frac{2}{1}$$

$h' = 6$ cm; Virtual and erect.

3. $h = 1.2$ m, $f = -20$ cm, $v = -60$ cm, $u = ?$ and $h' = ?$

We know that

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

$$\frac{1}{-60} + \frac{1}{u} = \frac{1}{-20}$$

$$\frac{1}{u} = \frac{1}{-20} + \frac{1}{60} = \frac{-2}{60} = \frac{-1}{30}$$

$u = -30$ cm

$$\frac{h'}{h} = \frac{-v}{u}$$

$$\frac{h'}{1.2} = \frac{-(-60)}{-30} = -2$$

$h' = -1.2 \times 2 = -2.4$ m

Negative sign represents inverted image.

4. $h = 5$ cm , $f = 15$ cm, $u = -30$ cm, $v = ?$, $h' = ?$

We know that

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

$$\frac{1}{v} + \frac{1}{-30} = \frac{1}{15}$$

$$\frac{1}{v} = \frac{1}{15} + \frac{1}{30} = \frac{3}{30} = \frac{1}{10}$$

$v = 10$ cm

$$\frac{h'}{h} = \frac{-v}{u}$$

$$\frac{h'}{5} = \frac{(-10)}{-30} = \frac{1}{3}$$

$$h' = \frac{5}{3} = 1.66 \text{ cm}$$

Nature of the image is virtual and erect.

5. Object distance $u = -6$ cm

Focal length $f = -12$ cm

We know the formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} + \frac{1}{-6} = \frac{1}{-12}$$

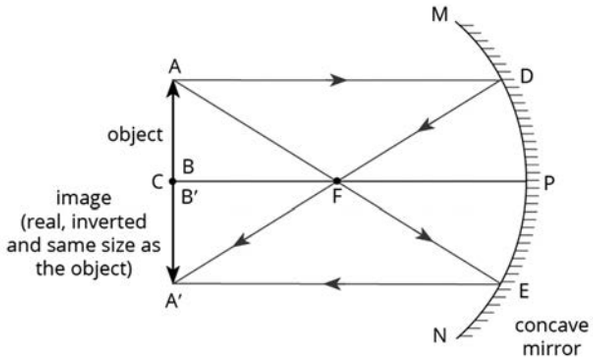
$$\frac{1}{v} = \frac{1}{12}$$

$$v = 12 \text{ cm}$$

$$\frac{h'}{h} = \frac{-v}{u}$$

$$\frac{h'}{4} = \frac{-12}{-6}$$

$h' = 8$ Virtual and erect.



Position of the object: at C

6. Object distance $u = -40$ cm

Focal length $f = -20$ cm $v = ?$

We know the formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} + \frac{1}{-40} = \frac{1}{-20}$$

$$\frac{1}{v} = \frac{-1}{20} + \frac{1}{40}$$

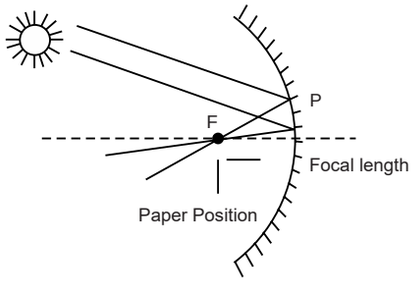
$$\frac{1}{v} = \frac{-1}{40}$$

$v = -40$ cm,

Image is real and inverted.

7. a. To burn the paper student should move the mirror in such a way that paper is positioned at the focus of the mirror.

b. Student has the converging type of mirror that is concave mirror.



c. Yes, he can measure the approximate value of focal length from this activity as paper will burn when it will be kept at focus of the mirror, as shown is figure.

8. Object distance $u = -20$ cm

Focal length $f = -40$ cm $v = ?$

We know the formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} + \frac{1}{-20} = \frac{1}{-40}$$

$$\frac{1}{v} = \frac{-1}{40} + \frac{1}{20}$$

$$\frac{1}{v} = \frac{1}{40}v = 40 \text{ cm}$$

The positive sign shows the image is virtual.

The four characteristics of the image formed by a concave mirror are:

i. The image formed is virtual.

ii. The image is erect.

iii. The image is enlarged.

iv. The image is formed behind the mirror.

9. Focal length $f = 200$ cm

Object distance $u = -400$ cm

We know the formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} + \frac{1}{-400} = \frac{1}{200}$$

$$\frac{1}{v} = \frac{1}{200} + \frac{1}{400}$$

$$v = \frac{400}{3} = 133.3 \text{ cm}$$

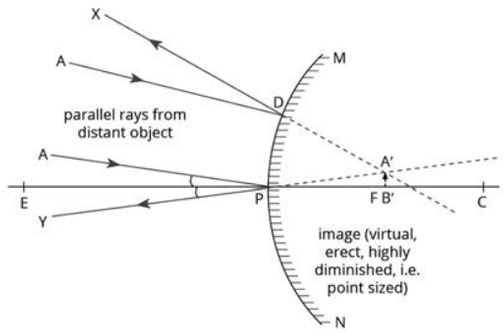
$$\text{Magnification} = \frac{v}{-u}$$

$$= \frac{133.3}{400} = 1/3 \text{ approx.}$$

Size of image will be $\frac{1}{3}$rd size of the object.

Image is virtual and erect.

10.



Object at infinity

Angle of incidence = ∠APE

Angle of reflection = ∠EPY

11. Object distance u = ? , h = 4 cm , v = −30 cm, h = 4 cm

Focal length f = −20 cm

We know the formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{-30} + \frac{1}{u} = \frac{1}{-20}$$

$$\frac{1}{u} = \frac{-1}{20} + \frac{1}{30}$$

$$\frac{1}{u} = \frac{-1}{60}$$

$$u = -60 \text{ cm},$$

$$\frac{h'}{h} = \frac{-v}{u}$$

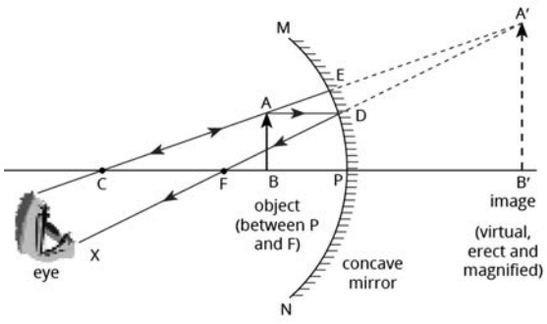
$$\frac{h'}{4} = -\left(\frac{-30}{-60}\right) = \frac{-1}{2}$$

$$h' = -2 \text{ cm}.$$

12. a. The range of distance of object should be between pole and focus.

b. The image will be larger (enlarged) than the object.

c.



Position of the object: between P and F

D. Long Answer Type Questions

1. Object distance u = −25 cm

Focal length f = −15 cm

We know the formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} + \frac{1}{-25} = \frac{1}{-15}$$

$$\frac{1}{v} = \frac{1}{-15} + \frac{1}{25} = \frac{-2}{75}$$

$$v = \frac{-75}{2} = -37.5 \text{ cm}$$

$$\frac{h'}{h} = \frac{-v}{u} = -\left(\frac{-37.5}{-25}\right)$$

$$\frac{h'}{4} = -\frac{37.5}{25}$$

$$h' = \frac{-(37.5 \times 4)}{25} = -6 \text{ cm}$$

Size of the image = 6 cm, real and inverted.

2. Radius of curvature = 0.4 m

Focal length f = 0.2 m

Object distance u = −0.8 m

We know the formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} + \frac{1}{-0.8} = -\frac{1}{0.2}$$

$$\frac{1}{v} = \frac{-1}{0.2} + \frac{1}{0.8}$$

$$v = \frac{-0.8}{3} \text{m}$$

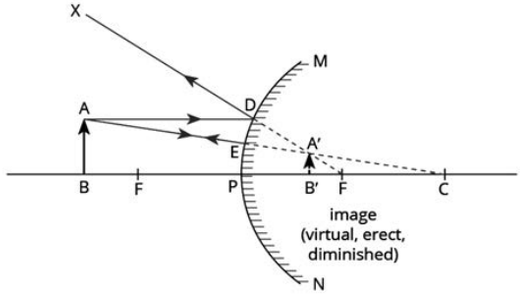
$$\frac{h'}{h} = \frac{-v}{u}$$

$$\frac{h'}{0.4} = \frac{-\left(\frac{-0.8}{3}\right)}{-0.8}$$

$$h' = \frac{0.4}{3} \text{m, real and inverted.}$$

3. a. The image formed by a mirror for all positions of the object placed in front of the mirror is the convex mirror in which image formed is always diminished, erect and virtual.

Such mirrors are used as rear view mirror in automobiles, as convex mirror gives erect, and wider range of view of objects coming behind the automobile.



Object between the pole and infinity

b. The radius of the hollow **sphere of which the reflecting surface of the spherical mirror is a part is called the radius of curvature of the spherical mirror.** In other words, the distance between the pole and the centre of curvature of the spherical mirror (PC) is called its radius of curvature.

Radius of curvature = 24 cm

So its focal length = $\frac{24}{2}$ = 12 cm

Since the focal length of the given mirror is positive, the mirror is the convex mirror.

4. Object distance $u = -10$ cm

Focal length $f = 15$ cm

We know the formula,

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

$$\frac{1}{v} + \frac{1}{-10} = \frac{1}{15}$$

$$\frac{1}{v} = \frac{1}{15} + \frac{1}{10}$$

$$v = 6 \text{ cm}$$

$$\frac{h'}{h} = \frac{-v}{u}$$

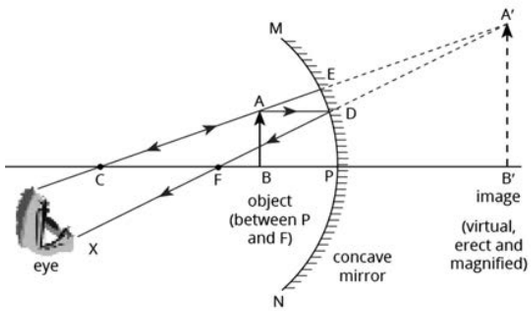
$$\frac{h'}{15} = \frac{-6}{-10}$$

$$h' = \frac{(6 \times 15)}{10}$$

= 9 cm, virtual and erect

5. a. The range of distance of object should be between pole and focus.

b. The image will be larger (enlarged) than the object.



Position of the object: between P and F

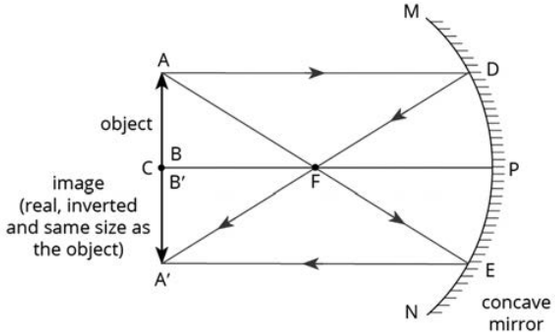
c. $u = -24$ cm, $f = -12$ cm

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

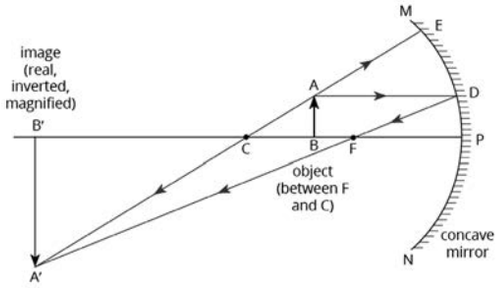
$$\frac{1}{v} + \frac{1}{-24} = \frac{1}{-12}$$

$$\frac{1}{v} = \frac{-1}{12} + \frac{1}{24} = \frac{-1}{24}$$

$$v = -24 \text{ cm}$$



Position of the object: at C



Position of the object: between F and C

6. Object distance $u = -45$ cm , $h = 6$ cm

Focal length $f = -30$ cm

We know the formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} + \frac{1}{-45} = \frac{1}{-30}$$

$$\frac{1}{v} = \frac{-1}{30} + \frac{1}{45} = \frac{(-3+2)}{90} = \frac{-1}{90}$$

$$v = -90 \text{ cm}$$

$$\frac{h'}{h} = \frac{-v}{u} = \frac{-(-90)}{-45}$$

$$\frac{h'}{6} = -2$$

$$h' = -2 \times 6 = -12 \text{ cm}$$

Size of the image = −12 cm, and it is real and inverted.

7. The sign convention for reflection of light by spherical mirrors is as follows:

a. The object is always placed to the left of the mirror. This implies that the light from the object falls on the mirror from the left hand side.

b. All distances parallel to the principal axis are measured from the pole of the mirror. The pole of the mirror is taken as the origin

c. Principal axis of the mirror is taken as the X-axis (X'X) of the coordinate system. All the distances measured to the right of the origin are taken as positive while those measured to the left of the origin are taken as negative.

d. Heights and distances measured above and perpendicular to the principal axis are taken as positive.

e. Heights and distances measured below and perpendicular to the principal axis are taken as negative.

$$u = -16 \text{ cm}$$

Since the image formed is real therefore, M is negative.

$$M = -3$$

$$M = \frac{-v}{u}$$

$$-3 = \frac{v}{16}$$

$$v = -48 \text{ cm}$$

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

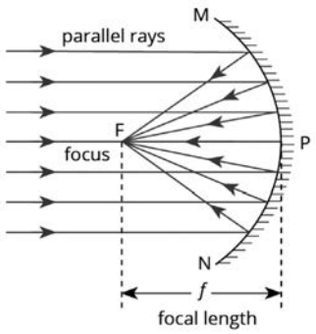
$$= \frac{1}{-48} + \frac{1}{-16}$$

$$= \frac{-1}{48} - \frac{1}{16}$$

$$= \frac{-4}{48} = \frac{-1}{12}$$

$$f = -12 \text{ cm}$$

Therefore, it is a concave mirror.



Concave mirror

8. a. Characteristics of an image formed by a plane mirror

i. The image is formed behind the mirror and has the same size as the object.

ii. The image is laterally inverted.

iii. The image is as far behind the mirror as the object is in front of it.

iv. The image is virtual. It cannot be received on a screen.

b. Object distance $u = -20$ cm , $h = 5$cm

Focal length $f = -30$ cm

We know the formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} + \frac{1}{-20} = \frac{1}{-30}$$

$$\frac{1}{v} = \frac{-1}{30} + \frac{1}{20} = \frac{(-2+3)}{60} = \frac{1}{60}$$

$$v = 60 \text{ cm}$$

$$\frac{h'}{h} = \frac{-v}{u} = \frac{-(60)}{-20} = \frac{3}{1}$$

$$\frac{h'}{5} = 3$$

$$h' = 3 \times 5 = 15 \text{ cm}$$

Size of the image = 15 cm, and it is virtual and erect.

E. Source-Based/Case-Based/Passage-Based/ Integrated Assessment Questions

1. a. iii. frequency

b. ii. Concave mirror

c. iv. All of the above.

d. ii. yes.

e. iii. virtual.

2. a. iii. A convex mirror.

b. iii. 40 cm.

c. ii. convex mirror.

d. iv. same for all lights.

e. ii. Image distance is always positive.

F. Value-Based Questions (Optional)

1. a. When light falls on the objects in the room, it is reflected back from their surfaces. When this reflected light enters our eyes, the eyes sense it and send message to the brain. The brain converts this message into images of the objects. Thus, we can see things around us only in the presence of light.

b. This shows that Zoya is a helpful person. She wanted her friend to not get hurt in dark so she opened the light.

2. a. Frosting of a glass pane of a window makes it slightly opaque. This allows natural light inside the window while obscuring views into the room.

b. The values displayed by Joy are that he is very kind and helpful. He always wants to help his friends.

3. a. Lateral inversion

b. Raman's actions depict that he is very intelligent and has a good knowledge about mirrors. He is very helpful and caring. He wants her younger sister to know the reason behind this phenomenon.

4. a. Convex mirrors are used as rear view mirrors because:

i. The image formed by a convex mirror is highly diminished due to which it gives a wide field of view.

ii. A convex mirror always produces an erect image.

b. This shows that Sarita is very smart and intelligent. She knows the importance of rear view mirrors. She has a helping nature and wants to help her uncle.

5. a. We will keep the mirrors in front of us one by one and observe the images formed.

i. If the size of the image is same as that of object then it is a plane mirror.

ii. If the image formed is enlarged when placed close and can see inverted image when kept away, then it is a concave mirror.

iii. If the image formed is small and erect, then it is a convex mirror.

b. Sujoy is a very intelligent boy who is aware of the mirrors used in daily life. He is smart and quick. He is a quick observer too.

CHAPTER–5

REFRACTION OF LIGHT

P. 180 Check Your Progress 1

A. Multiple-choice Questions

1. a **2**. c **3**. d **4**. c **5**. b

B. Very Short Answer Type Questions

1. The change in the direction of light when it passes obliquely from one transparent medium to another at the boundary separating the two media is called refraction of light.

2. When a ray of light travels from a rarer medium to a denser medium, it bends towards the normal.

3. When a ray of light travels from a denser medium to a rarer medium, it bends away from the normal (at the point of incidence).

4. If the incident ray falls normally (or perpendicularly) on the surface of a glass slab, then there is no bending of the ray of light and it goes straight.

$$\angle i = \angle r = 0°$$

5. **a.** Air highest, **b.** Glass lowest.

6. Yes

7. **a.** The lemons kept in water in a glass tumbler or the rasgullas kept in sugar syrup in a glass jar appear bigger than their actual size, when viewed from the side.

b. A stick partially immersed in water in a glass tumbler appears to be bent and short at the surface of water when it is viewed obliquely from above.

8. A medium in which the speed of light is more is known as an optically rarer medium. A medium in which the speed of light is less is known as an optically denser medium.

9. Y because the light is travelling slower in Y and the higher the density of the medium, the lower is the speed of light in it.

10. No.

C. Short Answer Type-I Questions

1. The letters appear raised because when light rays are made to go from one transparent medium to another, they change their directions at the boundary separating two media.

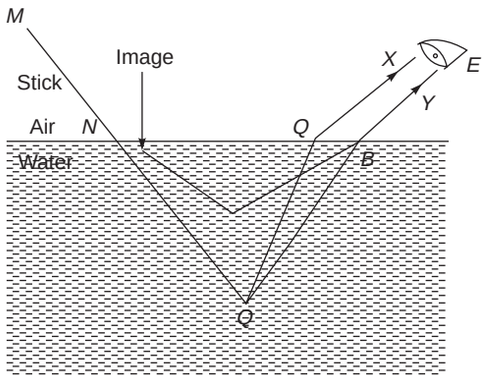
2. If the incident ray falls normally (or perpendicularly) on the surface of a glass slab, then there is no bending of the ray of light and it goes straight. Since the incident ray goes along the normal to the surface, the angle of incidence in this case is zero (0°) and the angle of refraction is also zero (0°), *i.e.* $\angle i = \angle r$ and $\angle i = \angle r = 0°$. The glass window panes are usually thin, and therefore the shifts in the rays of light passing through them are not noticeable.

3. They appear to be raised. That is because light travels between two different media, i.e. air and water and the light rays bend at the interface of the two media, i.e. refraction of light takes place.

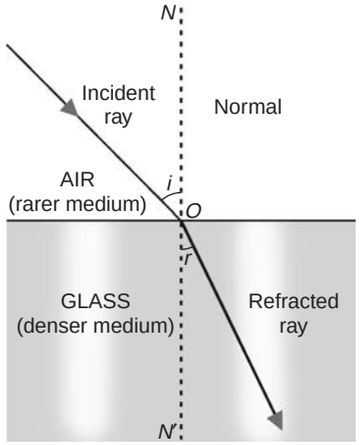
D. Short Answer Type-II Questions

1. Consider a thin stick MO immersed (its lower portion, say NO in water, as shown in the figure.) Though the stick is actually straight but on immersing in water, it appears to be bent at the point N.

Actually this happens because a ray of light OQ coming from the lower end of the stick passes from water into air at point Q and gets refracted from the normal in the direction QX (because it passes from a denser medium water into a rarer medium air). Another ray of light OR gets refracted in the direction RY.



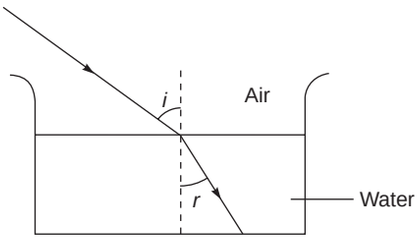
2.



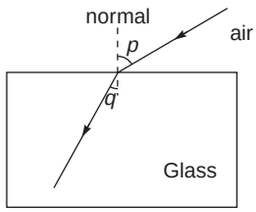
a. **Angle of incidence:** The angle between the incident ray and normal is called the angle of incidence.

b. Angle of refraction: The angle between refracted ray and normal is called angle of refraction.

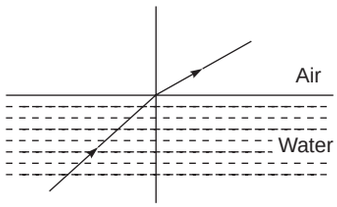
3. a.



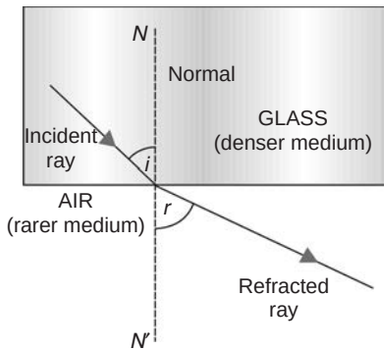
b.



c.



d.



4. We must be careful while stepping into a pond because the actual depth of the pond is more than what appears. This is due to refraction of light as the light travels from air to water (which is optically denser than air). The optical illusion of the pond being less deep may make us fall.

P. 183–184 Check Your Progress 2

A. Multiple-choice Questions

1. b **2**. b **3**. c **4**. b **5**. b

B. Very Short Answer Type Questions

1. This happens due to the phenomenon of refraction of light. When the rays of light from the coin, in the denser medium, fall on the interface separating the two media, the rays of light move away from the normal after refraction. The point from which the refracted rays appear to come gives the apparent position of the coin. As the rays appear to come from a point above the coin, the coin appears to be raised.

2. The ratio of sine of the angle of incidence to sine of the angle of refraction or refractive index.

3. There will be no bending of the ray of light and it goes straight.

4. Constant. It is called refractive index

5. Parallel to the incident ray.

6. The actual depth of the bucket will be more than what appears. This optical illusion is because of refraction of light as the light passes from air to water. Hence, we do not succeed in picking the coin.

7. First law of refraction of light: The incident ray, the refracted ray and the normal at the point of incidence, all lie in the same plane.

8. According to Snell's law of refraction of light, the ratio of sine of the angle of incidence to the sine of the angle of refraction is a constant for the light of a given colour and for a given pair of media (such as air and glass or air and water).

C. Short Answer Type-I Questions

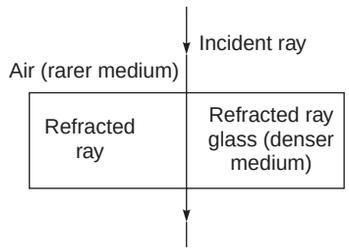
1. a. First law of refraction of light: The incident ray, the refracted ray and the normal at the point of incidence, all lie in the same plane.

b. According to Snell's law of refraction of light, the ratio of sine of the angle of incidence to the sine of the angle of refraction is a constant for the light of a given colour and for a given pair of media (such as air and glass or air and water).

2. When it is incident normally to the interface of two media.

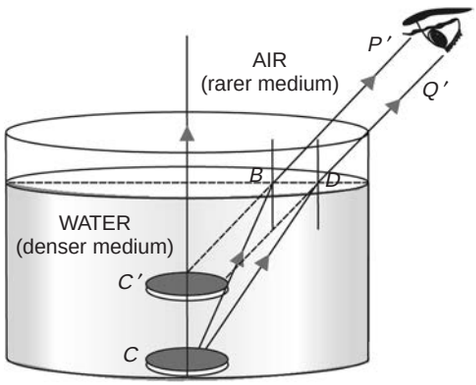
D. Short Answer Type-II Questions

1.



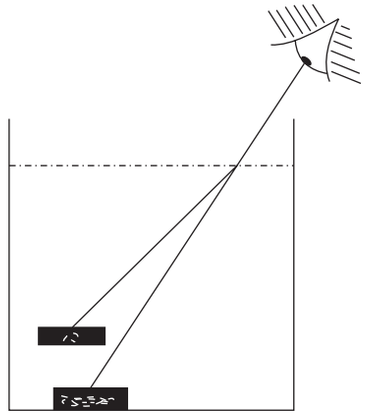
Both angle of incidence and angle of refraction are 0°.

2.

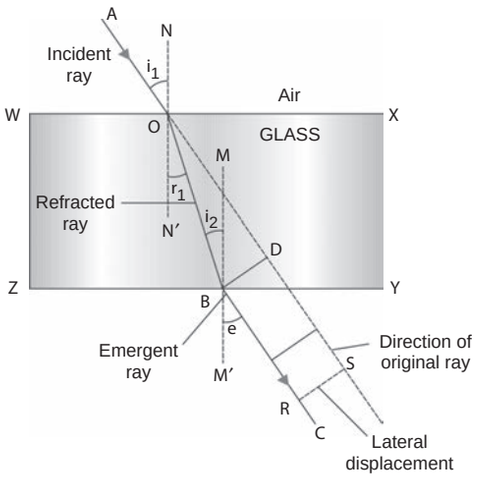


This happens due to the phenomenon of refraction of light. When the rays of light from the coin, in the denser medium, fall on the interface separating the two media, the rays of light move away from the normal after refraction. The point from which the refracted rays appear to come gives the apparent position of the coin. As the rays appear to come from a point above the coin, the coin appears to be raised.

3.



4.



P. 187–188 Check Your Progress 3

A. Multiple-choice Questions

1. b **2.** c **3.** c **4.** c **5.** d

B. Very Short Answer Type Questions

1. Refractive index of a medium is also defined as the ratio of the speed of light in vacuum or air and the speed of light in that medium.

2. Refractive index.

3. $^{air}m_{glass} = \dfrac{\text{Speed of light in air}}{\text{Speed of light in glass}}$

4. However, an optically denser medium may not possess greater mass density. For example, kerosene has refractive index 1.44 and water has 1.33. So, kerosene is optically denser than water. But kerosene has less mass density than water.

5. Since the refractive index is a ratio of two similar quantities (the sines of angles), it has no units. It is a pure number.

6. Speed of light in glass Speed of light in air

7. Medium C

8. **a.** Kerosene **b.** Water

9. **a.** crown glass, **b.** water
c. diamond **d.** crown glass.

10. It means the ratio of speed of light in air to that in crown glass is 1.52.

C. Short Answer Type-I Questions

1. **a.** A **b.** B

2. Angle of incidence $i = 40°$

Angle of refraction $r = 30°$

$\sin i = \sin 40° = 0.6428$

$\sin r = \sin 30° = 0.500$

$$\text{Refractive index} = \frac{\sin i}{\sin r} = \frac{0.6428}{0.500} = 1.28.$$

3. Refractive index for light going from air to glass $\mu_1 = 1.5$

Refractive index for light going from glass to air $\mu_2 = ?$

$$\mu_2 = \frac{1}{\mu_1} \qquad \mu_2 = \frac{1}{1.5} = 0.67.$$

4. Refractive index of flint glass = 1.65

Speed of light in vacuum = 3×10^8 m/s

Speed of light in glass (v) = ?

$$\text{Refractive index of glass} = \frac{\text{Speed of light in air}}{\text{Speed of light glass}}$$

$$1.65 = \frac{(3\times10^8)}{v} \quad v = \frac{(3\times10^8)}{1.65}$$

$$= 1.82 \times 10^8 \text{ m/s.}$$

5. ${}^{l}n_T = \frac{1.65}{1.47} = 1.12.$

D. Short Answer Type-II Questions

1. If the incident ray is travelling through vacuum or air and is then refracted in a medium, then the ratio is $\frac{\sin i}{\sin r}$, is called the absolute refractive index of the medium.

2. a. Speed of light in vacuum = ?

n of glass = $\frac{4}{3}$

$$n \text{ of glass} = \frac{\text{Speed of light in vaccum}}{\text{Speed of light in glass}}$$

$$\frac{4}{3} = \frac{v}{(2\times10^8)}$$

$$v = (2\times10^8)\times\frac{4}{3}$$

$$= 2.67 \times 10^8 \text{ m/s}$$

b. Speed of light in water = ?

n of water = $\frac{3}{2}$

$$\frac{3}{2} = \frac{(2.67\times10^8)}{\text{Speed of light in water}}$$

$$\text{Speed of light in water} = \frac{2}{3}\times\frac{8}{3}\times10^8 \text{ m/s}$$

$$= \frac{16}{9}\times10^8\times \text{m/s}$$

$$= 1.78 \times 10^8 \text{ m/s}$$

c. n of glass = $\frac{4}{3}$

Speed of light in glass = 2×10^8

$$\frac{4}{3} = \frac{\text{Speed of light in air}}{\text{Speed of light in glass}}$$

$$v = 2\times10^8\times\frac{4}{3}$$

$$= 2.67 \times 10^8 \text{ m/s}$$

3. Speed of light in water = 2.25×10^8 m/s

Speed of light in air = 3×10^8 m/s

$$\text{Refractive index } {}^{air}\mu_{water} = \frac{(2.25\times10^8)}{(3\times10^8)}$$

$$= 1.33.$$

4. n of water = 1.33

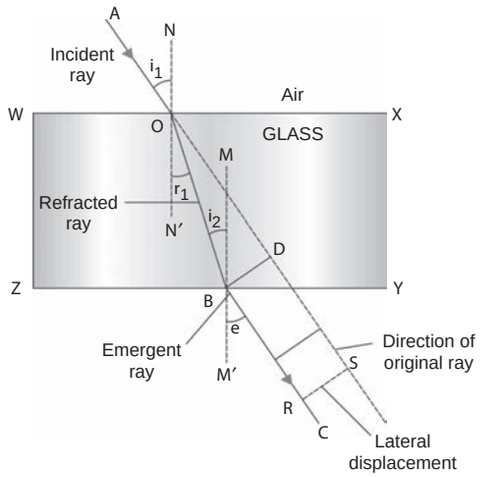
Speed of light in air = 3×10^8 *m/s*

$$n \text{ of water} = \frac{\text{Speed of light in air}}{\text{Speed of light in water}}$$

$$\text{Speed of light in water} = \frac{(3\times10^8)}{1.33} \text{ m/s}$$

$$= 2.25 \times 10^8 \text{ m/s}$$

5. According to principle of reversibility of light, if a reflected ray or a refracted ray is reversed in direction, it retraces its original path. Incident ray is parallel to emergent ray of light when light falls obliquely on a side of rectangular glass slab.



P. 191–192 Check Your Progress 4

A. Multiple-choice Questions

1. b **2.** a **3.** b **4.** c **5.** b

B. Very Short Answer Type Questions

1. A lens is a piece of transparent, optical material bounded by two refracting surfaces which are usually spherical, or one surface being spherical and the other being plane. Concave and Convex.

2. Convex

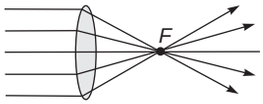
3. Convex

4. A convex lens is held in hand and directed towards the sun. The sunlight is focussed on a sheet of paper to obtain a bright image of sun. The distance from the lens to the spot is the focal length of the convex lens.

C. Short Answer Type-I Questions

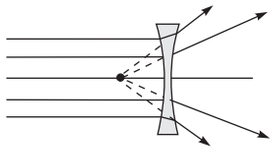
1. Focus is the point on the principal axis at which parallel rays of light after passing through a lens converge (in case of convex lens) or appear to diverge (in case of concave lens).

a.



Principal focus of a convex lens

b.



Principal focus of a concave lens

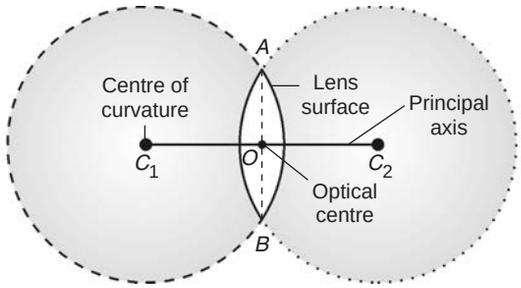
2. The light from the sun constitutes parallel rays of light. These parallel rays of light are converged by the lens at the sharp bright spot formed on the paper. The bright sun rays generate heat. This heat causes the paper to burn and also catch fire.

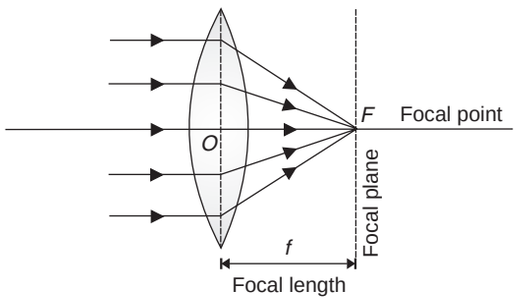
3.

Convex lens	Concave lens
A convex lens is thicker in the middle and thinner at the edges.	A concave lens is thinner in the middle and thicker at the edges.
A parallel beam of light passing through this lens converges at a point after refraction.	A parallel beam of light passing through this lens appears to diverge from a point after refraction.

D. Short Answer Type-II Questions

1.





a. The geometrical centre of the lens is called optical centre.

b. The centre of curvature of a lens is defined as the centre of the spherical surface from which the lens has been cut.

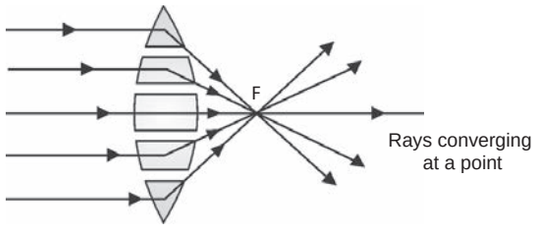
c. Principal axis is an imaginary straight line passing through the two centres of curvature of lens.

d. Aperture is the maximum portion of the spherical surfaces from which refraction takes place.

e. Focus is the point on the principal axis at which parallel rays of light after passing through a lens converge (in case of convex lens) or appear to diverge (in case of concave lens).

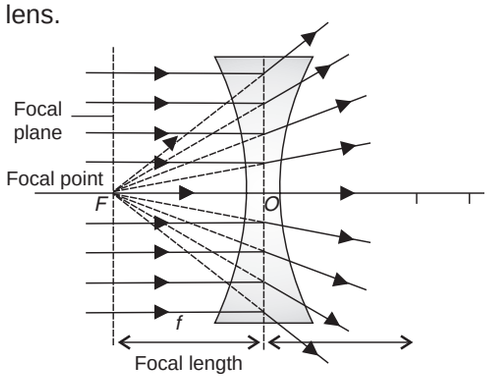
f. Focal length is the distance between optical centre and principal focus.

2.



A convex lens converges the parallel beam of light at a point. Hence, it is called a converging lens.

3.



The concave lens diverges the parallel rays of light and the diverged rays appear as if they are coming from a point. Hence, it is called a diverging lens.

P. 197 Check Your Progress 5

A. Multiple-choice Question

1. c **2.** d **3.** b **4.** b **5.** b

B. 1 Very Short Answer Type Questions

1. a. It is used as a magnifying glass in labs.

b. In making searchlights and spotlights in theatres.

c. In film and slide projectors.

d. Photographic camera, where a small, real and inverted image of an object is formed on the film.

e. Used as a burning glass.

2. a. Between optical centre and principal focus

b. Not possible

c. Between F_1 and $2F_1$

d. At $2F_1$

e. Beyond $2F_1$

f. At infinity

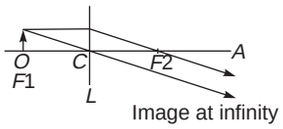
C. Short Answer Type-I Questions

1.

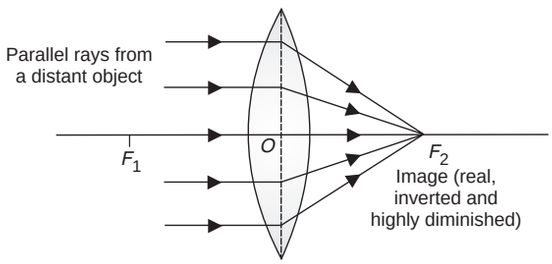
Virtual Image	Real Image
The rays of light after refraction appear to meet at same point.	The rays of light after refraction actually meet at same point.
It cannot be obtained on the screen.	It can be obtained on the screen.
It is always erect.	It is always inverted

D. Short Answer Type-II Questions

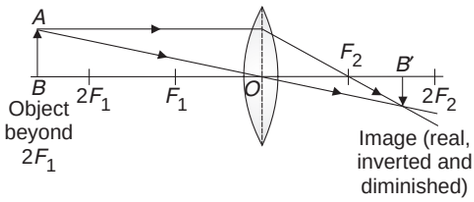
1. a. At focus F_1 – Image is formed at infinity. The image is real, inverted and highly enlarged.



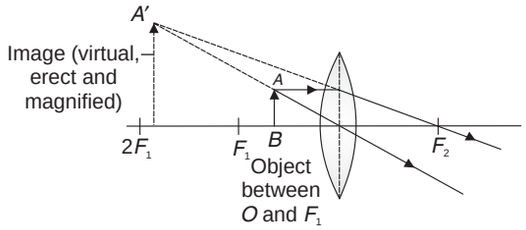
b. At infinity (coming rays parallel to principal axis) – Image is formed at F_2. image is real, inverted and highly diminished.



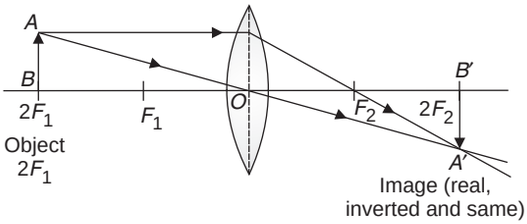
c. Beyond $2F_1$ – Image is formed between F_2 and $2F_2$. Image is real, inverted and diminished.



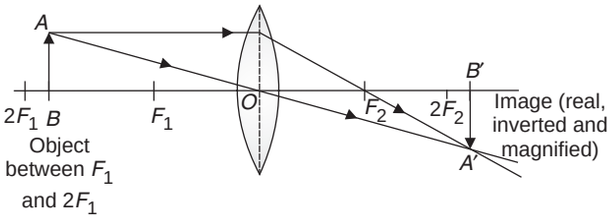
d. Between F_1 and optical centre of the lens image is formed on the same side of the lens behind the object. Image is virtual, erect and magnified.



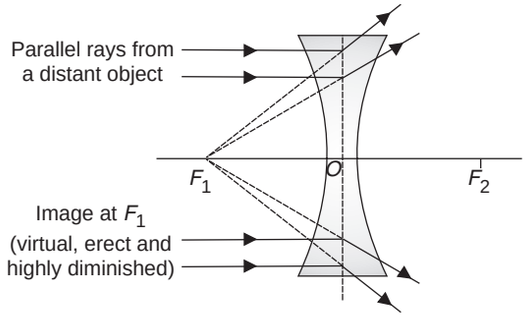
e. At $2F_1$ – Image is formed at $2F_2$ on the other side of the lens. Real and inverted, same size.



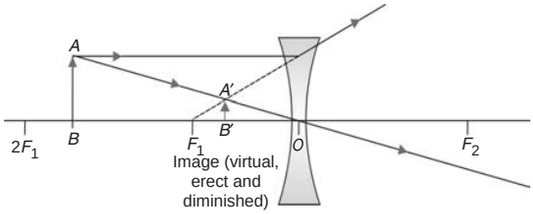
f. Between F_1 and $2F_1$ – Image is formed beyond $2F_2$.Image is real, inverted and enlarged.



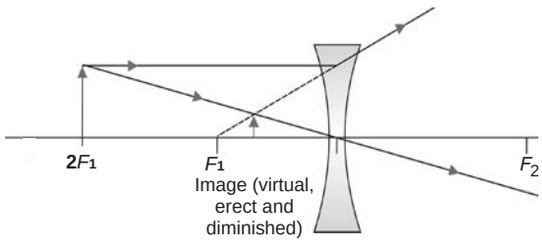
2. a. At infinity – Image is formed at F_1. Image is virtual, erect and highly diminished.



b. Between F_1 and $2F_1$ – Image is formed between focus and lens. Image is virtual, erect and diminished.



c. At $2F_1$ – Image is formed between focus and lens. Image is virtual, erect and diminished



P. 202–203 Check Your Progress 6

A. Multiple-choice Questions

1. d **2**. c **3**. b **4**. a **5**. c

B. Very Short Answer Type Questions

1. The magnification produced by the lens is defined as the ratio of the height of the image to the height of the object.

2. One dioptre is the power of a lens whose focal length is one metre. Dioptremeter.

3. **a.** Convex, **b**. Concave

4. Magnification produced by the lens is also defined as the ratio of the image distance (v) and the object distance (u), *i.e*.

$$\text{Magnification (Image)} = \frac{\text{Image distance } (v)}{\text{Object distance } (u)}$$

5. **a.** Left side of the convex lens, virtual and erect.

b. Right side of the convex lens, real and inverted

C. Short Answer Type-I Questions

1. The power of a lens is defined as the reciprocal of its focal length (in metres). The SI unit of the power of a lens is dioptre.

2. Place the lens close to your face. If the image formed is magnified then it is a convex lens. If the image is diminished then it is a concave lens.

3. $f = 10 \text{ cm} = \frac{10}{100} = 0.1 \text{ m}$

(Value of focal length of a lens should always be taken in metres. A convex lens has

positive focal length.)

$$P = \frac{1}{f \text{ (in metres)}}$$

$$P = \frac{1}{0.1} = 10$$

P = +10 dioptres (or + 10 D)

Thus, the power of the convex lens is + 10 D.

4. Object distance $u = -50$ cm

Focal length $f = 20$ cm

We know the formula, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} - \frac{1}{-50} = \frac{1}{20}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{50}$$

$$\frac{1}{v} = \frac{3}{100}$$

$$v = \frac{100}{3} = 33.33 \text{ cm}$$

$$\frac{h'}{h} = \frac{v}{u} = \frac{33.33}{-50}$$

$$\frac{h'}{10} = \frac{33.33}{-50}$$

$$h' = \frac{-(10 \times 33.33)}{50} = -6.67 \text{ cm}$$

Real, inverted image of size 6.67m

5. Image distance $v = -10$ cm

Focal length (f) = –20 cm

We know the formula, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{-10} - \frac{1}{u} = \frac{1}{-20}$$

$$\frac{1}{u} = \frac{1}{20} - \frac{1}{10}$$

$$u = -20 \text{ cm}$$

6. Object distance $u = -50$ cm

Image distance $v = -10$ cm

Focal length f = ?

We know $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{-10} - \frac{1}{-50} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{-1}{10} + \frac{1}{50} = \frac{-4}{50}$$

$$f = \frac{-50}{4-} = -12.5 \text{cm}$$

Since the sign is negative, it is a concave lens.

7. Focal length = –50 cm = 0.5 m

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

$$P = \frac{1}{-0.5} = -2 \text{ D}$$

D. Short Answer Type-II Questions

1. Focal length of A = +10 cm = + 0.1 m

Focal length of B = −10 cm = −0.1 m

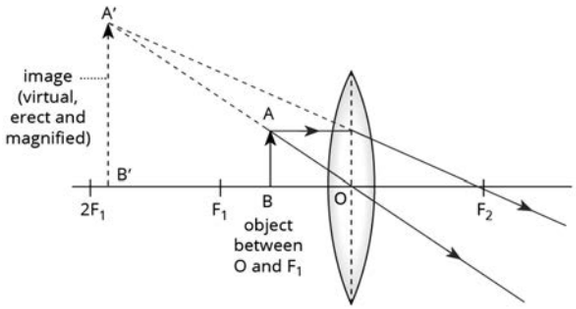
Since lens A has positive focal length, therefore, it is a convex lens.

$$P = \frac{1}{f} = \frac{1}{0.10} = 10 \text{ D}$$

Since lens B has negative focal length, therefore, it is a concave lens.

$$P = \frac{1}{-f} = \frac{1}{-0.10} = -10 \text{ D}$$

Convex lens will form a virtual and magnified image of an object placed at a distance of 8 cm from the lens.



Object between O and F_1

2. $u = -12$ cm, $h = 7$ cm, $f = 8$ cm

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

$$\frac{1}{8} = \frac{1}{v} - \frac{1}{-12}$$

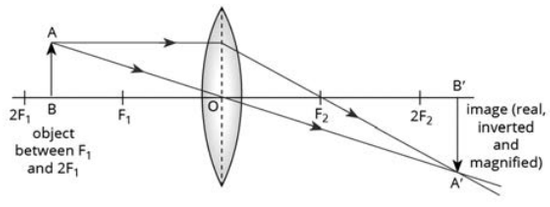
$$\frac{1}{v} = \frac{1}{8} - \frac{1}{12}$$

$$\frac{1}{v} = \frac{(3-2)}{24}$$

$$v = 24 \text{ cm}$$

$$M = \frac{v}{u} = \frac{24}{-12} = -2$$

3. The two rays chosen to construct a ray diagram are



Object between F_1 and $2F_1$

a. A ray of light parallel to principal axis, after passing through the lens, converges at the focus.

b. A ray of light passing through the optical centre of the lens, emerges without any deviation after refraction.

4. Sign convention followed in case of refraction of light through spherical lenses are:

- All distances are measured from the optical centre of the lens.
- The distances measured in the direction of incident ray are taken as positive whereas the distances measured against the direction of incident ray are taken as negative.
- The distance measured upwards and perpendicular to the principal axis are taken as positive whereas distances measured downwards and perpendicular to principal axis are taken as negative.

Since the image formed by the lens is real and magnified, therefore, it is a convex lens.

$$m = 3, u = -16$$

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

$$3 = \frac{v}{-16}$$

$$v = -48$$

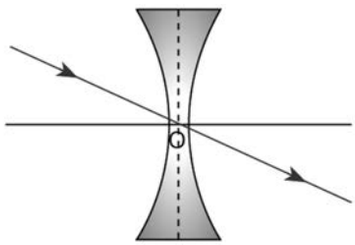
$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$= \frac{1}{-48} - \frac{1}{-16}$$

$$\frac{1}{f} = \frac{-1}{48} + \frac{1}{16} = \frac{2}{48}$$

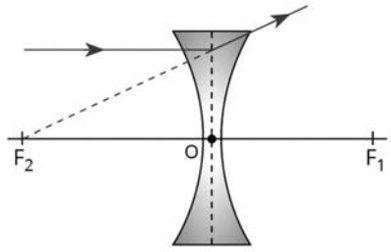
$$f = 24 \text{ cm}$$

5. a



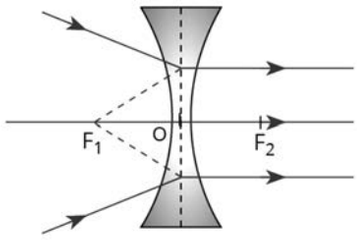
A ray of light passing through the optical centre goes undeviated.

b.



A ray of light parallel to the principal axis appears to diverge from the focus of a concave lens.

c.



Rays of light appear to meet at the focus

6. $v = 25$ cm (image is real) u = ??

$$M = -1$$

$$\frac{v}{u} = -1$$

$$v = -u$$

$$-25 = u$$

25 cm from convex lens.

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

$$= \frac{1}{25} - \frac{1}{-25} = \frac{2}{25}$$

$$f = \frac{25}{2}$$

$$P = \frac{1}{f} = \frac{2}{25} = 008.\ D$$

7. a. $P = P_1 + P_2 = 2 + (-1.5) = 0.5$ D

b. Focal length of the combination

$$f = \frac{1}{P} \left(\text{since } P = \frac{1}{f}\right)$$

$$f = \frac{1}{0.5} = 2 \text{ m} = 200 \text{ cm}$$

c. Converging lens.

8. Focal length $f = 10$ cm

Image distance $v = 12$ cm

Object distance u = ?

We know $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$$\frac{1}{10} = \frac{1}{12} - \frac{1}{u}$$

$$\frac{1}{u} = \frac{1}{12} - \frac{1}{10}$$

$$u = -60$$

$u = -60$ cm from the lens.

9. The distance between the object and the lens (u) = -50 cm

Focal length $f = -20$ cm

Distance of the image from the optic centre = v

We know $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$$\frac{1}{-20} = \frac{1}{v} - \frac{1}{-50}$$

$$\frac{1}{v} = \frac{-1}{50} - \frac{1}{20} = \frac{-7}{100}$$

$$v = \frac{-100}{7} = -14.29 \text{ cm}$$

The image is formed 14.29 cm away from the lens on the same side as the object and since v is negative, the image formed is virtual and erect.

10. Power of lens = 2.5 D

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

$$2.5 = \frac{1}{f}$$

$$f = \frac{1}{2.5} = 0.4 \text{ m} = 40 \text{ cm}.$$

It is a convex lens, since focal length is positive.

P. 204–206 Higher Order Thinking Skills (HOTS) Questions

A. Multiple-choice Questions

1. a **2**. d **3**. b **4**. d **5**. a

B. Very Short Answer Type Questions

1. It changes. If the light travels from optically rarer medium to denser medium, its velocity decreases and wavelength increases and vice versa.

2. When the light ray incident perpendicular to the surface.

3. Laws of Refraction are as follows:

- First law of refraction of light: The incident ray, the refracted ray and the normal to the point of incidence, all lie in the same plane.
- Second law of refraction of light: According to Snell's law, the ratio of sine of the angle of incidence to the sine of the angle of refraction is a constant for the light of a given colour and for a given pair of media.

$$n = 1.5$$

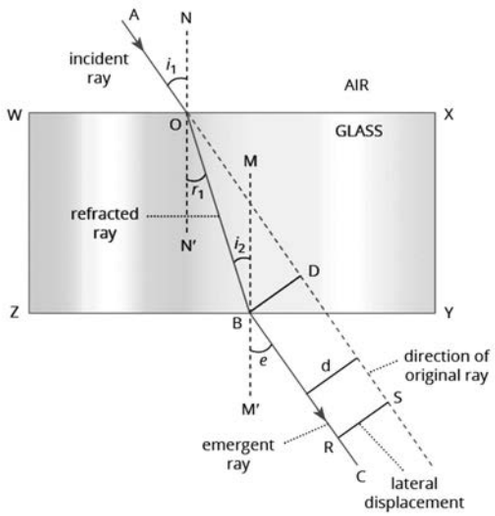
$$n = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in given media}}$$

$$1.5 = 3 \times \frac{10^8}{\text{Speed of light in medium}}$$

$$\text{Speed of light in medium} = \frac{\left(3 \times 10^8\right)}{1.5}$$

$$= 2 \times 10^8 \text{ m/s}$$

4.



Refraction of light through a glass slab

5. **a.** D **b.** C

6. Convex

7. Concave

8. Only yellow

9. Clay

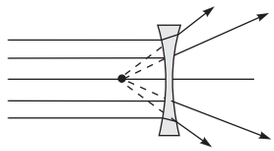
10. Yes. It will. The remaining half of the lens will refract the rays.

11. **a.** Diamond and water

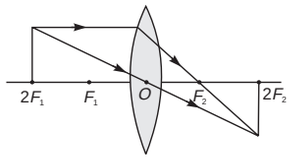
b. Water and ruby

C. Short Answer Type-I Questions

1. The lens used is a concave lens. Image formed is virtual, erect and highly diminished.



2. The lens is convex



3. **a.** Position of object is at infinity, position of image is at focus.

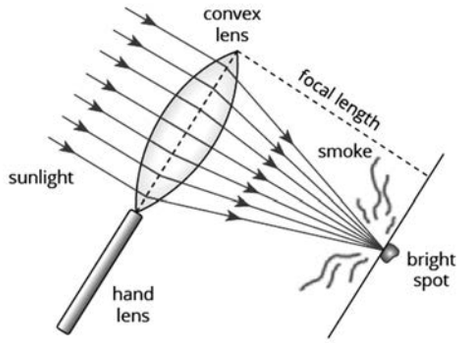
b. Position of object is between optical centre and the principal focus. The position of image is formed on the same side of the lens behind the object

4. The fish appears raised to the bird because water is optically denser than air and the bird appears farther to the fish for the same reason.

5. Convex lens is used for reading books and concave lens enables one to read from a blackboard in a class.

6. Convex. Between optical centre and principal focus.

7. Yes. By focusing sunlight onto a piece of paper.



A convex lens converges sunlight to a point.

8. It changes because the speed of light depends on the density of a medium. If the medium is denser the speed of light will reduce, if it is rarer, the speed will increase.

9. f = 12 cm, v = 48 cm , u = ?

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

$$\frac{1}{12} = \frac{1}{48} - \frac{1}{u}$$

$$\frac{1}{u} = \frac{-3}{48}$$

$$u = \frac{-48}{3} \quad -16 \text{ cm}$$

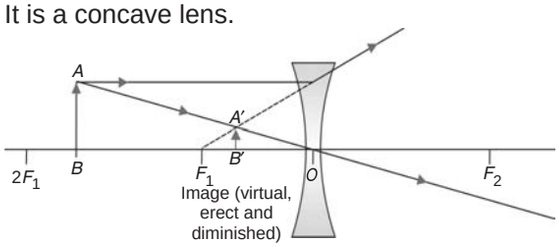
10. When viewed normally from above, the depth of a tank of water remains same as the incident ray does not undergo refraction ($\angle i = \angle r = 0°$), when it falls normally.

D. Short Answer Type-II Questions

1. **a.** Because the angle of emergence is equal to the angle of incidence. Hence, the two rays must be parallel.

b. It is shifted sideward because when it enters into glass from air, it bends towards normal but when it goes from glass to air, it bends away from normal. This bend leads to lateral shift

2. It is a concave lens.



3. $u = -40$ cm , $v = 40$ cm

Since the image is formed on the other side of the lens, therefore, it is real and the lens is a common lens.

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

$$= \frac{1}{40} - \frac{1}{-40}$$

$$= \frac{1}{40} + \frac{1}{40} = \frac{2}{40} = \frac{1}{20}$$

$$f = 20 \text{ cm}$$

If candle flame is shifted 25 cm towards the lens,

$$u = (-40 + 25) = -15 \text{ cm}$$

$$f = 20 \text{ cm}$$

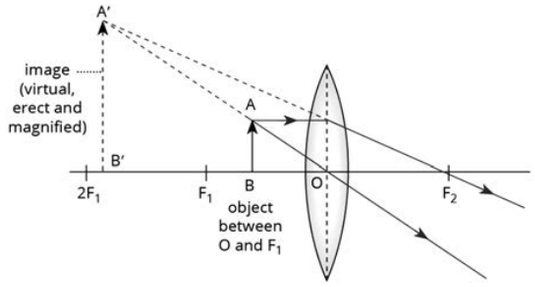
$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{20} = \frac{1}{v} - \frac{1}{-15}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{15}$$

$$v = -60 \text{ cm}$$

The image formed is virtual, erect and enlarged.



Object between O and F_1

4. $P_1 = 3.5$ D

$P_2 = -2.5$ D

Power of lens combination = $P_1 + P_2$

$= 3.5 + (-2.5) = 1$ D

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

$$f = \frac{1}{P} = \frac{1}{1} = 1 \text{ m} = 100 \text{ cm}$$

P. 206–211 Exercises

A. Objective Type Questions

I. Multiple-choice Questions

1. c **2.** d **3.** c **4.** d **5.** b

II. Fill in the blanks

1. greater **2.** denser

3. convex **4.** optical

5. dioptremeter

III. Assertion–Reasoning Type Questions

1. b. **2.** a. **3.** b. **4.** d. **5.** b.

6. c. **7.** a. **8.** d. **9.** a. **10.** c.

IV. Very Short Answer Type Questions

1. Concave lens

2. Laws of refraction of light state that:

a. The incident ray, the refracted ray and the normal at the point of incidence, all lie in the same plane.

b. According to Snell's law, the ratio of sine of the angle of incidence to sine of the angle of refraction is a constant for light of a given colour and for a given pair of media.

Absolute refractive index of a medium =

Speed of light in vacuum/ Speed of light in medium

3. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

4. Object is placed at $2F_1$.

5. When object is placed between O and F_1.

6. Because it converges the parallel beam of light at a point.

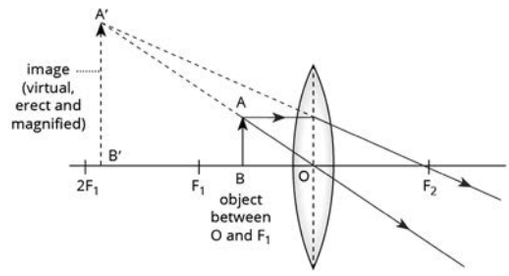
7. Due to the change in density of the medium, the speed of light changes.

B. Short Answer Type-I Questions

1. Refer to Check Your Progress –4 Section B Q–1, Section C–Q–3, (Page 192)

2. Refer to Check Your Progress–2 Section D – Q-4 (Page 184)

3.



Object between O and F_1

4. According to formula

$$P = \frac{1}{f} \text{ or } f = \frac{1}{P}$$

$$f = \frac{1}{5} = 0.2 \text{ m} = 20 \text{ cm}$$

5. According to formula

$$P = \frac{1}{f} \quad \text{and} \quad f = 5 \text{ cm}$$

So, $$P = \frac{1\,\text{m}}{5\,\text{cm}} = \frac{100\,\text{cm}}{5\,\text{cm}} = +20\ \text{D}$$

6. $f = 10$ cm (Convex lens), $u = -5$ cm, $v = ?$

According to lens formula

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

$$\frac{1}{v} - \frac{1}{-5} = \frac{1}{10}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{5} = \frac{-1}{10}$$

$$v = -10 \text{ cm}$$

$$M = \frac{v}{u} = \frac{-10}{-5} = 2$$

C. Short Answer Type-II Questions

1. The object distance $u = 50 - 26 = -24$ cm
The distance of the image $v = 74 - 50 = 24$ cm

a. Using the lens formula let us find the focal length of the lens

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

$$\frac{1}{f} = \frac{1}{24} - \frac{1}{-24}$$

$$\frac{1}{f} = \frac{1}{24} + \frac{1}{24} = \frac{2}{24} = \frac{1}{12}$$

$$f = 12 \text{ cm}$$

When the candle is positioned at 38 cm. The distance between the lens and the candle is $50 - 28 = -12$ cm.

b. Hence using lens formula let us find the image distance

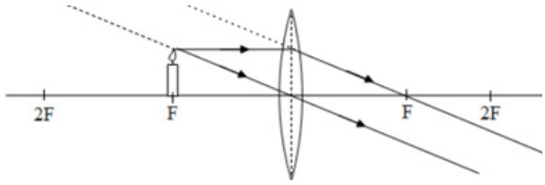
$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{12} = \frac{1}{v} + \frac{1}{12}$$

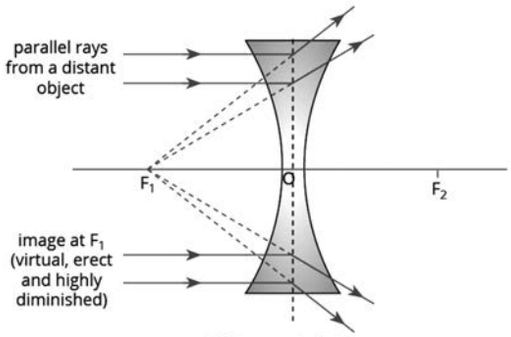
$$\frac{1}{v} = \frac{1}{12} - \frac{1}{12} = 0$$

$$v = \infty$$

Hence the image will be formed at an infinite distance as compared to the size of the apparatus used in the experiment.

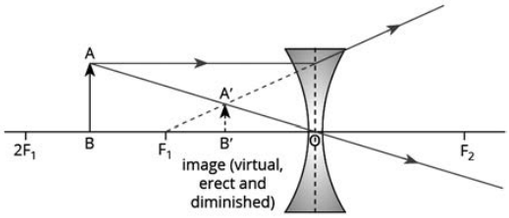


2. a



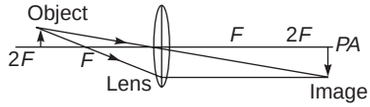
Object at infinity
(rays parallel to the principal axis)

b.



Object between infinity and optical centre

3.



4. Refractive index of the benzene (μ) = 1.50

Let v be the velocity of the light in benzene. Then,

Refractive index of the benzene,

$$\mu = \frac{c}{v}$$

$$v = \frac{c}{\mu}$$

$$v = \frac{\left(3 \times 10^8\right)}{1.50}$$

$$= 2 \times 10^8 \text{ m/s}$$

Hence, the change in velocity of light $= c - v$

$$= 3 \times 10^8 - 2 \times 10^8 = 1 \times 10^8 \text{ m/s}$$

Therefore, the percentage of reduction in speed will be

$$= \frac{(110^8)}{(3 \times 10^8)} \times 100 = 33.3\%$$

OR

From Snell's law

$$n = \frac{\sin i}{\sin r} = \frac{c}{v}$$

Increase in refractive index increases the range of bending. Here angle of incidence is same in every case. The angle of refraction is greater in *c*.It has less refractive index and hence, light suffers less bending, which increases its speed.

5. $^{air}\mu_{water} = \dfrac{\text{Speed of light in air}}{\text{Speed of light in water}} = 1.33$ (i)

$$^{air}\mu_{benzene} = \frac{\text{Speed of light in air}}{\text{Speed of light in benzene}}$$

$$= 1.50 \quad \text{(ii)}$$

$$^{water}\mu_{benzene} = \frac{\text{Speed of light in water}}{\text{Speed of light in benzene}}$$

Dividing Equation (ii) by Equation (i) we get

$$\frac{^{air}\mu_{benzene}}{^{air}\mu_{water}}$$

$$= \frac{\left(\dfrac{\text{Speed of light in air}}{\text{Speed of light in benzene}}\right)}{\left(\dfrac{\text{Speed of light in air}}{\text{Speed of light in water}}\right)}$$

$$= \frac{\text{Speed of light in benzene}}{\text{Speed of light in water}}$$

since $^{water}\mu_{benzene} = \dfrac{\text{Speed of light in water}}{\text{Speed of light in benzene}}$

$$= \frac{1.50}{1.33} = 1.127 = 1.13$$

6. $^{air}\mu_{ice} = 1.31$ (i)

$$^{air}\mu_{rocksalt} = 1.54 \quad \text{(ii)}$$

$$^{ice}\mu_{rocksalt} = \frac{\text{Equation (ii)}}{\text{Equation (i)}}$$

$$= \frac{1.54}{1.31} = 1.17$$

7. $\text{R.I.} = \dfrac{\text{Speed of light in vaccum}}{\text{Speed of light in Ruby}}$

$$1.7 = \frac{3 \times 10^8 \text{ m/s}}{V_R}$$

$$VR = \frac{3 \times 10^8 \text{ m/s}}{1.7} = 1.764 \times 10^8 \text{ m/s}$$

8. Refractive index of a medium is also defined as the ratio of the speed of light in air and the speed of light in that medium. If *c* is the speed of light in air and *v* is the speed of light in the medium then the refractive index of the medium (*n*) is given by

$$n = \frac{\text{Speed of light in air}}{\text{Speed of light in the medium}} = \frac{c}{v}$$

The refractive index of the medium $n = 1{\cdot}5$

The speed of light in a medium $= 2 \times 10^8 \text{ ms}^{-1}$

The speed of light in vacuum = ?

$$1.5 = \frac{c}{2} \times 10^8$$

$$c = nv = 1.5 \times 2 \times 10^8 = 3 \times 10^8$$

9. We know speed of light in air $= 3 \times 10^8$ m/s

Let the speed of light in glass be *v*

$$\frac{\text{Speed of light in air}}{\text{Speed of light in glass}} = 1.50$$

(since that is the refractive index)

$$3 \times \frac{10^8}{v} = 1.50$$

$$v = \frac{3 \times 10^8}{1.50} = 2 \times 10^8 \text{ m/s}$$

10. Object distance *u* = ?

Focal length $f = -15$ cm (concave lens)

Height of the object = 3 cm

Image distance $v = -10$ cm

Applying $\quad \dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}$

$$\frac{1}{-10} - \frac{1}{u} = \frac{1}{-15}$$

$$\frac{1}{u} = \frac{1}{-10} - \frac{1}{-15} = \frac{-1}{10} + \frac{1}{15}$$

$$= \frac{-3+2}{30} = \frac{-1}{30}$$

$$u = -30 \text{ cm}$$

$$\frac{h'}{h} = \frac{v}{u}$$

$$\frac{h'}{3} = \frac{-10}{-30} = \frac{1}{3}$$

$$h' = 1 \text{ cm.}$$

Virtual and erect image.

11. Only concave lens forms a diminished and erect image when placed in front of the lens.

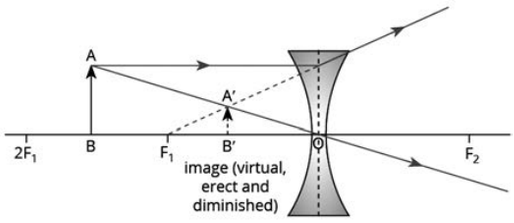
We know that $\quad f = \dfrac{1}{p}$

So, power = 10 d

$$f = \frac{1}{10}$$

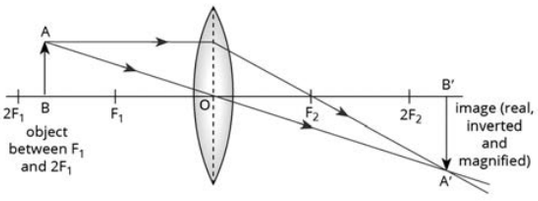
$$f = \frac{100}{10} = -10 \text{ cm}$$

Here $f = -10$ cm because concave lens have focal length in negative.



Object between infinity and optical centre

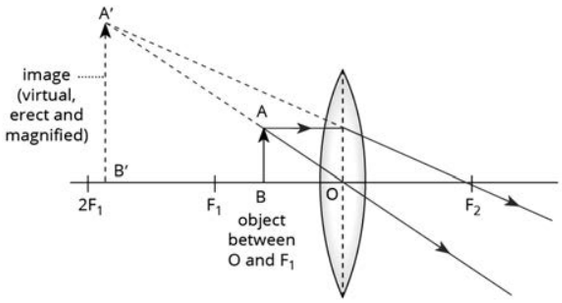
12. When object is placed between F and 2F the image is real and magnified.



Object between F_1 and $2F_1$

OR

When object is placed between F and optical centre of the lens, the image is virtual and magnified.



Object between O and F_1

13. a. Optical centre: The geometrical centre of the lens is called the optical centre.

b. $f = -20$ cm (concave lens)

$h = 4$ cm , $u = ?$ $v = -10$ cm

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{-10} - \frac{1}{u} = \frac{1}{-20}$$

$$\frac{-1}{10} - \frac{1}{u} = \frac{-1}{20}$$

$$\frac{1}{u} = \frac{-1}{10} + \frac{1}{20}$$

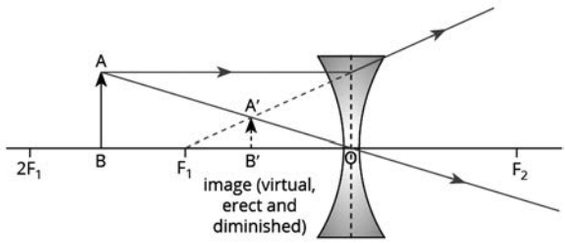
$$u = -20$$

$$\frac{h'}{h} = \frac{v}{u}$$

$$\frac{h'}{4} = \frac{-10}{-20} = \frac{1}{2}$$

$$h' = \frac{4}{2} = 2 \text{ cm}$$

c.



Object between infinity and optical centre

14. $f = -60$ cm, $u = -30$ cm $h = 9$ cm

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

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

$$= \frac{1}{-30} + \frac{1}{-60} = \frac{-1}{30} - \frac{1}{60}$$

$$= \frac{-3}{60}$$

$$v = -20 \text{ cm}$$

$$\frac{h'}{h} = \frac{v}{u}$$

$$\frac{h'}{9} = \frac{-20}{-30} = \frac{2}{3}$$

$$h' = \frac{2}{3} \times 9 = 6 \text{ cm}$$

15. Here, focal length (f) = -30 cm, Object distance (u) = 15 cm

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

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

$$= \frac{1}{-15} + \frac{1}{-30}$$

$$= \frac{-1}{15} - \frac{1}{30}$$

$$= \frac{-3}{30} = \frac{-1}{10}$$

$$\frac{1}{v} = \frac{-1}{10} \text{ cm}$$

$$v = -10 \text{ cm}$$

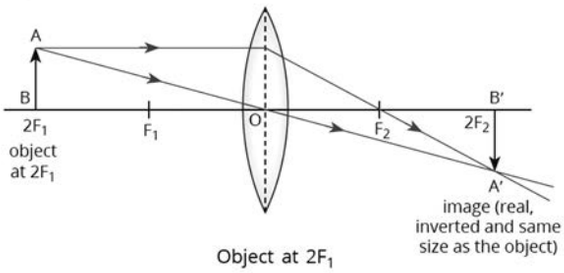
So image is erect, virtual, $\frac{1}{3}$ size of object, and

10 cm from the lens, (between lens and object)

16. a. To obtain a real and inverted image of same size we must use convex lens. In a convex lens when object is held at $2f$ then the image is formed real and inverted.

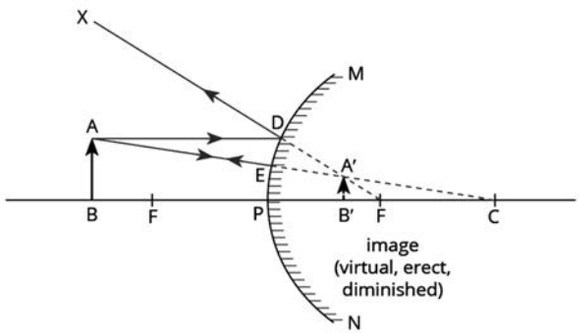
b. We know that: $u = 2f = 4$ m $f = 4/2 = 2$ m Hence, The focal length is 2 m. The lens is placed at a distance of 4 m from the candle.

c.



Object at $2F_1$

17. Yes, the lens covered with a black paper on one side can produce an image of a complete object. The lens now acts like a convex mirror.



Object between the pole and infinity

18. $f = 20$ cm $u = -15$ cm $h = 4$ cm

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} - \frac{1}{-15} = \frac{1}{20}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{15} = \frac{-1}{60}$$

$$v = -60 \text{ cm}$$

$$\frac{h'}{h} = \frac{v}{u}$$

$$\frac{h'}{4} = \frac{-60}{-15} = 4$$

$h' = 16$ cm Image is virtual, erect and magnified.

19. $h = 10$ cm $f = 20$ cm $u = -10$ cm

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

$$= \frac{-1}{10} + \frac{1}{20} = \frac{1}{20}$$

$$v = -20 \text{ cm}$$

$$m = \frac{v}{u} = \frac{-20}{-10} = 2$$

Image is virtual, erect and enlarged and is formed at the same side of lens.

20. $m = \frac{-2}{3}$ $u = -12$ cm

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

$$\frac{-2}{3} = \frac{v}{-12}$$

$$v = \frac{-2}{3} \times -12 = 8 \text{ cm}$$

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

$$\frac{1}{8} - \frac{1}{-12} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{1}{8} + \frac{1}{12} = \frac{5}{24}$$

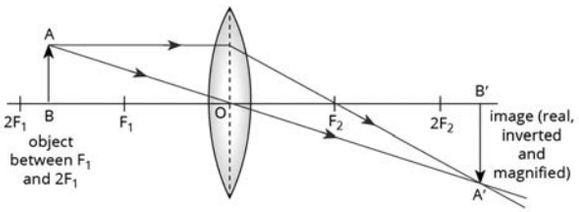
$$f = \frac{24}{5} = 4.8 \text{ cm}$$

21. a. He should use a convex lens because it creates a real image.

b. i. To get a magnified image, the candle must be placed between F_1 and $2F_1$ or at F_1.

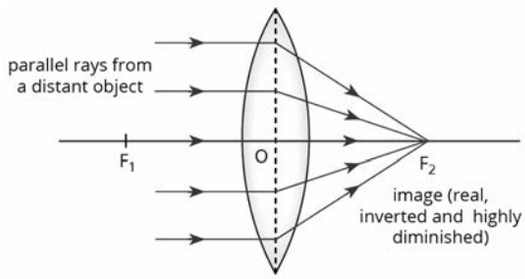
ii. To get a diminished image, the candle must be placed at infinity.

c. i.



Object between F_1 and $2F_1$

ii.



Object at infinity (rays parallel to the principal axis)

22. a. Power of lens is defined as the reciprocal of its focal length (in metres). Its SI unit is Dioptre (D).

One dioptre is defined as the power of lens whose focal length is 1 metre.

b. Focal length +50 cm (positive), therefore, convex lens

$$P = \frac{100}{50} = 2D$$

Focal length −50 cm (negative), therefore, concave lens

$$P = \frac{100}{-50} = -2D$$

The lens with negative focal length will always give virtual, erect and diminished image irrespective of the position of object.

23. The lens is a convex lens since power is '+' 5.

Focal length (f) = $\frac{1}{\text{power}}$.

so, $\frac{1}{5}$ = 0.2 m = 20 cm.

Inverted image of same size will be obtained when object is placed at 2F, which is double of focal length.

So, object distance = 20 × 2 = 40 cm.

24. The power of a lens is the degree of convergence or divergence of light rays. It is defined as the reciprocal of its focal length (in metres). It is represented by the letter P. The SI unit of the power of a lens is dioptre.

$$P = \frac{1}{f} \quad \text{[in meters]}$$

Given $L_1 = +10D$

$$P_1 = \frac{100}{f}$$

$$10 = \frac{100}{f}$$

$$f_1 = \frac{100}{10} = 10 \text{ cm}$$

$$L_2 = +5D$$

$$f_2 = \frac{100}{5} = 20 \text{ cm}$$

$$L_3 = -10D$$

$$f_3 = \frac{-100}{10} = -10 \text{ cm}$$

So first and second lens are convex lens and third lens is a concave lens because focal length is negative.

Lens 2 that is with focal length 20 cm will produce magnified and virtual image of an object placed at 15 cm because the position of the object is between P and F.

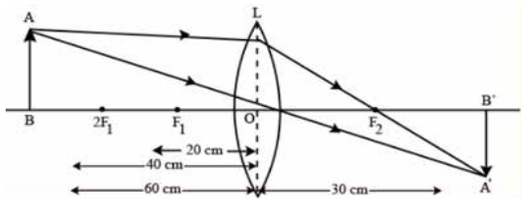
D. Long Answer Type Questions/Numericals

1. From the observation 3, the radius of curvature of the lens is 40 cm as distance of object and the distance of the image is same.

We know, focal length, $f = \frac{R}{2} = \frac{40}{2} = 20$ cm

b. S. No. 6 is not correct, because for this observation the object distance is between focus and pole and for such cases, the image formed is always virtual. But in this case real image is formed as the image distance is positive.

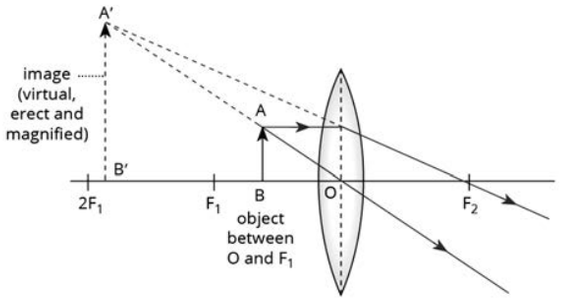
c.



From the figure, object distance $u = -60$ cm and image distance v = 30 cm. We know,

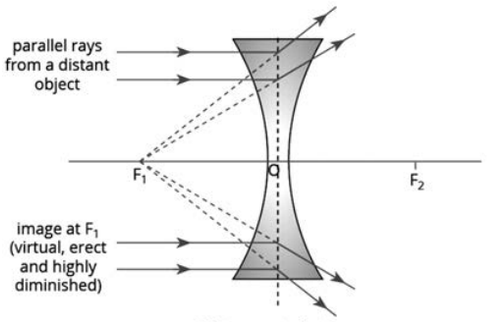
magnification = $\frac{v}{u} = \frac{+30}{-60} = -0.5$

2. a. Between optical centre and principal focus of a convex lens.



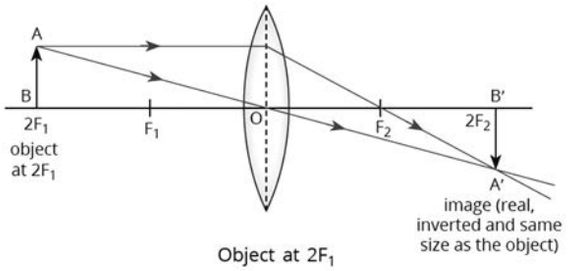
Object between O and F_1

b. Anywhere in front of a concave lens.



Object at infinity
(rays parallel to the principal axis)

c. at 2F of a convex lens.



Object at $2F_1$

In case-

i. sign of m is positive and $m > 1$.

ii. sign of m is positive and $m < 1$.

3. Focal length $f = 25$ cm

Image distance $v = 75$ cm

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{75} - \frac{1}{u} = \frac{1}{25}$$

$$\frac{1}{u} = \frac{1}{75} - \frac{1}{25} = \frac{1-3}{75}$$

$$u = -37.5 \text{ cm}$$

$$M = \frac{v}{u} = \frac{75}{-37.5} = -2$$

The image will be real and inverted (negative sign).

4. a. i. Image formed on the same side of lens as the object.

ii. The Image is enlarged / magnified

iii. The Image is erect

iv. The image is virtual.

b. $f = 20$ cm

$$\frac{h'}{h} = \frac{1}{3} = \frac{v}{u} \text{ So } u = 3 \text{ v}$$

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} - \frac{1}{3v} = \frac{1}{20}$$

$$-\frac{2}{3}v = \frac{1}{20} \; v = \frac{-40}{3}$$

$$u = 3 \times \frac{-40}{3} = -40 \text{ cm}$$

5. Focal length $f = 30$ cm

Image distance $v = 60$ cm

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{60} - \frac{1}{u} = \frac{1}{30}$$

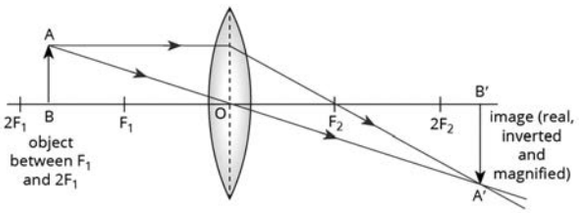
$$\frac{1}{u} = \frac{1}{60} - \frac{1}{30} = \frac{-1}{60}$$

$$u = -60 \text{ cm}$$

$$M = \frac{v}{u} = \frac{60}{-60} = -1$$

6. $h = 6$ cm, $u = -50$ cm $f = 30$ cm $h = -3$ cm

Lens formula = $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$



Object between F_1 and $2F_1$

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

$$\frac{1}{v} = \frac{1}{30} - \frac{1}{50}$$

$$= \frac{(5-3)}{150}$$

$$= \frac{2}{150}$$

$$v = \frac{150}{2} = +75 \text{ cm}$$

$$\frac{h'}{h} = \frac{v}{u}$$

$$\frac{h'}{6} = \frac{75}{-50}$$

$$h' = \frac{75 \times 6}{-50}$$

$$= -9 \text{ cm}$$

Hence, image formed is real, inverted and magnified.

7. Object distance $u = -20$ cm

Focal length $f = 30$ cm (convex lens)

Height of the object = 10 cm

Image distance v = ?

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} - \frac{1}{-20} = \frac{1}{30}$$

$$\frac{1}{v} = \frac{1}{30} - \frac{1}{20}$$

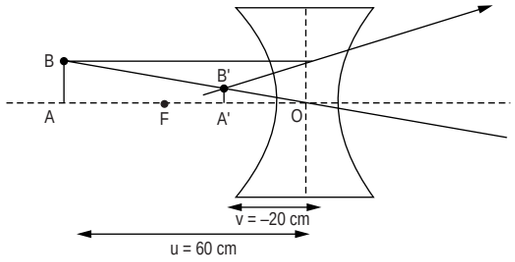
$$v = -60 \text{ cm}$$

$$\frac{h'}{h} = \frac{v}{u}$$

$$\frac{h'}{10} = \frac{-60}{-20} = \frac{3}{1}$$

h' = 30 cm Virtual, erect image.

8. a. u = – 60 cm , f = – 30 cm, v = ?



(*c*) The ray diagram

Using lens formula, we get-

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

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

$$\frac{1}{v} = \frac{1}{(-30)} + \frac{1}{(-60)}$$

$$\frac{1}{v} = \frac{-1}{30} - \frac{1}{60}$$

$$\frac{1}{v} = \frac{-2-1}{60}$$

$$\frac{1}{v} = \frac{-3}{60}$$

$$\frac{1}{v} = \frac{-1}{20}$$

v = – 20 cm

b. The four characteristics of the image are:

Image is virtual.

Image is erect.

Image is diminished (sm aller than the object).

Image is formed at a distance of 20 cm from the optical centre of the concave lens on the same side of the object.

9. Object distance u = –20 cm

Focal length f = 12 cm (convex lens)

Height of the object = 3 cm

Image distance v = ?

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} - \frac{1}{-20} = \frac{1}{12}$$

$$\frac{1}{v} = \frac{1}{12} - \frac{1}{20} = \frac{2}{60}$$

v = 30 cm

$$\frac{h'}{h} = \frac{v}{u}$$

$$\frac{h'}{3} = \frac{30}{-20}$$

h' = –4.5 cm

Real and inverted image (negative sign).

10. h = 6 cm, f = –5 cm , u = –10 cm

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} - \frac{1}{-10} = \frac{1}{-5}$$

$$\frac{1}{v} = \frac{-1}{5} - \frac{1}{10} = \frac{-3}{10}$$

$$v = \frac{-10}{3}$$

$$\frac{h'}{h} = \frac{v}{u}$$

$$\frac{h'}{6} = \frac{\left(\frac{-10}{3}\right)}{-10} = \frac{1}{3}$$

$$h' = \frac{6}{3} = 2 \text{ cm}$$

Virtual, erect and diminished.

11. u = –45 cm

v = 90 cm

Since the image is formed on screen, therefore, the image is real and the lens is convex.

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{f} = \frac{1}{90} - \frac{1}{-45} = \frac{3}{90}$$

f = 30 cm

$$\frac{h'}{h} = \frac{v}{u}$$

$$\frac{h'}{2} = \frac{90}{-45} = -2$$

h' = –4 cm

12. a. h = 5 cm f = 20 cm u = –30 cm

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} - \frac{1}{-30} = \frac{1}{20}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{30}$$

$$= \frac{(3-2)}{60} = \frac{1}{60}$$

$v = 60$ cm

Thus, the position of the image is 60 cm from the lens, and the plus sign implies that it forms behind the lens (on the right side). Also, the nature of the image is real as it forms on the right side.

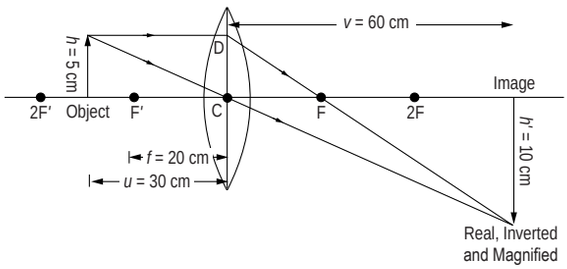
$$\frac{h'}{h} = \frac{v}{u}$$

$$\frac{h'}{5} = \frac{60}{-30}$$

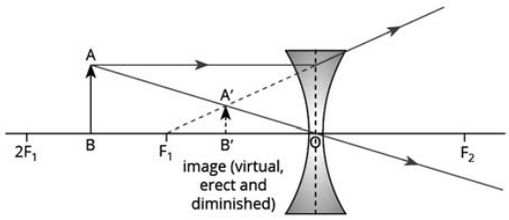
$h' = -10$ cm

Thus, the size of the image is 10 cm, and the minus sign implies that the image is inverted .

b.



13. a.



Object between infinity and optical centre

b. $f = -15$ cm

$v = -10$ cm

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{-10} - \frac{1}{u} = \frac{1}{-15}$$

$$\frac{1}{u} = \frac{-1}{10} + \frac{1}{15}$$

$$\frac{1}{u} = \frac{-1}{30}$$

$u = 30$

i. $M = \frac{v}{u} = \frac{-10}{-30} = \frac{1}{3}$

ii. Virtual, erect and diminished.

14. $h = 2.5$ cm

$u = -15$ cm

$f = 10$ cm

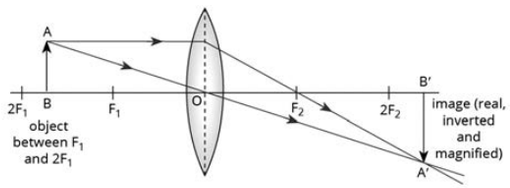
Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} - \frac{1}{-15} = \frac{1}{10}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{15}$$

$v = 30$ cm

$$h' = 2.5 \times \frac{30}{-15} = -5 \text{ cm}$$



Object between F_1 and $2F_1$

15. $h = 4$ cm, $u = -12$ cm, $v = 24$ cm

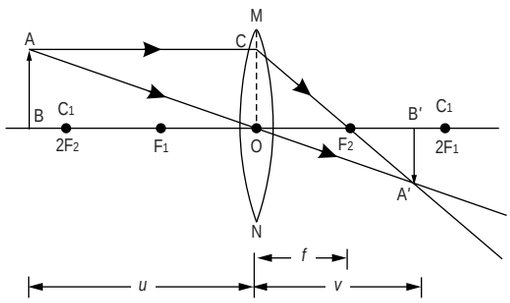
Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{f} = \frac{1}{24} - \frac{1}{-12} = \frac{1}{24} + \frac{1}{12} = \frac{3}{24} = \frac{1}{8}$$

$f = 8$ cm

If the object is moved away from lens then the lens should be moved towards the lens to obtain a sharp image. The magnification of the image will also decrease.

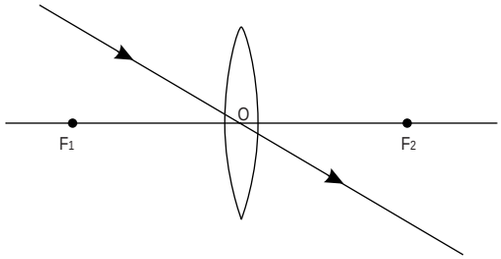
16.



a. The image will be real and inverted, since the magnification has negative value. The lens that can produce a real and inverted image is a converging/ convex lens.

In the figure $OF_1 = OF_2 = 6$ cm.

b. The girl must have directed the ray of light along the direction of the optical centre of the lens because the ray of light passes straight through the optical centre of the lens.



OR

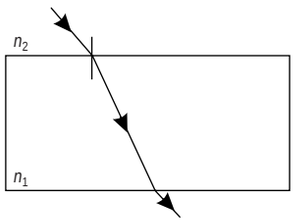
a. Refractive Index of a medium (μ)

$$= \frac{\text{Velocity of light in vacuum}}{\text{Velocity of light in the medium}}$$

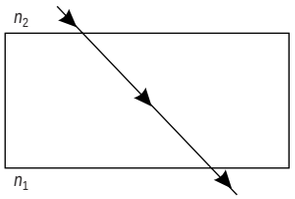
Let the velocity of light in vacuum be v_1 and velocity of light in the medium be v_2. $\frac{v_1}{2} = v_2$.

Hence $\mu = \frac{v_1}{v_2} = \frac{v_1}{\left(\frac{v_1}{2}\right)} = 2$.

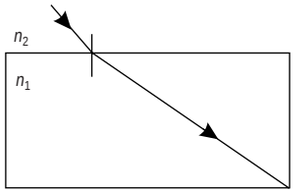
b.



i. The ray moves towards the normal



ii. The ray moves undeviated.



iii. The ray moves away from the normal.

E. Source-Based/Case-Based/Passage-Based/ Integrated Assessment Questions

1. a. ii. aperture of the lens.

b. ii. convex lens.

c. i. between infinity and 2F.

d. iv. all of the above.

e. ii. clay.

2. a. ii. convex lens.

b. i. convex lens.

c. ii. enlarged, real and inverted.

d. iii. simple microscope.

e. iii. beyond 2F.

F. Value-Based Questions (Optional)

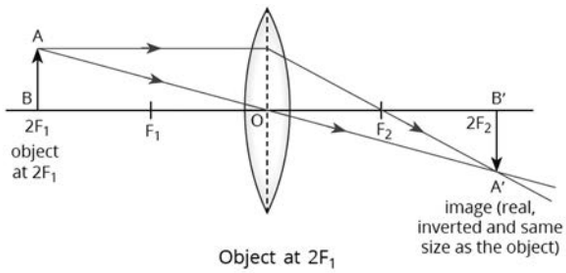
1. a. The pencil in the glass tumbler filled with water appears to be shortened and bent. This apparent bending of pencil is due to the refraction of light when it passes from water (denser) into air rarer.

b. This shows that Sanjay is a very helpful boy. He is kind enough to explain the logic behind the bending of pencil.

2. a. The pool of water appears less deep than its actual depth. The bottom of pool appears to be raised. This is because light comes from a denser (water) medium into a rarer medium (air) thus, the direction of light changes and the pool appears less deep.

b. Radha's action shows that she is very attentive and helpful. She responded very quickly and jumped inside the pool to save her friend.

3. a.



b. This shows that Sushil is a keen learner and is interested to know more about terrestrial telescopes. He is very kind and helpful too.

4. a. sPrateek was able to distinguish between a convex and a concave lens. He kept it close to his face and observed the image. If the image formed was magnified then it was a convex lens, if the image was diminished then it was a concave lens.

b. This shows that Prateek is very smart and intelligent. He is very helpful and has a great knowledge about lenses.

CHAPTER–6

THE HUMAN EYE AND THE COLOURFUL WORLD

P. 217 Check Your Progress 1

A. Multiple-choice Questions

1. c **2**. c **3**. b **4**. a **5**. b

B. Very Short Answer Type Questions

1. The outer part of the eye is composed of three layers of tissues namely, sclerotic, choroid and retina.

2. The farthest point up to which the eye can see objects clearly without strain is called the far point of the eye.

3. Crystalline double convex lens.

4. The ciliary muscles relax and the eye lens becomes thinner, i.e. less curved. When less curved, the focal length of the eye increases and a sharp image of the distant object is formed at the retina.

5. The ciliary muscles attached to lens contract and the lens becomes thicker, i.e. more curved. When more curved, the focal length of eye lens decreases and a sharp image of nearly object is formed on the retina.

6. As we bring an object closer to the eye, the focal length of the eye lens changes so as to form the image of the object at retina. However, there is a limit to how close the object may be to the eye and the image still be clearly seen. If the object is closer than 25 cm to the eye, the lens cannot curve enough to focus the image on the retina. Therefore, the image is blurred.

7. Near point increases with age because of decreasing effectiveness of the ciliary muscles and loss of flexibility of eye lens.

8. A normal eye is capable of seeing objects clearly from a far point (infinity) up to a near point of 25 cm.

C. Short Answer Type-I Questions

1. The minimum distance at which objects can be seen most clearly without strain is called the near point of the eye. The least distance of distinct vision for a normal eye is 25 cm.

2. The ability of the eye lens to adjust its focal length so as to see the objects located anywhere is called the power of accommodation.

3. The crystalline lens in the human eye focusses the light rays to form a real and inverted image on the retina.

D. Short Answer Type-II Questions

1. a. It protects the vital internal parts of the eye.

b. It darkens the eye from inside and hence, prevents any internal reflection.

c. The retina of an eye is where the image of an object is formed.

d. Lends colour to the eye.

e. Rods are sensitive to the intensity of light.

f. Cones are sensitive to colour.

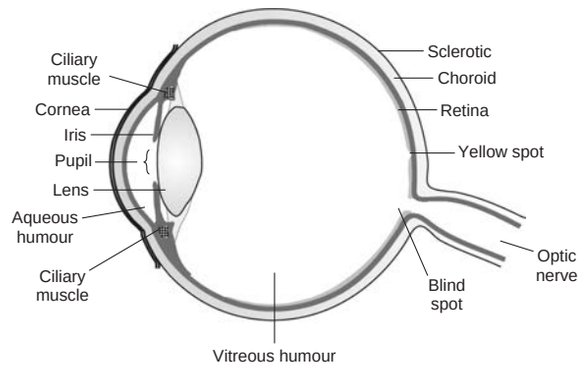
g. Connect the rods and the cones of retina to the brain.

2. Iris and pupil: Behind the cornea is an opaque diaphragm called the iris. It lends colour to the eye. The iris has a central circular aperture called the pupil. The iris regulates the amount of light entering the eye by adjusting the size of the pupil in the following way:

If the intensity of the light is low (dim light as in a dark room), the iris makes the pupil to expand to allow more light to enter the eye.

If the intensity of the light is high (bright light as on a sunny day), the iris makes the pupil to contract in order to decrease the amount of light enter the eye. The iris consists of muscles that expand and contract the pupil.

3. Labelled diagram of human eye:



P. 221–222 Check Your Progress 2

A. Multiple-choice Questions

1. a **2**. a **3**. b **4**. d **5**. b

B. Very Short Answer Type Questions

1. Myopia, Hypermetropia.

2. Increase in size of the eye: Leads to the increase in the distance of the retina from the eye lens. In such a case, the image of a distant object is formed in front of the retina.

3. Ciliary muscles in human eye relax (lens becomes thinner) and contract (lens becomes thicker) to alter the focal length of the lens in order to see objects at various distances.

   Presbyopia arises due to gradual weakening of the ciliary muscles. Elderly people need to use spectacles with a convex lens to see objects clearly.

4. The far point shifts towards the eye.
5. For a hypermetropic eye, the near point shifts away from the eye.
6. These days, it is possible to correct the refractive defects with contact lenses or through surgical interventions.
7. **Excessive curvature of the eye:** Leads to the thickening of the eye lens. This decreases the focal length of the eye lens. In such a case, the image of the object is formed in front of the retina.
8. In hypermetropic eye, the image of the nearly object O is formed behind the retina and not at the retina itself. So, the nearby object is not seen by the hypermetropic eye.
9. Thinning of eye lens causes the image of the nearby objects to form behind the retina because focal length increases.
10. Shortening or decrease in the size of the eye lens leads to decrease in the distance of the retina from the eye lens. In such a case, the image of the nearby object is formed behind the retina.
11. **a.** Myopia **b.** Hypermetropia
12. **a.** Hypermetropia **b.** Myopia **c.** Presbyopia

C. Short Answer Type-I Questions

1. Inability to see nearby objects.
2.

Hypermetropia	Presbyopia
It caused due to the contraction in the size of the eye ball, i.e. the eye ball becomes small.	The eye ball has normal size. It does not contract.
No effect on ciliary muscles.	This is caused due to the gradual weakening of the ciliary muscles.
It can affect young as well as old people.	This defect is most common only in the old people.

3. Power of distant vision = −4 D

   We know $P = \frac{1}{f}$

   $-4 = \frac{1}{f}$

   $f = -0.25 \text{ m} = -25 \text{ cm}$

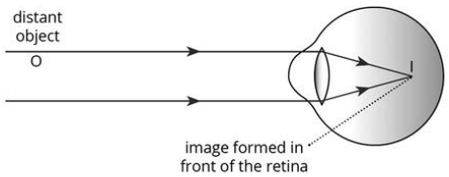
4. Hypermetropia. It can be corrected by using spectacles with convex lens of suitable focal length.

D. Short Answer Type-II Questions

1. A person with myopia can see nearby objects clearly but cannot see distant objects distinctly. In other words, the far point shifts towards the eye.

   The two possible cause of myopia are:

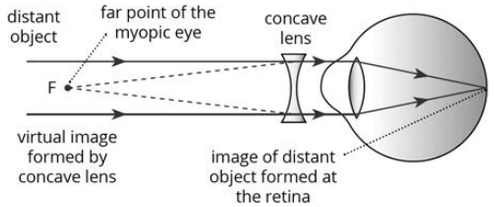
   a. Excessive curvature of eye: This leads to thickening of the eye lens. This decreases the focal length of the eye lens. In such a case, the image of the object is formed in front of the retina.



Myopic eye

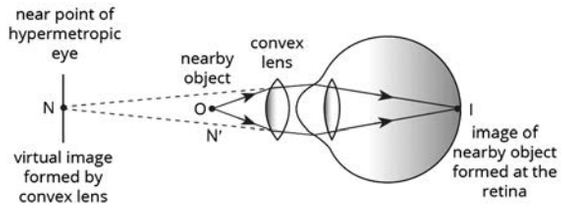
   b. Elongation or increase in size of the eye lens: This leads to increase in distance of retina from the lens. The image of a distant object is formed in front of retina.

   This defect can be corrected by using a concave lens of suitable focal length.



Correction for myopia

2. Hypermetropia is an eye defect in which we cannot see nearby objects distinctly. To correct a hypermetropic eye, the person has to use spectacles with a convex lens of suitable focal length. In fact the rays of light from nearby objects, after refraction through the convex lens, converge at N (near point of the hypermetropic eye). The convex lens forms a virtual image of the nearby object at a near point N of the hypermetropic eye. Therefore, rays of light appear to come from the image at the near point N of the hypermetropic eye and not from the nearby object. So, the final image is formed at the retina and the hypermetropic eye is able to see the nearby object. Thus, the eye defect is corrected.



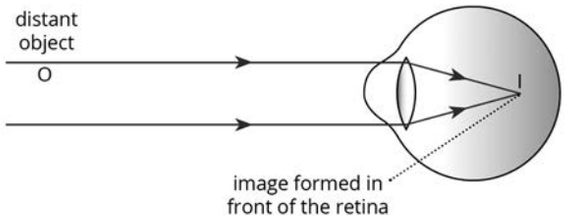
Correction for hypermetropic eye

3. a. Myopia. It can be corrected by using spectacles with concave lens of suitable focal length.

b. Care for others, scientific temperament, friendliness, helping others, etc.

c. He must thank his teacher and friend, both.

4.



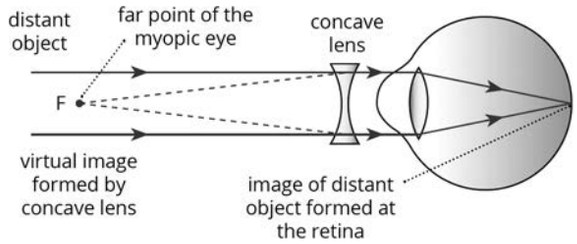
Myopic eye

The two possible causes of myopia are:

a. Excessive curvature of eye: This leads to thickening of eye lens. This decreases the focal length of the eye lens. In such a case, the image of the object is formed in front of the retina.

b. Elongation or increase in size of eye lens: This leads to increase in the distance of retina from the eye lens. In such a case, image of distant object is formed in front of retina.

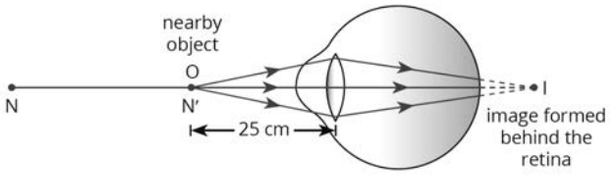
The person should use a spectacle with a concave lens to correct the defect.



Correction for myopia

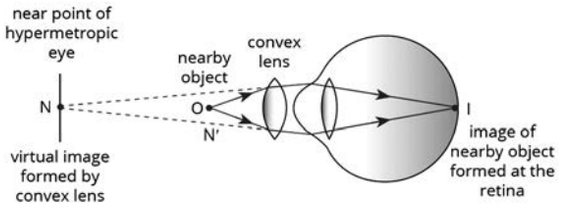
5. Presbyopia: As a person gets older, the ciliary muscles holding the eye lens weaken and the lens loses some of its elasticity. Therefore, the power of accommodation of the eye decreases with ageing. For most old people, the near point gradually recedes away. They find it difficult to see nearby objects comfortably and distinctly without corrective eye glasses. This defect is called presbyopia. To correct this defect, the elderly people need to use spectacles with a convex lens. They need to wear these spectacles for reading or similar kind of close work.

6. The person is suffering from hypermetropia.



Hypermetropic eye

The two possible causes of hypermetropia are:



Correction for hypermetropic eye

a. The focal length of eye lens is too long. This is due to thinning of the eye lens. In such a case, the image of the nearby object is formed behind the retina.

b. Shortening or decrease in the size of the eye lens. This leads to the decrease in the distance of the retina from the eye lens. In such a case, the image of a nearby object is formed behind the retina.

E. Numerical Problems

1. Power of lens:

To see an object at infinity

Object distance $u = \alpha$

The corrective concave lens should form the image of distant object at infinity at the far point of the myopic eye, i.e.

Image distance $= -75$ cm

Focal length $f = ?$

We know a person with myopic eye should use spectacles made of concave lens of suitable focal length.

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

$$\frac{1}{-75} - \frac{1}{\alpha} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{-1}{75}$$

$$f = -75 \text{ cm}$$

The negative sign of focal length shows that the lens required is concave lens.

We know $P = \frac{1}{f}$ (where focal length is in metres)

$$P = \frac{-1}{75} = -1.33 \text{ D}$$

2. The near point of normal eye = 25 cm

The near point of hypermetropic eye = 50 cm. It is the nearest point up to which the hypermetropic eye can see objects clearly. To correct this defect the person must use spectacles made of convex lens of suitable focal length.

Object distance $u = -25$ cm

Image distance $v = -50$ cm

Focal length $f = ?$

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

$$\frac{1}{-50} - \frac{1}{-25} = \frac{1}{f}$$

$$\frac{-1}{50} + \frac{1}{25} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{1}{50}$$

$$f = 50 \text{ cm} = 0.5 \text{ m}$$

We know, $P = \frac{1}{f}$

Therefore, power of the lens $= \frac{1}{0.5} = +2$ D

3. Object distance $u = -25$ cm

Image distance $v = 2.5$ cm

Height of the object $h = 2$ cm

Applying $\frac{h'}{h} = \frac{v}{u}$

$$\frac{h'}{2} = \frac{2.5}{25}$$

Size of the image h' = –0.2 cm Inverted image is formed.

4. $v = -30$ cm $u = -40$ cm

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

$$\frac{1}{-30} - \frac{1}{-40} = \frac{1}{f}$$

$$\frac{-1}{30} + \frac{1}{40} = \frac{1}{f}$$

$f = -120$ cm $= -1.2$ m

The lens is a concave lens of focal length 120 cm or 1.2 m.

$$P = \frac{1}{f} = \frac{-1}{-1.2} = -0.833 \text{ D}$$

5. $u = -25$ cm, $v = -150$ cm

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

$$\frac{1}{-150} - \frac{1}{-25} = \frac{1}{f}$$

$$\frac{-1}{150} + \frac{1}{25} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{(-1+6)}{150} = \frac{5}{150} = \frac{1}{30}$$

$$f = 30 \text{ cm}$$

The lens is a convex lens of focal length 30 cm.

$$P = \frac{1}{f} = \frac{1}{30} = \frac{100}{30} = 3.33 \text{ D}$$

6. Image distance $v = 75$ cm, Object distance $u = -25$ cm

Focal length $f = ?$

We know, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

Putting these values in the lens formula, we get

$$\frac{1}{-75} - \frac{1}{-25} = \frac{1}{f}$$

$$\frac{1}{-75} + \frac{1}{25} = \frac{1}{f}$$

$$\frac{(-1+3)}{75} = \frac{1}{f}$$

$$f = \frac{75}{2} \text{ cm}$$

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

$$P = \frac{2}{75} = \frac{(2 \times 100)}{75} = 2.666 \text{ D} = 2.67 \text{ D}$$

7.

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

$$2 = \frac{1}{f}$$

$$f = \frac{1}{2} = 0.5 \text{ m} = 50 \text{ cm}$$

P. 226–227 Check Your Progress 3

A. Multiple-choice Questions

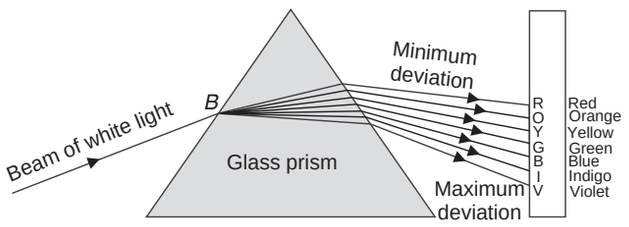
1. d **2.** c **3.** c **4.** b **5.** b

B. Very Short Answer Type Questions

1. The phenomenon of splitting of white light into a component colours on passing through a glass prism is called dispersion of light.

2. The band of coloured components of a light beam obtained on a white screen, when white light passes through a prism, is called spectrum.
3. A rainbow is a natural spectrum of sunlight in the form of bows appearing in the sky when the sun shines on raindrops after the rain. It is formed due to reflection, refraction and dispersion of sunlight by tiny water droplets, present in the atmosphere.
4. A prism is a transparent refracting medium (glass) bounded by three plane surfaces making a triangle.
5. Violet, Indigo, Blue, Green, Yellow, Orange, and Red (VIBGYOR).
6. No
7. Different colours of light bend through different angles with respect to the incident ray as they pass through a prism. Thus, when white light is incident on the face of a prism, waves of different colours (having different wavelengths hence different refrangibility) deviate through different angles and in the process get separated or dispersed.
8. Red
9. Violet

C. Short Answer Type-I Questions

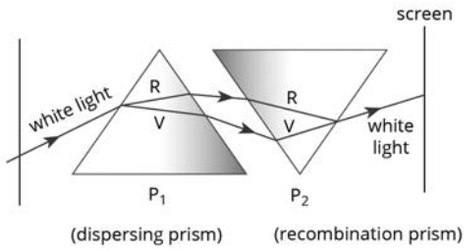
1. **a.** As the ray of light PE (incident ray) travels from air (rarer medium) to glass (denser medium), it bends towards the normal and is refracted along the path EF (refracted ray).
   b. The ray of light travels from glass (denser medium) to air (rarer medium), it bends away from the normal.
2. **a.** Since the wavelength of violet colour (in the spectrum) is the least, it ends or deviates the most.
   b. Red colour (in the spectrum) has highest wavelength, hence, it bends or deviates the least.
3. 

4. The water droplets over the cloud act like small prisms.
   a. When white light from the sun enters a spherical raindrop, the light is refracted and dispersed. The different colours of light are bent through different angles.
   b. When different colours of light fall on the back inner surface of the water drop, it (water drop) reflects them (different colours of light) internally (total internal reflection).
   c. The water drop finally refracts the different colours of light again when it comes out of the raindrop.
   d. These different colours of light after leaving the raindrop reach the observer's eye. Thus, we see a rainbow.

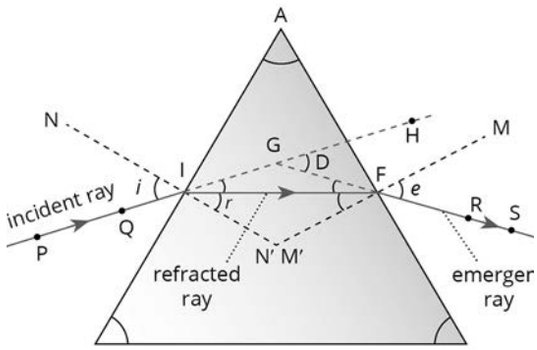
D. Short Answer Type-II Questions

1. The band of coloured components of a light beam obtained on a white screen, when white light passes through a prism is called spectrum of white light.

   We can recombine the components of white light after a prism has separated them by placing another prism in an inverted position of same material and same refracting angle as the first prism.



Recombination of different colours forms white light

2. 

   ∠i = angle of incidence, ∠r = angle of refraction, ∠e = angle of emergence.

3.

Refraction through a glass slab	Refraction through a prism
The glass slab makes the emergent ray parallel to direction of the incident ray.	The prism makes the emergent ray bent at an angle to the direction of the incident ray.

A light ray passing through a glass slab is displaced but its direction is not changed.	A light ray passing through a prism is deviated and its direction is also changed.
If the path of the ray of light is reversed, the ray of light retraces back its entire path (returned to its original direction).	If the path of the ray of light is reversed, the ray of light cannot retrace back its entire path (cannot return to its original direction).

4. Newton allowed sunlight to enter his dark room through a small hole in the window and placed a prism in the path of the light rays. He received the light emerging from the prism on a white screen. He was surprised to see the band of colours of the rainbow.

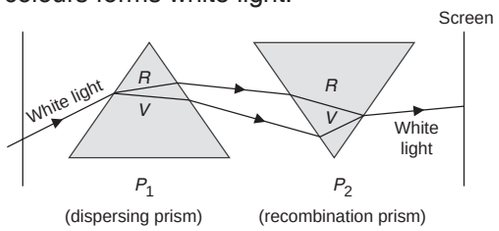
Based on this experiment, Newton concluded that white light is composed of seven different colours.

5. Newton took two prisms P_1 and P_2 of the same material and having the same refracting angles. He made white light pass through a slit and allowed it to fall on the prism P_1. He obtained a spectrum (VIBGYOR) on the white screen. He removed the white screen and placed prism P_2 in an inverted position. It is observed that the light coming out of the second prism P_2 was almost white. The experiment proved that the Prism P_1 dispersed the white light into its constituent colours.

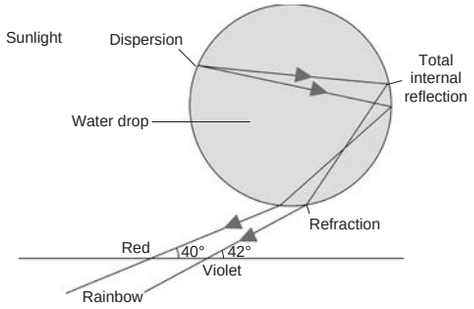
Hence, this prism was called the dispersing prism. The second prism P_2 recombined the seven constituent colours to form white light. Hence, the prism was called the recombination prism. The experiment thus proved that

i. The prism by itself produces no colours.

ii. The recombination of the seven constituent colours forms white light.



6.



7. Same answer as of Question 6.

P. 231–232 Check Your Progress 4

A. Multiple-choice Questions

1. b **2.** d **3.** a **4.** b **5.** d

B. Very Short Answer Type Questions

1. When the light rays pass through the atmosphere having layers of different densities and refractive indices, then refraction of light takes place. This refraction of light by the earth's atmosphere is called atmospheric refraction.

2. The difference in the densities and refractive indices of different layers of atmosphere causes atmospheric refraction.

3. Twinkling of stars, the sun is visible two minutes before the actual sunrise and remains visible two minutes after the actual sunset.

4. The colour of the clear sky looks blue due to the scattering of light in the earth's atmosphere.

5. Red

6. Among the colours of visible light, red colour has the largest wavelength and hence, is least scattered. Thus, red light can easily pass through fog or mist or smoke without getting scattered. It can be seen from maximum distance. That is why, red colour is used as universal danger signal.

7. The sky would have appeared dark if earth had no atmosphere. No particles would have been present. Thus, no scattering of light.

8. The stars seem to be higher in the sky than they actually are due to atmospheric refraction.

9. When a beam of light strikes colloidal particles, they scatter the light falling on them in all directions and make the particles illuminated.

10. Scattering of light

11. Tyndall effect can be observed when a fine beam of sunlight enters a smoke-filled room through a small hole. The smoke particles become visible due to the scattering of light by these particles.

12. Tyndall effect can be observed when sunlight passes through dense canopy of a forest. Tiny water droplets in mist scatter light.

13. Blue light

14. Red

15. The planets are very close to the earth as compared to the stars. So, the intensity of light we receive from the planets is very large. Therefore, small variations in their positions and brightness are not noticeable. Thus, the brightness of a planet always remains the same. The continuously changing atmosphere is unable to cause variations in the light

rays coming from a big-sized planet (due to atmospheric refraction). Therefore, planets do not twinkle at all.

16. The twinkling of stars is due to the atmospheric refraction of the light rays coming from them. Light rays from a star travel through the space unhindered. When they enter the earth's atmosphere, they undergo reaction due to varying optical densities of air. The continuously changing atmosphere (due to varying atmosphere temperature and density) refracts the light from the stars by varying amounts and in different directions from one moment to the next.

C. Short Answer Type-I Questions

1. Scattering of light is the phenomenon of change in the direction of light on striking particles like water droplets, dust particles, etc.

   The colour of sky looks blue due to scattering of light in the atmosphere. The atmosphere consists of dust particles of smoke, water droplets and suspended dust particles. These particles are smaller than wavelength of visible light. They are more effective in scattering light of shorter wavelength. So blue light is scattered strongly and effectively than red light. Hence, the sky looks blue.

2. The earth's atmosphere contains large number of particles like smoke, water droplets, dust particles and molecules of air called colloidal particles. When a beam of light strikes such particles, the path of the beam becomes visible due to the scattering of light by these particles.

3. When beam of light strikes colloidal particles, they scatter the light falling on them in all the directions making the particles illuminated. This phenomenon is known as Tyndall effect.

4. Tyndall effect can be observed when sunlight passes through a canopy of a dense forest and when fine beam of light enters a smoke-filled room through a hole.

5. Most blue, least red.

6. On a misty day, the air has large amount of tiny particles of water droplets, dust and smoke. These tiny particles present in the air scatter blue colour of the white light passing through it. When this scattered blue light reaches our eyes, the smoke appears blue.

7. At the time of sunrise and sunset, the sun is near the horizon. The light rays from the sun near the horizon have to pass through larger distance in the earth's atmosphere before reaching our eyes. Since the sunlight has to travel maximum distance inside the earth's atmosphere, it passes through maximum number of particles, suspended in the air. Near the horizon, most of the blue light and other lights of shorter wavelengths (green, yellow) are scattered away by these particles. The red colour which has the largest wavelength is scattered least, i.e. red colour enters our eyes. This gives rise to reddish appearance of the sun, both at the time of sunrise and sunset.

D. Short Answer Type-II Questions

1. a. **Twinkling of stars:** The twinkling of stars is due to the atmospheric refraction of the light rays coming from them. Light rays from a star travel through the space unhindered. When they enter the earth's atmosphere, they undergo reaction due to varying optical densities of air. The continuously changing atmosphere (due to varying atmosphere temperature and density) refracts the light from the stars by varying amounts and in different directions from one moment to the next.

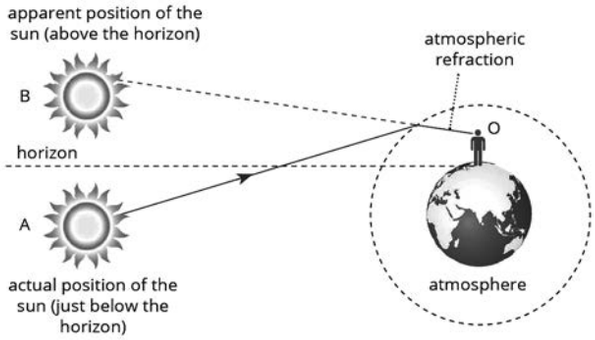
   b. **Advanced sunrise and delayed sunset:** Actual sunrise takes place when the sun is just above the horizon. When sun is just below the horizon, the light rays coming from it on entering the atmosphere suffer atmospheric refraction from a rarer to denser medium. Due to the continuous refraction, it follows a curved path and the sun appears to be above horizon whereas it is actually below the horizon. We see the sun for about two minutes even after sunset below the horizon due to atmospheric refraction.

2. At the time of sunrise and sunset, the sun is near the horizon. The light rays from the sun near the horizon have to pass through larger distance in the earth's atmosphere before reaching our eyes. Since the sunlight has to travel maximum distance inside the earth's atmosphere, it passes through maximum number of particles, suspended in the air. Near the horizon, most of the blue light and other lights of shorter wavelengths (green, yellow) are scattered away by these particles.

   The red colour which has the largest wavelength is scattered least, i.e. red colour enters our eyes. This gives rise to reddish appearance of the sun, both at the time of sunrise and sunset.

3. The actual sunrise takes place when the sun is just above the horizon. When the sun is just below the horizon, the light rays coming from it, on entering the earth's atmospheric refraction

from a rarer medium to a denser medium. So, they bend towards the normal at each refraction. Due to the continuous refraction of light rays at each layer of the atmosphere, it follows a curved path, and it reaches the eyes of the observer at O. The actual position of the sun is at A, just below the horizon but it appears to be at position B above the horizon. As a result, we can see the sun two minutes before it rises above the horizon in the morning.



Effect of atmospheric refraction at sunrise

4. Sun appears oval shaped at morning and evening (flattening of the sun): In the morning and evening, the sun is near horizon. The refractive index of the layers of the atmosphere decreases with the height. The rays of light from the lower edges of the sun are refracted more than those from the upper edges, due to the passage through greater thickness of air. In other words, the rays of light from the upper and the lower edges of the sun bend unequally. Due to this unequal bending of light, the image of the sun appears oval and larger in size.

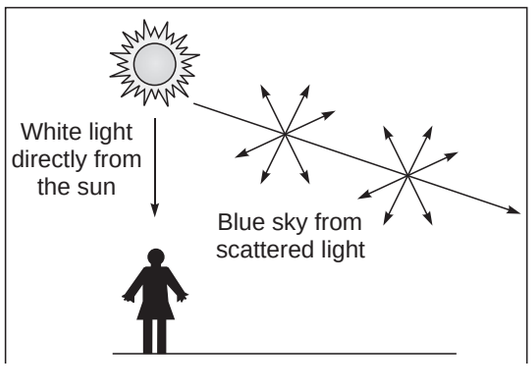
However, at noon when the sun is overhead, the rays have to pass through the minimum thickness of air. Therefore, the sun appears circular at noon.

OR

Since the sunlight has to travel a large distance in the morning inside the earth's atmosphere, red light having largest wavelength is least scattered. So, the sun appears reddish in the morning (Refer fig 6.23 of the book)

5. The blue colour of the sky is due to Rayleigh scattering. As light moves through the atmosphere, most of the longer wavelengths pass straight through. Little of the red, orange and yellow light is affected by the air.

However, much of the shorter wavelength light is absorbed by the gas molecules. The absorbed blue light is then radiated in different directions by smoke, dust particles, water droplets, air molecules, etc. It gets scattered all around the sky. Whichever direction one looks, some of this scattered blue light reaches that person. Since that person sees the blue light from everywhere overhead, the sky looks blue. Colour of sky appears dark to astronauts because there is no scattering of light due to lack of atmosphere.



6. This effect is called twinkling of stars. When light ray from star enters the earth's atmosphere, it undergoes refraction due to varying optical densities of air. The continuously changing atmosphere refracts the light from stars by varying amounts and in different directions from one moment to the next.

7. The size of the particles in the true solution is very small. These particles do not scatter light. Therefore, true solution does not show Tyndall effect.

8. If earth has no atmosphere, no particles would be present. Thus, no scattering of light would take place and hence, the sky would appear dark.

9. On a foggy day, the air has large amount of water droplets. If a motorist uses white light while driving in fog, then the water droplets present in the air scatter large amount of the blue light. This on reaching our eyes decreases visibility and hence driving becomes extremely difficult. The orange light has longer wavelength and hence it is least scattered. Thus, orange light can easily pass through fog without getting scattered and hence, is visible from maximum distance. So, the driver can see ahead clearly (remember, red light is not permitted to be used by the motorist as it is the universal signal).

10. Orange light has longer wavelength and can easily pass through long distances without getting scattered.

11. Red light has a long wavelength of 720 nm where as blue light has short wavelength of 450–495 nm.

12. When the white sunlight passes through earth's atmosphere, the molecules of air and other finer particles present in the atmosphere scatter light of shorter wavelength like the violet and indigo and blue colours. Although, violet and indigo lights are scattered more than blue light, but our eyes are not very sensitive to both the colours. However, the white light gets deficient in violet, indigo and blue colour on account of scattering and the resultant sunlight appears yellowish instead of white. When this resultant yellowish sunlight enters our eyes then to us sun appears yellowish instead of white. For similar reasons, the sunlight reaching the earth appears yellowish to us.

P. 233–234 Higher Order Thinking Skills (HOTS) Questions

A. Multiple-choice Questions

1. b **2**. a **3**. a **4**. c **5**. b

B. Very Short Answer Type Questions

1. The focal length of the eye changes by contraction and relaxation of ciliary muscles.

2. **a.** Myopia **b.** Hypermetropia

3. **a.** Blue **b.** Red

4. Because the densities of different layers of atmosphere are different.

5. Iris regulates the amount of light entering the eye by adjusting the size of the pupil.

6. Violet

7. Concave lens

8. Myopia

9. Hypermetropia

10. Presbyopia

11. The deep sea appears to be blue because water like air prefers to absorb longer wavelengths which are red and orange, and scatter shorter wavelengths, i.e. blue.

12. Among the colours of visible light, red colour has the largest wavelength and hence, is least scattered. Thus, red light can easily pass through fog or mist or smoke without getting scattered. It can be seen from maximum distance. That is why red colour is used as signal.

13. It remains the same. The eye lens changes its focal length such that the image is still formed on the retina.

14. **a.** As the observer goes to higher altitudes, the sky appears dark because at higher altitudes very less number of particles are present and hence no scattering of light takes place.

b. When observer is on the surface of earth.

15. Reflection, refraction and dispersion.

16. White

C. Short Answer Type-I Questions

1. When we look at nearby object, the ciliary muscles of the eye lens contract and the lens becomes thicker, i.e. more curved. Due to this the focal length of the eye lens decreases and a sharp image of the nearby object is formed on the retina.

2. When we look at a distant object, the ciliary muscles of the eye lens relax and the lens becomes thinner, i.e. less curved. Due to this the focal length of the eye lens increases and a sharp image of the distant object is formed on the retina.

3. As a person gets older, the ciliary muscles holding the eye lens weaken and the lens loses some of its elasticity. Therefore, the power of accommodation of the eye decreases with ageing. For most old people, the near point gradually recedes away. They find it difficult to see nearby objects comfortably and distinctly without corrective eye glasses. This defect is called presbyopia.

4. Clouds appear white because they reflect sunlight. This is because the tiny particles of water in the clouds are so close to each other that sunlight cannot infiltrate deep into the clouds. This results in the reflection of light, which subsequently makes cloud appear white.

5. To see nearby objects, the lens becomes thicker and the focal length decreases. A normal eye is not able to see clearly the objects placed closer than 25 cm because the focal length of the eye lens cannot be decreased below it.

6. Small particles scatter light of short wavelengths.

7. The image distance remains the same because the ciliary muscles contract and adjust the focal length to enable one see the object.

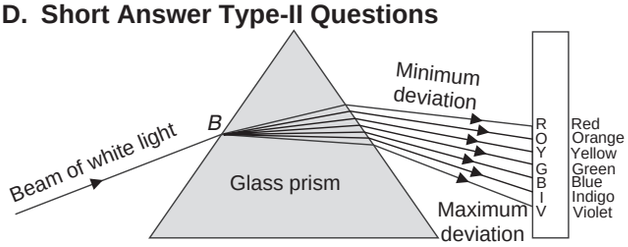
8. A rainbow is seen after rain in the sky in a direction opposite to that of sun.

9. **a.** Dual eye defect

b. Bifocal lens will be required to increase his range of vision. It consists of both concave and convex lens. The upper portion consists of concave lens. It corrects myopia and helps to see distant objects. The lower portion consists of a convex lens. It corrects hypermetropia and helps us to see nearby objects.

10. A normal person can see nearby as well as distant objects clearly because he can adjust his focal length so as to see the objects located anywhere.

D. Short Answer Type-II Questions



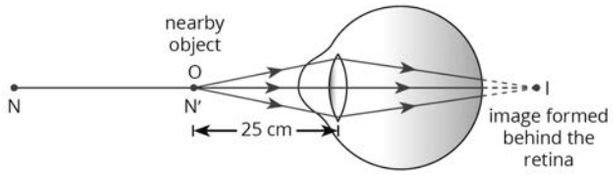
1. a. This phenomenon is known as dispersion of light. Different colours of light bend through different angles with respect to the incident ray as they pass through the prism. Thus, when white light is incident on the face of the prism, waves of different colours deviate through different angles and in the process get dispersed.

b. It is observed in the rainbow.

c. The conclusion that can be drawn about the constituents of white light is that white light is composed of seven different colours of different wavelength.

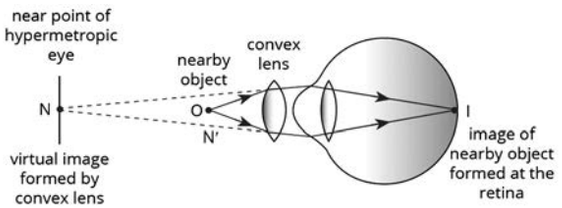
2. Hypermetropia. It can be corrected by using spectacles of convex lens.

a.



Hypermetropic eye

b.



Correction for hypermetropic eye

3. Refraction, dispersion, total internal reflection.

4. When a fine beam of sunlight enters a smoke-filled room through a hole. The smoke particles become visible due to scattering of light by them.

5. School buses are painted orange because it has longer wavelength and hence is less scattered.

6. On a misty day, the air has large amount of water droplets and tiny particles of dust and smoke. These particles scatter blue light, hence the smoke appears blue.

P. 235–240 Exercises

A. Objective Type Questions

I. Multiple-choice Questions

1. c **2.** b **3.** a **4.** a **5.** b

6. d

II. Fill in the blanks

1. cornea **2.** 25 cm

3. Cataract **4.** Newton

5. atmospheric refraction

III. Assertion–Reasoning Type Questions

1. a **2.** c **3.** a **4.** d **5.** b

6. a **7.** c **8.** d **9.** c **10.** b

IV. Very Short Answer Type Questions

1. The minimum distance at which objects can be seen most clearly without strain in the eye is called the near point of the eye.

2. The farthest point up to which objects can be seen most clearly without strain in the eye is called the far point of the eye.

3. Myopia, Hypermetropia and presbyopia

4. Myopia

5. Hypermetropia

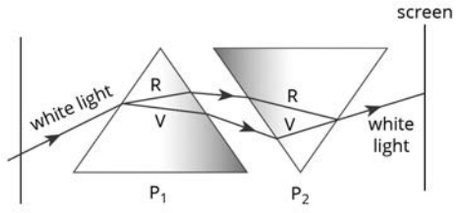
6. Convex

7. Rods are sensitive to intensity of light and cones are meant for colour perception.

8. It darkens the eye from inside and hence, prevents any internal reflection.

9. A triangular glass prism is a transparent refracting medium bounded by three plane surfaces making a triangle.

10. A spectrum is a band of seven colours obtained after white light is split. We can recombine the components of white light by placing another inverted prism.



Recombination of different colours forms white light

11. Violet

12. Red

13. The phenomenon of splitting of white light into its component colours on passing through a glass prism is called dispersion of light.

14. A colloid is a type of chemical mixture where one substance is dispersed evenly throughout another. The particles of the dispersed substance are only suspended in the mixture, unlike a solution, where they are completely dissolved within. This occurs because the particles in a colloid are larger than in a solution–small enough to be dispersed evenly and maintain a homogenous appearance, but large enough to scatter light and not dissolve.

15. When beam of light strikes colloidal particles, they scatter the light falling on them in all the directions making the particles illuminated. This phenomenon is known as Tyndall effect.

16. The colour of sky will appear dark because there will be no particles due to the absence of atmosphere. Hence, no scattering of light would take place.

B. Short Answer Type-I Questions

1. a. The moon has no atmosphere and hence no particles to scatter light. Thus, it appears dark.

b. Rainbow is never formed because there are no water molecules in the moon to cause scattering.

2. The iris has a central circular aperture called the pupil. The iris regulates the amount of light entering the eye by adjusting the size of the pupil in the following way. If the intensity of the light is low (dim light as in a dark room), the iris makes the pupil to expand to allow more light to enter the eye.

3. The near point increases with age because of decreasing effectiveness of the ciliary muscles and loss of flexibility of the eye.

4. Excessive curvature leads to thickening of eye lens thereby decreasing the focal length of the eye lens. Leads to formation of image infront of retina.

5. Decrease in size of eye lens leads to decrease in the distance of the retina from the eye lens. In such a case the image of a nearby object is object behind the retina.

6. Refer to Check Your Progress–3 (P–227), Section D, Question 2**.**

7. Different colours have different wavelengths and hence different refracting ability.

8. a. It bends towards the normal because glass is optically denser than air.

b. It bends away from normal as air is optically rarer than glass.

9. When light passes through a canopy of a dense forest tiny water drops in mist scatter light and the path of light becomes visible. When a beam of light enters into a smoke-filled room through a tiny hole, the smoke particles become visible due to scattering of light by these particles.

10. Planets do not twinkle because they appear larger in size than the stars as they are relatively closer to earth. Planets can be considered as a collection of a large number of point-size sources of light. The different parts of these planets produce either brighter or dimmer effect in such a way that the average of brighter and dimmer effect is zero. Hence, the twinkling effects of the planets are nullified and they do not twinkle.

11. Stars emit their own light and they twinkle due to the atmospheric refraction of light. Stars are very far away from the earth. Hence, they are considered as point sources of light. When the light coming from stars enters the earth's atmosphere, it gets refracted at different levels because of the variation in the air density at different levels of the atmosphere. When the star light refracted by the atmosphere comes more towards us, it appears brighter than when it comes less towards us. Therefore, it appears as if the stars are twinkling at night.

12. The person is suffering from an eye defect called myopia. In this defect, the image is formed in front of the retina. Hence, a concave lens is used to correct this defect of vision.

Object distance, u = infinity = ∞

Image distance, $v = -80$ cm

Focal length $f = ?$

According to the lens formula,

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

$$\frac{1}{-80} - \frac{1}{\infty} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{-1}{80}$$

$$f = -80 \text{ cm} = -0.8 \text{ m}$$

13. Focal length $f = -2$ m

Power $P = 1 - 2 = -0.5$ D

14. The stars seem to be higher in the sky than they actually are due to atmospheric refraction.

15. On a foggy day, the air has large amount of water droplets. If a motorist uses white light while driving in fog, then the water droplets present in the air scatter large amount of the blue light. This on reaching our eyes decreases visibility and hence driving becomes extremely difficult. The orange light has longer wavelength and hence it is least scattered. Thus, orange light can easily pass through fog without getting scattered and hence, is visible from maximum distance. So, the driver can see ahead clearly (remember, red light is not permitted to be used by the motorist as it is the universal signal).

16. The colour of clear sky looks blue due to scattering of light in the earth's atmosphere.

C. Short Answer Type-II Questions

1. The ability of the eye lens to adjust its focal length so as to see the objects located anywhere is called power of accommodation.

When the eye looks at nearby objects, the ciliary muscles attached to the lens of the eye contract and the lens becomes thicker, i.e. more curved. When more curved, the focal length of the eye lens decreases. A sharp image of the nearby object is formed on the retina. This enables us to see nearby objects.

2. Receptor → Sensory neuron → Brain → Motor neuron → Eye → Eye muscle contracts

3. The eye lens is a transparent crystalline double convex lens situated just behind the iris. It is held in position with the help of ciliary muscles. The ciliary muscles, together with the suspensory ligaments, can increase or decrease the curvature and therefore, the focal length of the eye lens required to focus objects at different distances on the retina.

4. When we decrease the distance of an object from 10 m to 1 m, our eye changes its focal length to focus the image on the retina itself. So, when we change the object distance within specified limits, image distance remains the same due to the ability of accommodation.

5. a. The defect of vision he is suffering from is myopia or short-sightedness because the focal length of the spectacles is negative.

b. Concave lens (or diverging lens) is used for the correction of this defect.

Focal length $f = ?$

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

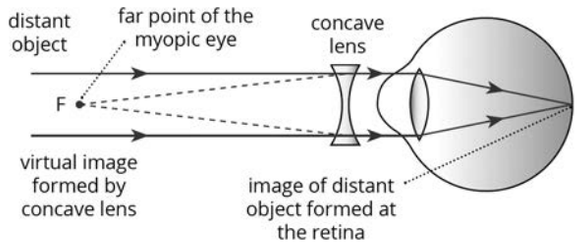
$$-0.5 = \frac{1}{f}$$

$$f = \frac{-1}{0.5} = -2 \text{ m}$$

c. The two main causes of developing this defect are:

i. Due to elongation of the eyeball.

ii. Due to the high converging power of the eye lens.



Correction for myopia

6. Myopia is the inability of an eye in viewing long distant objects. The image in this case is formed before the retina. For every myopic eye, there exists a far point beyond which a clear image cannot be seen. The short-sightedness is corrected by using a concave lens which diverges and shifts the image to the retina.

7. The power of accommodation of the eye decreases with aging. For most people the near point gradually recedes. This defect is called presbyopia. It arises due to the gradual weakening of the ciliary muscles and diminishing flexibility of the eye lens. Such a person may myopia and hypermetropia. This defect is then corrected by using bi-focal lenses of suitable focal lengths. The upper part of the lens is concave lens which correct myopia to see the distant objects clearly while the lower part of the lens has convex lens which corrects the hypermeytopia to see nearby objects clearly.

8. a. Visible spectrum is the band of coloured components of a white light beam.

b. Red light is scattered the least by air molecules and has longer wavelength. It travels the longest distance.

c. The given set-up will behave like a glass slab, resulting in recombination of the seven colours to produce white light.

9. a. Iris regulates the amount of light entering the eye by adjusting the size of pupil in the following ways:

i. If the light is dim, the iris makes the pupil to become large and allow more light to enter.

ii. If the light is high, the iris makes the pupil to contract to decrease the amount of light entering the eye.

b. Retina is the innermost delicate membrane having large number of light sensitive cells called 'rods' and 'cones'. The retina of an eye is where the image of an object is formed.

c. Yes, we can aware the people about eye donation after death. It will be a boon for blind people. If a person donates his eyes, two blind people can see the world.

10. Power of lens to correct distant vision = −5 D

$$\text{Power} = \frac{1}{f}$$

Therefore, focal length

$$f = \frac{1}{-5} = -0.20 \text{ m} = -20 \text{ cm}$$

Power of lens to correct near = 1 D

$$\text{Power} = \frac{1}{f}$$

Therefore, focal length $f = \frac{1}{1} = 1 \text{ m} = 100 \text{ cm}$

11. Image distance = −75 cm, Object distance = −25 cm, Focal length f = ?

We know, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

Putting these values in the lens formula, we get

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

$$\frac{1}{-75} - \frac{1}{-25} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{-1}{75} + \frac{1}{25} = \frac{2}{75}$$

$$f = \frac{75}{2}$$

$$\text{P} = \frac{1}{f}$$

$$\text{P} = \frac{2}{75} = \frac{(2 \times 100)}{75} = 2.666 \text{ D}$$

$$= 2.67 \text{ D}$$

Focal length $f = \frac{75}{2} = 37.5 \text{ cm}$

12. Since the person has myopic eye, therefore,

a concave lens is used.

$u = -\infty$ (far point), $v = -150$ cm

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

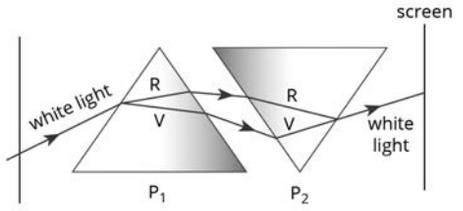
$$\frac{1}{-150} - \frac{1}{-\infty} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{-1}{150}$$

$$f = -150 \text{ cm} = -1.5 \text{ m}$$

$$\text{P} = \frac{1}{f} = \frac{-1}{1.5} = -0.67 \text{ D}$$

13. When second identical prism is placed in an inverted position with respect to the first prism, the recombination of seven constituent colours produces white light.



Recombination of different colours forms white light

14. When beam of a light gets refracted through a glass prism it splits into seven colours namely – violet, indigo, blue, green, yellow, orange, red (VIBGYOUR)

The colour deviates most - Violet

The colour deviates least - red

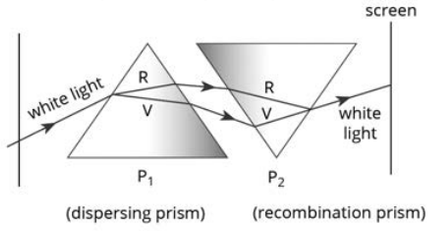
When a second identical prism is placed in an inverted position with respect to the first prism the seven colours disappear and converted into white beam of light.

15. In case of rectangular glass slab, there are two refracting surfaces that run parallel to each other, therefore, when white light falls on the first interface, it refracts. Since this interface is parallel to the second interface, each component gets refracted through same angle and emerges as white light. Whereas, in case of glass prism, the two refracting surfaces are inclined at an angle, thus the white light when incident on the first interface, gets refracted at different angles, and separates into its different components as it leaves the second surface. Hence, spectrum is observed.

16. When a narrow beam of monochromatic light passes through a glass slab it deviates from the actual path but the direction of the incident ray and emergent rays remain parallel to each other. But when the same light passes through a glass prism it also deviates from the actual path but the direction of the incident ray and emergent ray of light are not parallel to each other.

When a narrow beam of white light passes through a glass slab it does not split the white light into its constituent colours. The direction of the incident ray and emergent ray of light are parallel to each other. Whereas as in case of glass prism the splitting of white light into its constituent seven colours occurs, and the direction of the incident rays and emergent rays are not parallel to each other.

17. White light is dispersed into its seven-component colours by a prism. Different colours of light bend through different angles with respect to the incident ray as they pass through a prism. Thus, when white light is incident on the face of a prism, waves of different colours (having different wavelengths hence different refrangibility) deviate through different angles and in the process get separated or dispersed.



Recombination of different colours forms white light

Newton took two prisms of the same material and having the same refracting angle. He made white light pass through a slit and allowed it to fall on the first prism. He obtained a spectrum (VIBGYOR) on the white screen. He removed the white screen and placed a second prism in an inverted position. It was observed that the light coming out of second prism was almost white. This showed that while light is made of seven colours.

18. Different colours of light bend through different angles with respect to the incident ray as they pass through a prism. Thus, when white light is incident on the face of a prism, waves of different colours (having different wavelengths hence different refrangibility) deviate through different angles and in the process get separated or dispersed. Violet colour deviates most as it has the shortest wavelength.

19. Power of lens = −4 D

$$\text{Power} = \frac{1}{f}$$

Therefore, focal length $f = \frac{1}{\text{P}} = \frac{1}{-4}$

$= -0.25$ m $= -25$ cm

Since the focal length is negative the lens must be a concave lens.

20. $u = -25$ cm, $v = -50$ cm

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

$$\frac{1}{-50} - \frac{1}{-25} = \frac{1}{f}$$

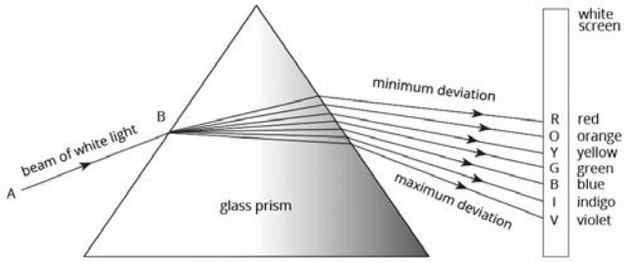
$$\frac{1}{f} = \frac{-1}{50} + \frac{1}{25}$$

$$= \frac{1}{50}$$

$$f = 50 \text{ cm}$$

$$\text{P} = \frac{1}{f} = \frac{100}{50} = 2 \text{ D}$$

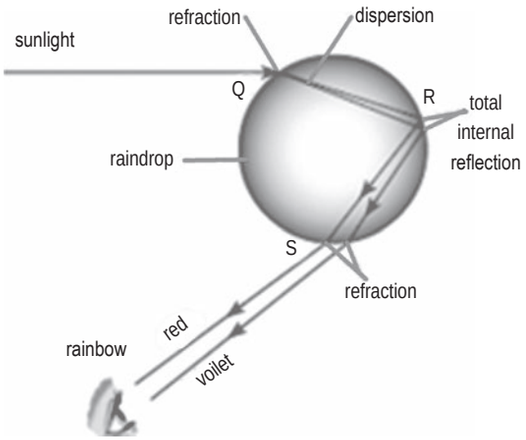
21. The phenomenon of splitting of white light into its component colours on passing through a glass prism is called dispersion of light. Different colours of light bend through different angles with respect to the incident ray as they pass through a prism. Thus, when white light is incident on the face of a prism, waves of different colours, having different wavelengths deviate through different angles and in the process get separated or dispersed.



A glass prism splits the white light into seven colours

22. Same as in Question 21 and 17. It is essential that the two prisms used for the purpose should be identical and placed in an inverted position with respect to each other so that the second prism completely nullifies the dispersion caused by the first prism and we get pure white light.

23. A rainbow is a natural spectrum of sunlight in the form of bows appearing in the sky when the sun shines on raindrops after a rain shower. It is formed due to the combined effect of dispersion, refraction and reflection of sunlight by tiny water droplets present in the atmosphere.

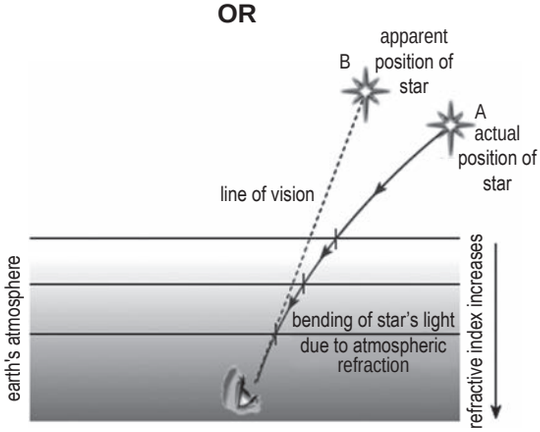


24. When light rays pass through the atmosphere having layers of different densities and refractive indices, then refraction of light takes place. This refraction of light by the earth's atmosphere is called atmospheric refraction.

The twinkling of stars is due to atmospheric refraction of the light rays coming from them. Light ray from a star travels through the space unhindered. When it enters the earth's atmosphere, it undergoes refraction due to varying optical densities of air. The continuously changing atmosphere refracts the light from the stars by varying amounts and in different directions from one moment to the next. This appears to be twinkling of stars.

The sun is visible to us about two minutes before the actual sunrise and remains visible for about two minutes after the actual sunset because of atmospheric refraction.

OR



Atmospheric refraction: Same as in above question.

The stars seem to be higher in the sky than they actually are due to atmospheric refraction. Though the actual position of the star is at A, but due to atmospheric refraction, it seems higher in the sky at position B.

25. Same as in Question No. 17 of the same section.

OR

Scattering of light is the phenomenon of change in the direction of light on striking particles like water droplets, dust particles, etc.

The colour of clear sky looks blue due to scattering of light in the earth's atmosphere. The atmosphere consists of particles of smoke, water droplets and suspended dust particles. These particles have size smaller than the wavelength of visible light. They are more effective in scattering light of shorter wavelength than light of longer wavelength. The red light has a wavelength about 1.8 times greater than blue light. So, the finer particles in air scatter the blue light (shorter wavelength) more strongly and effectively than the red light. The scattered blue light enters our eyes. Hence, the sky looks blue.

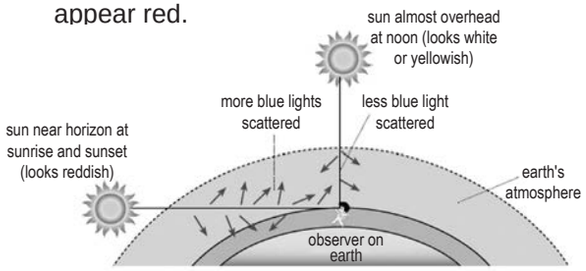
Reddening of the sun at sunrise and sunset: At the time of sunrise and sunset, the sun is near the horizon. Light rays from the sun which are near the horizon have to pass through larger distance in the earth's atmosphere before reaching our eyes. The sunlight passes through a large number of particles suspended in the air. Near the horizon, most of the blue light and other lights of shorter wavelengths (green, yellow) are scattered by these particles. The red light which has the largest wavelength is scattered the least. Among the colours of sunlight, the colour scattered the least, i.e. red colour enters our eye. This gives rise to reddish appearance of the sun, both at the time of sunrise and sunset.

26. Tyndall effect is the phenomenon in which the particles in a colloid scatter the beams of light that are directed at them. This effect is exhibited by all colloidal solutions and some very fine suspensions. Therefore, it can be used to verify if a given solution is a colloid. The intensity of scattered light depends on the density of the colloidal particles as well as the frequency of the incident light.

Four instances of observing the Tyndall effect are as follows:

- It can be observed when sunlight passes through a canopy of dense forest.
- It can be observed in the fog.
- It is the reason for the blue colour of the sky.
- It can be observed when light passes through the milk.

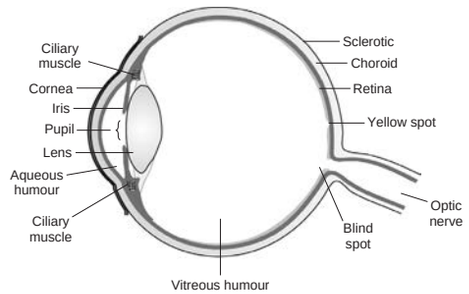
27. During sunrise and sunset, the rays have to travel a larger part of the atmosphere because they are very close to the horizon. Therefore, light other than red is mostly scattered away. Most of the red light, which is the least scattered, enters our eyes. Hence, the sun and the sky appear red.



At noon, the sun is overhead in the sky and the light coming from the sun travels a relatively shorter distance through the atmosphere to reach the earth. As the light coming from the overhead sun contains almost all its component colours in the right proportion, the sun appears white to us at noon.

D. Long Answer Type Questions

1. Human eye is almost spherical in shape having diameter about 2 × 3 cm with a slight bulge in the front part, as shown in the figure.



The bulged portion is called cornea which is transparent and light enters the eye through it. Just behind the cornea, there is a muscular diaphragm called iris which controls the size of the pupil, which is a variable aperture at the centre of the iris. It can adjust its size according to the intensity of light and helps in regulating the amount of light entering into the eye. There is a converging eye-lens behind the iris which is composed of fibrous, jelly-like material and is held in position by ciliary muscles. The curvature of the lens can be modified to some extent by these ciliary muscles. When the muscles are relaxed, the focal length of the lens becomes around 2·5 cm and we can see the distant objects clearly, and when we look at nearby objects, the ciliary muscles contract and the lens becomes more rounded and its focal length decreases. Aqueous humour fills the space between cornea and eye-lens.

The cornea and aqueous humour act as a lens and provide most of the refraction for light rays entering into the eye. The light entering the eye is focussed by the eye-lens, which forms a real and inverted image of the object on the retina behind the lens, which is a delicate semi-transparent membrane having a very large number of light-sensitive cells and is equivalent to the screen (or photographic plate) of a camera. It has a large number of rods and cones. The rods respond to the intensity of light and the cones respond the colour of light. When light enters into the eye and falls on the retina, the light-sensitive cells get activated and generate electrical nerve impulses which are sent to the brain via the optic nerve. These signals are processed by the brain and we are able to see the objects.

2. a. Same as Short Answer Type: II Question: 1

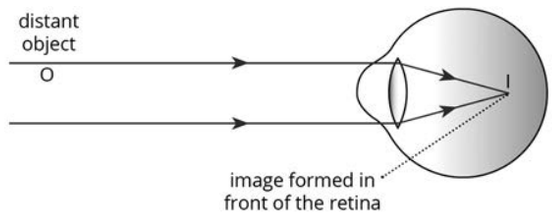
b. This defect of vision is Myopia.

Cause of this defect is:

1. excessive curvature of the eye lens

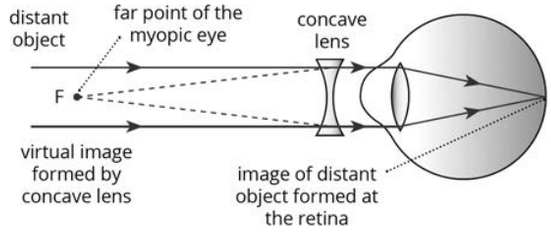
2. elongation of eye ball.

Concave lens is used for correcting his defect



Myopic eye

Myopic eye



Correction for myopia

Correction for the myopic eye

3. a. i. Myopia

Use spectacles of concave lens

ii. Hypermetropia

Use spectacles of convex lens

iii. Presbyopia

Use spectacles of convex lens

b. We students can organise march pasts and rallies so as to spread awareness amongst people regarding the corneal blindness. People can be asked to donate their eyes so as to give others the sensation of vision. Let us all come together to help each and every person suffering from corneal blindness and make their future better.

4. a. Two possible reason due to which the defect of vision may have arisen are: (1) increase in curvature of the lens. (2) increase in length of the eyeball. (i) A myopic eye has its far point nearer than infinity. It forms the image of a distant object in front of its retina. (Diagram as in Question 2)

In the given case, student's far point is 5 m. So, image of the object placed beyond 5 m from his eyes is formed in front of the retina and hence appears blurred. That is why the student is unable to see distinctly the objects placed beyond 5 m from his eyes. (ii) Since a concave lens has an ability to diverge incoming rays, it is used to correct this defect of vision. The image is allowed to form at the retina by using a concave lens of suitable power.

Given, focal length, $f = 5$ m. Since a concave lens is used, $f = -5$ m. Let power of the lens be 'P'. We know, $P = \frac{1}{f}$

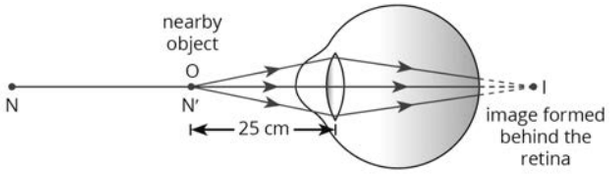
$$\therefore \quad P = \frac{-1}{5} = -0.2 \text{ D}$$

5. a. A person is unable to see object distinctly placed within 50 cm from his eyes, so the person is suffering from Hypermetropia. Hypermetropia is caused due to,

The focal length of the eye lens is too long

Shortening or decrease in the size of the eye lens:

b. So, this defect can be corrected using convex lens of appropriate focal length.



Hypermetropic eye

c. Correction for hypermetropic eye

The convex lens should form the image of the object placed at the distance of 25 cm or near point of the defective eye.

$$v = -50 \text{ cm} \quad u = -25 \text{ cm}$$

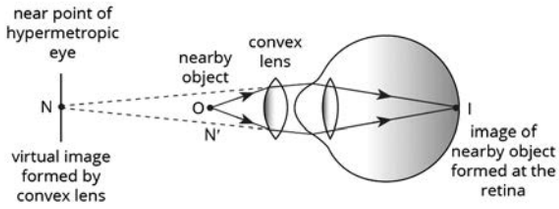
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{-1}{50} - \frac{1}{-25} =$$

$$\frac{1}{f} = \frac{-1}{50} + \frac{1}{25} = \frac{1}{50}$$

$$P = \frac{100}{50} = 2 \text{ D}$$

d. Hypermetropic eye



Correction for hypermetropic eye

6. When a person can see nearby objects clearly but cannot see distant objects distinctly, he is said to be myopic but when a person can see distant objects clearly but cannot see nearby objects distinctly, he is said to have hypermetropia. For a hypermetropic eye, the near point shifts away from the eye, i.e. farther away from the normal near point (25 cm).

The two possible causes of hypermetropia or far-sightedness are:

i. The focal length of the eye lens is too long: This is due to the thinning of the eye lens. In such a case, the image of the nearby object is formed behind the retina.

ii. Shortening or decrease in the size of the eye lens: This leads to the decrease in the distance of the retina from the eye lens. In such a case, the image of the nearby object is formed behind the retina.

To correct a hypermetropic eye, the person has to use spectacles with a convex lens of suitable focal length.

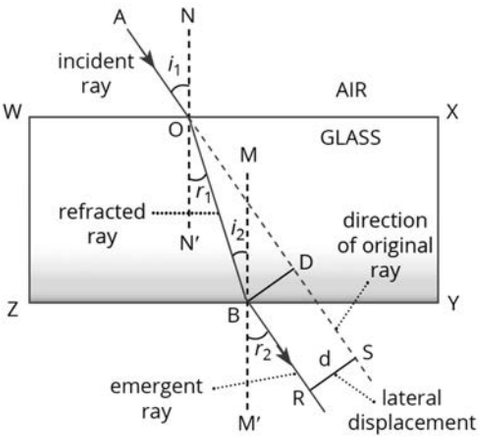
(Diagram as given in Question 5)

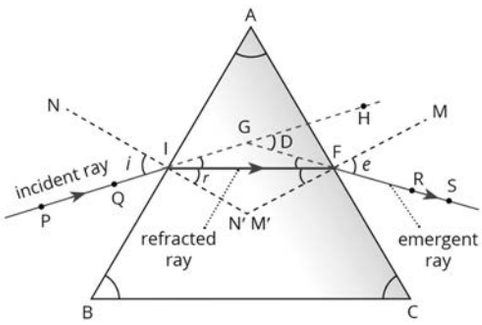
7. a. X – Red

Y – Violet

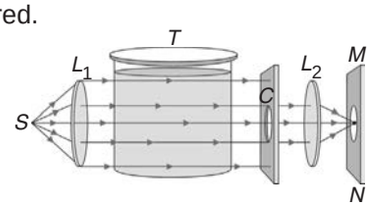
b. Different colours of light bend through different angles with respect to the incident ray because different colours have different wavelengths, hence different refrangibility.

8. Refer to Check Your Progress–3 Short Answer Type –II Question –3 (P–227).

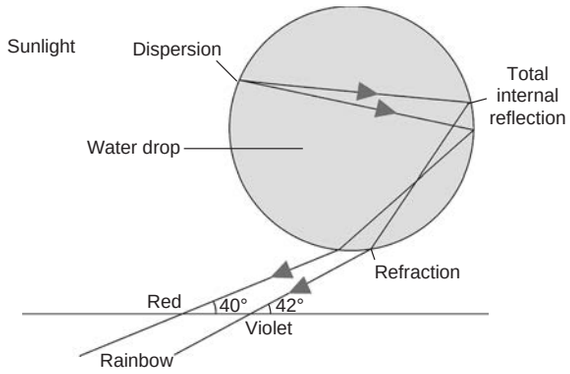




9. A strong source of white light is placed at the focus of a convex lens. The lens provides a parallel beam of light. The beam of light is then allowed to pass through a transparent beaker containing pure water. Then the beam of light from the beaker is allowed to pass through a circular hole in a cardboard. A sharp image of a circular hole is seen on the screen using a second convex lens. Now on addition of 200 g of sodium thiosulphate to water in beaker and then 1 to 2 ml of sulphuric acid is added, the colour of the screen seems to change from white to blue, then to orange and finally red. Initially when the sulphur particles are small, they scatter blue light and later as the reaction proceeds, more colloidal sulphur particles are formed and scatter light of longer wavelength, i.e. red.



10. A rainbow is a natural spectrum of sunlight in the form of bows appearing in the sky when the sun shines on raindrops after the rain. It is formed due to reflection, refraction and dispersion of sunlight by tiny water droplets, present in the atmosphere.



11. Refer Questions 25 (OR) and 27 of Short Answer Type: II Questions

E. Source-Based/Case-Based/Passage-Based/ Integrated Assessment Questions

1. a. iii. difference between apparent and real depth of a pond.

b. i. the angle of incidence in the denser medium must be greater than the critical angle for the two media.

c. ii. 48.750

d. iii. water is optically rarer than air but optically denser than glass.

e. iii. 90°

2. a. iii. optics.

b. i. cornea.

c. ii. thicker.

d. ii. choroid

e. iii. iris.

F. Value-Based Questions (Optional)

1. a. John is suffering from myopia or near-sightedness. It can be corrected by using spectacles with concave lens of suitable power

b. Teacher's action displays that she is worried about John's eye-problem. She is very understanding as she makes John sit in the first row so that he does not face any problem.

2. a. When sunlight passes through earth's atmosphere, the molecules of different gases and other fine particles present in the atmosphere scatter light of shorter wavelength like violet, indigo and blue. Although, violet and indigo lights are scattered more than blue light but our eyes are not very sensitive to both these colours. However, the white light gets deficient in violet, indigo and blue colours on account of

scattering and the resultant sunlight appears yellowish instead of white.

b. This shows that the teacher is very helpful. She wants her students to understand why sunlight appears yellowish instead of white. She is very impressive and understandable.

3. a. As we move up to very high altitudes, the atmosphere becomes thinner. The particles present here are very less. So, scattering of light is not prominent at such heights. Thus, sky appears dark to passengers flying at very high altitudes.

b. This shows that the teacher is very helpful and wants his students to have the correct knowledge of why the sky appears dark when flying at high altitudes. This will help students in future.

4. a. Among the colours of visible light, red colour has the largest wavelength and hence is the least scattered. Thus, red light can be seen from a very long distance. That is why red colour is used as danger signal.

b. Suhail's action shows that he is very helpful and he has a good knowledge of scattering of light.

5. a. Motorists use yellow light on a foggy day because yellow light has longer wavelength and hence, it is less scattered. Thus, yellow light can easily pass through fog without getting scattered and hence, is visible on a foggy day.

b. This shows that Sara wants to have a safe journey. She cares about her family. She is good learner and implements whatever she learns in daily life.

6. a. This phenomenon is known as dispersion of light. Violet colour deviates the most because wavelength of violet colour is smallest.

b. Sunder's father is very attentive to what his son is asking him. He is patient enough to answer his question. This shows he is very understanding and helpful.