

Chemical Reactions And Equations

Chapter 1



Chemicals of Rusting



CHAPTER 1

CHEMICAL REACTIONS AND EQUATIONS

Chemical Reaction: A chemical reaction is a process in which one or more substances, also called reactants, are converted to one or more different substances, known as products. Substances are either chemical elements or compounds. The following activities are as given below:

1. Magnesium ribbon burns with a dazzling white flame and changes into a white powder. This powder is magnesium oxide. It is formed due to the reaction between magnesium and oxygen present in the air.
2. Take lead nitrate solution in a test tube; add potassium iodide solution to this, and then we observed that lead (II) iodide and potassium nitrate is formed.
3. Take a few zinc granules in a conical flask, add dilute hydrochloric acid or Sulphuric acid to this, and then we observed that hydrogen gas is evolved.

From the above three activities, that any of the following observations helps us to determine whether a chemical reaction has taken place-

- Change in state
- Change in colour
- Evolution of gas
- Change in temperature.

Chemical Equations:

Chemical equations are symbolic representations of chemical reactions in which the reactants and the products are expressed in terms of their respective chemical formulae.

Rules for writing chemical equation:

Certain rules have to be followed while writing a chemical equation.

1. The reactants taking part in the reaction are written in terms of their symbols or molecular formulae on the left-hand side of the equation.
2. A plus (+) sign is added between the formulae of the reactants.
3. The products of reaction are written in terms of their symbols or molecular formulae on the right-hand side of the equation.
4. A plus (+) sign is added between the formulae of the products.
5. In between the reactants and the products an arrow sign (\rightarrow) is inserted to show which way the reaction is occurring.



In this hypothetical equation, A and B are the reactants, and C and D are the products. The arrow indicates that the reaction proceeds towards the formation of C and D.

Representing the Direction of the Chemical Reaction

The reactants and the products can be separated by one of the following four symbols:

- In order to describe a net forward reaction, the symbol \rightarrow is used.
- In order to describe a net backward reaction, the symbol \leftarrow is used.
- In order to describe a reaction that occurs in both forward and backward directions, the symbol \rightleftharpoons is used.
- In order to describe a state of chemical equilibrium, the symbol \rightleftharpoons is used.

Multiple entities on either side of the reaction symbols describe above are separated from each other with the help of the $+$ symbol in a chemical equation. It can be noted that the \rightarrow symbol, when used in a chemical equation, is often read as 'gives rise to' or 'yields'.

Representing the Physical States of the Reacting Entities

These symbols may be one of the following:

- The symbol (s) describes an entity in the solid state
- The symbol (l) denotes the liquid state of an entity
- The symbol (g) implies that the entity is in the gaseous state.
- The (aq) symbol corresponding to an entity in a chemical equation denotes an aqueous solution of that entity.

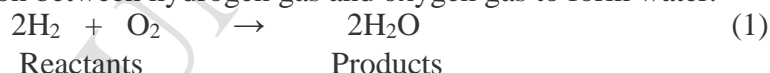
In some reactions, a reactant or a product may be in the form of a precipitate which is insoluble in the solution that the reaction is taking place in. The \downarrow symbol is written next to the chemical formula of these entities to describe them as precipitates.

Representing the Input of Energy in a Chemical Equation:

The Greek letter delta in its capitalized form (Δ) is used to state that an input of heat energy is required by the reaction.

An example for which is represented below:

The reaction between hydrogen gas and oxygen gas to form water.



The reacting entities are written on the left-hand side (2 molecules of hydrogen and one molecule of oxygen) whereas the products are written on the right-hand side (2 molecules of water is formed) of the chemical equation.

Equation (1) divided by 2 both sides and we get



The reacting entities are written on the left-hand side (1 molecules of hydrogen and half molecule of oxygen) whereas the products are written on the right-hand side (1 molecules of water) of the chemical equation.

It can also be observed that there are coefficients assigned to each of the symbols of the corresponding reactants and products. These coefficients of entities in a chemical equation are the exact value of the stoichiometric number for that entity.

Balanced Chemical Equations:

The law of conservation of mass that mass can neither be created nor destroyed in a chemical reaction. The total mass of the elements present in the products of a chemical reaction has to be equal to the total mass of the elements present in the reactants.

EXAMPLE 1:

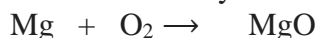
Write the chemical equation for the formation of magnesium oxide.

Step 1: Magnesium burns in oxygen to give magnesium oxide. Here, the reactants are magnesium and oxygen. The product is magnesium oxide.

Step 2: Thus, the word equation is

Magnesium + Oxygen \rightarrow Magnesium oxide

Step 3: Replacing the names with symbols and formulae, we get the chemical equation as

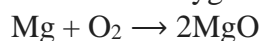


Reactants Products

Step 4: The numbers of atoms of the elements are

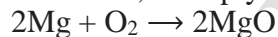
Element	Number of atoms in LHS	Number of atoms in RHS
Mg	1	1
O	2	1

To balance oxygen on both sides, multiply RHS by 2, i.e.,



Now, the number of oxygen atoms is balanced but the number of magnesium atoms is not.

Therefore, multiply magnesium on the LHS by 2. Thus, the equation becomes



this is the balanced chemical equation.

EXAMPLE 2:

The word-equation represented as –



The above word-equation may be represented by the following chemical equation –



Let us examine the number of atoms of different elements on both sides of the arrow.

Element	Number of atoms in reactants (LHS)	Number of atoms in products (RHS)
Zn	1	1
H	2	2
S	1	1
O	4	4

As the number of atoms of each element is the same on both sides of the arrow is a balanced chemical equation.

EXAMPLE 3:

Let us try to balance the following chemical equation –



Step I: To balance a chemical equation, first draw boxes around each formula. Do not change anything inside the boxes while balancing the equation.



Step II: List the number of atoms of different elements present in the unbalanced equation.

Element	Number of atoms in reactants (LHS)	Number of atoms in products (RHS)
Fe	1	3
H	2	2
O	1	4

Step III:

Element	Number of atoms in reactants (LHS)	Number of atoms in products (RHS)
Fe	1 x 3	3
H	2 x 4	2 x 4
O	1 x 4	4

Balanced equation:



As the number of atoms of each element is the same on both sides of the arrow is a balanced chemical equation.

List some Examples of Chemical Equations.

A few examples of chemical equations are listed in bulleted text below.

- $\text{PCl}_5 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_4 + \text{HCl}$
- $\text{SnO}_2 + \text{H}_2 \rightarrow \text{H}_2\text{O} + \text{Sn}$
- $\text{TiCl}_4 + \text{H}_2\text{O} \rightarrow \text{TiO}_2 + \text{HCl}$

- $\text{H}_3\text{PO}_4 + \text{KOH} \rightarrow \text{K}_3\text{PO}_4 + \text{H}_2\text{O}$
- $\text{Na}_2\text{S} + \text{AgI} \rightarrow \text{NaI} + \text{Ag}_2\text{S}$
- $\text{Fe} + \text{CuCl}_2 \rightarrow \text{FeCl}_3 + \text{Cu}$
- $\text{CaCl}_2 + \text{AgNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{AgCl}\downarrow$

TYPES OF CHEMICAL REACTIONS:

1. **Combination Reaction:** A reaction in which two or more substances combine to form a single new substance. Combination reactions can also be called synthesis reactions.

1. $\text{CaO}(\text{s}) + \text{H}_2\text{O}(\text{l}) \longrightarrow \text{Ca}(\text{OH})_2(\text{aq})$
(Quick lime) (Slaked lime)
2. $\text{Ca}(\text{OH})_2(\text{aq}) + \text{CO}_2(\text{g}) \longrightarrow \text{CaCO}_3(\text{s}) + \text{H}_2\text{O}(\text{l})$
(Calcium hydroxide) (Calcium carbonate)
3. $\text{C}(\text{s}) + \text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g})$
4. $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{H}_2\text{O}(\text{l})$
5. $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
6. $\text{C}_6\text{H}_{12}\text{O}_6(\text{aq}) + 6\text{O}_2(\text{aq}) \longrightarrow 6\text{CO}_2(\text{aq}) + 6\text{H}_2\text{O}(\text{l}) + \text{energy}$
(Glucose)

2. **Decomposition Reaction:** A reaction in which a compound breaks down into two or more simpler substances.

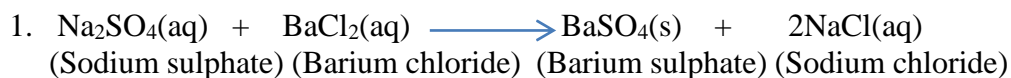
Most decomposition reactions require an input of energy in the form of heat, light, or electricity.

1. $2\text{FeSO}_4(\text{s}) \xrightarrow{\text{Heat}} \text{Fe}_2\text{O}_3(\text{s}) + \text{SO}_2(\text{g}) + \text{SO}_3(\text{g})$
(Ferrous sulphate) (Ferric oxide)
2. $\text{CaCO}_3(\text{s}) \xrightarrow{\text{Heat}} \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
(Limestone) (Quick lime)
3. $2\text{AgCl}(\text{s}) \xrightarrow{\text{Sunlight}} 2\text{Ag}(\text{s}) + \text{Cl}_2(\text{g})$
4. $2\text{Pb}(\text{NO}_3)_2(\text{s}) \xrightarrow{\text{Heat}} 2\text{PbO}(\text{s}) + 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$
(Lead nitrate) (Lead oxide) (Nitrogen dioxide) (Oxygen)
5. $2\text{AgBr}(\text{s}) \xrightarrow{\text{Sunlight}} 2\text{Ag}(\text{s}) + \text{Br}_2(\text{g})$

3. **Displacement Reaction:** A chemical reaction in which a more reactive element displaces a less reactive element from its aqueous salt solution.

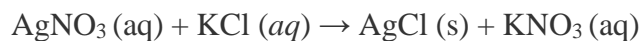
1. $\text{Fe}(\text{s}) + \text{CuSO}_4(\text{aq}) \longrightarrow \text{FeSO}_4(\text{aq}) + \text{Cu}(\text{s})$
(Copper sulphate) (Iron sulphate)
2. $\text{Zn}(\text{s}) + \text{CuSO}_4(\text{aq}) \longrightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu}(\text{s})$
(Copper sulphate) (Zinc sulphate)
3. $\text{Pb}(\text{s}) + \text{CuCl}_2(\text{aq}) \longrightarrow \text{PbCl}_2(\text{aq}) + \text{Cu}(\text{s})$
(Copper chloride) (Lead chloride)

4. Double Displacement Reaction: A chemical reaction in which ions get exchanged between two reactants which form a new compound is called a double displacement reaction.



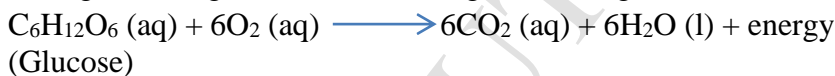
5. Precipitation reaction: A precipitation reaction is a chemical reaction that occurs in aqueous solution and forms precipitates. The insoluble salt that falls out of the solution is known as the precipitate. It can occur when two solutions containing different salts are mixed, and a cation/anion pair in the resulting combined solution forms an insoluble salt. For example,

Aqueous silver nitrate (AgNO_3) is added to a solution containing potassium chloride (KCl), and the precipitation of a white solid, silver chloride (AgCl), is observed:



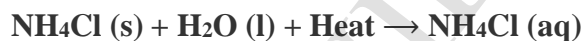
EXOTHERMIC AND ENDOTHERMIC CHEMICAL REACTIONS:

EXOTHERMIC CHEMICAL REACTIONS: Reactions in which heat is released along with the formation of products are called exothermic reactions. For examples:



ENDOTHERMIC CHEMICAL REACTIONS: A reaction that the system absorbs energy from its surroundings in the form of heat.

When ammonium chloride (NH_4Cl) is dissolved in water, an endothermic reaction takes place. The salt dissociates into ammonium (NH_4^+) and chloride (Cl^-) ions. The chemical equation can be written as follows:



Other Endothermic Processes:

- (i) The melting of ice to form water.
- (ii) Evaporation of liquid water, forming water vapour.
- (iii) Sublimation of solid CO_2 .
- (iv) The baking of bread.

OXIDATION: Oxidation refers to the loss of electrons or increase in oxidation state by a molecule, atom, or ion.

REDUCTION: Reduction refers to the gain of electrons or decrease in oxidation state by a molecule, atom, or ion.

REDOX REACTIONS: A reduction-oxidation or redox reaction is a type of chemical reaction in which reduction and oxidation occur at the same time.

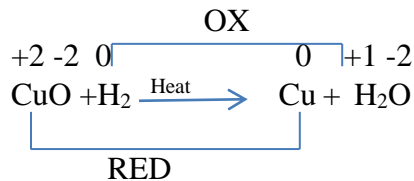
OXIDATION: If a substance gains oxygen during a reaction, it is said to be oxidised. For example:



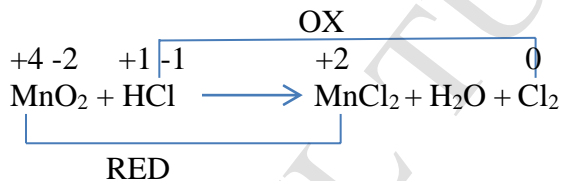
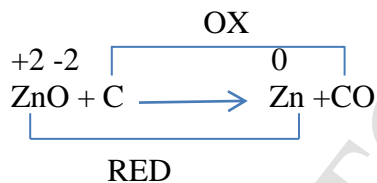
REDUCTION: If substance loses oxygen during a reaction, it is said to, be reduced. For example:



REDOX REACTIONS: If one reactant gets oxidised while other gets reduced during a reaction. Such reactions are called oxidation-reduction reaction or Redox reaction.



Some other examples of Redox reactions are:



Multiple Choice Questions:

Q1. Identify x and y in the following reaction: $\text{Cu} + x\text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + y\text{NO}_2 + 2\text{H}_2\text{O}$

- (a) 4 and 2
- (b) 3 and 5
- (c) 2 and 3
- (d) 4 and 4

Q2. Which of the following can be decomposed by the action of sunlight?

- (a) Potassium bromide
- (b) Silver bromide
- (c) Magnesium oxide
- (d) Sodium chloride

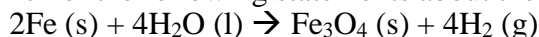
Q3. The carbonate of lead is a white solid. It decomposes when heated to form carbon dioxide and a yellow solid oxide 'X'. What is X?

- (a) Zinc oxide
- (b) Lead oxide
- (c) Silver oxide
- (d) Magnesium oxide

Q4. Identify the endothermic process from the following?

- (a) $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$
- (b) $\text{CaO}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Ca}(\text{OH})_2(\text{aq})$
- (c) Combustion of methane
- (d) Addition of conc. HCl to water

Q5. Which of the following statements about the given reaction are correct?



- 1. Iron metal is getting oxidized.
- 2. Water is getting reduced.
- 3. Water is acting as reducing agent.
- 4. Water is acting as oxidizing agent.

- (a) 1, 2 and 3
- (b) 3 and 4
- (c) 1, 2 and 4
- (d) 2 and 4

Q6. When Ag is exposed to air it gets a black coating of

- (a) AgNO_3
- (b) Ag_2S
- (c) Ag_2O
- (d) Ag_2CO_3

Q7. $\text{MnO}_2 + 4\text{HCl} \rightarrow \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$

Identify the substance oxidized in the above equation.

- (a) MnCl_2
- (b) HCl
- (c) H_2O
- (d) MnO_2

Q8. Zinc reacts with silver nitrate to form which compounds?

- (a) $\text{Zn}(\text{NO}_3)_2 + \text{Ag}$
- (b) $\text{ZnNO}_3 + \text{Ag}$
- (c) $\text{AgNO}_3 + \text{Zn}(\text{NO}_3)_2$
- (d) $\text{Ag} + \text{Zn}(\text{NO}_3)_3$

Q9. In the double displacement reaction between aqueous potassium iodide and aqueous lead nitrate, a yellow precipitate of lead iodide is formed. While performing the activity if lead nitrate is not available, which of the following can be used in place of lead nitrate?

- (a) Lead sulphate (insoluble)
- (b) Lead acetate

- (c) Ammonium nitrate
- (d) Potassium sulphate

Q10. The brown gas evolved on heating of copper nitrate is

- (a) O₂
- (b) NO₂
- (c) N₂
- (d) NO

Q11. Electrolysis of water is a decomposition reaction. The mole ratio of hydrogen and oxygen gases liberated during electrolysis of water is:

- (a) 1: 1
- (b) 2:1
- (c) 4:1
- (d) 1:2

Q12. A substance 'X' is used in white-washing and is obtained by heating limestone in the absence of air. Identify 'X'.

- (a) CaOCl₂
- (b) Ca (OH)₂
- (c) CaO
- (d) CaCO₃

Q13. $2\text{HNO}_3 + \text{Ca}(\text{OH})_2 \rightarrow \text{Ca}(\text{NO}_3)_2 + 2\text{H}_2\text{O}$; is an example of

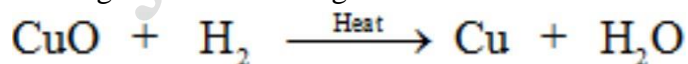
- (i) displacement reaction (ii) double displacement reaction
- (iii) neutralisation reaction (iv) combination reaction.

- (a) (i) and (ii)
- (b) (ii) and (iii)
- (c) (iii) and (iv)
- (d) (i) and (iv)

Q14. A substance X which is a group 2 element is used intensively in the cement industry. This element is present in bones also. On treatment with water, it forms a solution which turns red litmus blue. Element X is

- (a) Cu
- (b) Ca
- (c) Na
- (d) Al

Q15. You are given the following chemical reaction:



This reaction represents:

- (a) Combination reaction as well as double displacement reaction
- (b) Redox reaction as well as displacement reaction
- (c) Double displacement reaction as well as redox reaction
- (d) Decomposition reaction as well as displacement reaction

ANSWERS

Q1. (a)	Q2. (b)	Q3. (b)	Q4. (a)	Q5. (c)
Q6. (b)	Q7. (d)	Q8. (a)	Q9. (b)	Q10. (b)
Q11. (b)	Q12. (a)	Q13. (b)	Q14. (b)	Q15. (b)

Assignment:

Q1. What happens chemically when quicklime is added to water filled in a bucket?

Answer. Quicklime reacts with water to form slaked lime and produces lot of heat and hissing sound.

Q2. On what basis is a chemical equation balanced?

Answer. A chemical reaction is balanced on the basis of law of conservation of mass.

Q3. What change in colour is observed when white silver chloride is left exposed to sunlight?

State the type of chemical reaction in this change.

Answer. Silver chloride becomes grey. It is a photochemical decomposition reaction.

Q4. A solution of potassium chloride when mixed with silver nitrate solution, an insoluble white substance is formed. Write the chemical reaction involved and also mention the type of the chemical reaction?

Answer. $\text{KCl (aq)} + \text{AgNO}_3 \text{ (aq)} \longrightarrow \text{AgCl (s)} + \text{KNO}_3 \text{ (aq)}$

It is a double displacement reaction. It is also a precipitation reaction as AgCl is a white precipitate.

Q5. Translate the following statement into chemical equation and then balance it Barium Chloride reacts with Aluminium sulphate to give Aluminium Chloride and a precipitate of Barium Sulphate. State the two types in which this reaction can be classified.

Answer. $3\text{BaCl}_2 \text{ (aq)} + \text{Al}_2 \text{ (SO}_4\text{)}_3 \text{ (aq)} \longrightarrow 3\text{BaSO}_4 \text{ (s)} + 2\text{AlCl}_3 \text{ (aq)}$

It can be classified as double displacement as well as precipitation reaction.

Q6. Why decomposition reactions are called the opposite of combination reactions? Write equations for these reactions.

Answer. In decomposition reaction, a compound is broken down into simpler compounds or elements, e.g. $\text{CuCO}_3 \text{ (s)} \longrightarrow \text{CuO (s)} + \text{CO}_2 \text{ (g)}$

Combination reaction is a reaction in which two or more elements or compounds combine to form a new compound, e.g. $\text{N}_2 \text{ (g)} + \text{H}_2 \text{ (g)} \longrightarrow 2\text{NH}_3 \text{ (g)}$

Thus, decomposition and combination reactions are opposite to each other.

Q7. What is redox reaction? Identify the substance oxidized and the substance reduced in the following reactions.

(i) $2\text{PbO} + \text{C} \longrightarrow 2\text{Pb} + \text{CO}_2$

(ii) $\text{MnO}_2 + 4\text{HCl} \longrightarrow \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$

Answer. Those reactions in which oxidation and reduction takes place simultaneously are called redox reactions.

(i) PbO is getting reduced and C is getting oxidized.

(ii) MnO₂ is getting reduced and HCl is getting oxidized.

Q8. Using a suitable chemical equation, justify that some chemical reactions are determined by:

(i) change in colour, (ii) change in temperature.

Answer. (i) $\text{Pb (NO}_3\text{)}_2 \text{ (aq)} + 2\text{KI} \longrightarrow \text{PbI}_2 + 2\text{KNO}_3 \text{ (aq)}$

Colourless

Yellow ppt.

(ii) $\text{CaO (s)} + \text{H}_2\text{O (l)} \longrightarrow \text{Ca (OH)}_2 + \text{heat}$

Q9. Write balanced equations for the following mentioning the type of reaction involved.

(i) Aluminium + Bromine \longrightarrow Aluminium bromide

(ii) Calcium carbonate \longrightarrow Calcium oxide + Carbon dioxide

(iii) Silver chloride \longrightarrow Silver + Chlorine

Answer. (i) $2\text{Al (s)} + 3\text{Br}_2\text{(g)} \longrightarrow 2\text{AlBr}_3\text{(s)}$

(ii) $\text{CaCO}_3\text{(s)} \longrightarrow \text{CaO} + \text{CO}_2$

(iii) $2\text{AgCl (s)} \longrightarrow 2\text{Ag (s)} + \text{Cl}_2\text{(g)}$

Q10. (a) Why is respiration considered as an exothermic reaction?

(b) Define the terms oxidation and reduction.

(c) Identify the substance that is oxidized and reduced in the following reaction.

$\text{CuO (s)} + \text{Zn (s)} \longrightarrow \text{Cu (s)} + \text{ZnO (s)}$

Answer. (a) It is because heat is evolved during respiration.

(b) Oxidation is a process in which O_2 is added or H_2 is removed or loss of electrons takes place.

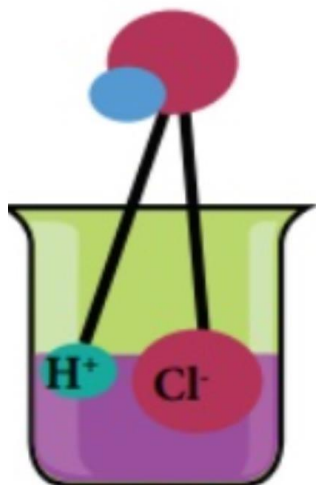
Reduction is a process in which H_2 is added or O_2 is removed or gain of electrons take place.

(c) Zn is getting oxidized, CuO is getting reduced.

Acids Bases & salts

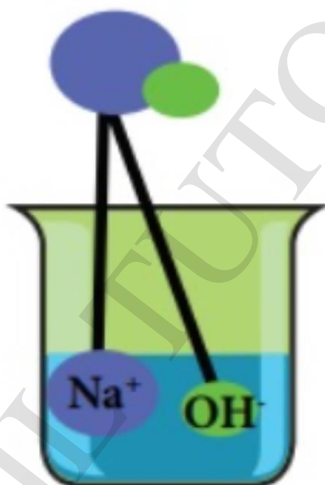


HCl



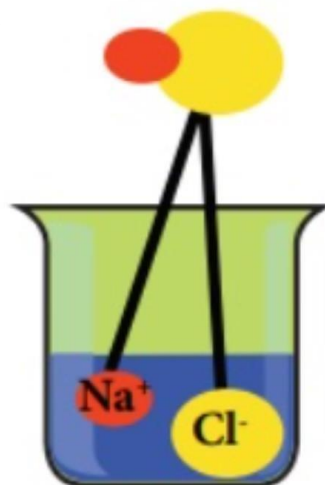
(a) Acid

NaOH

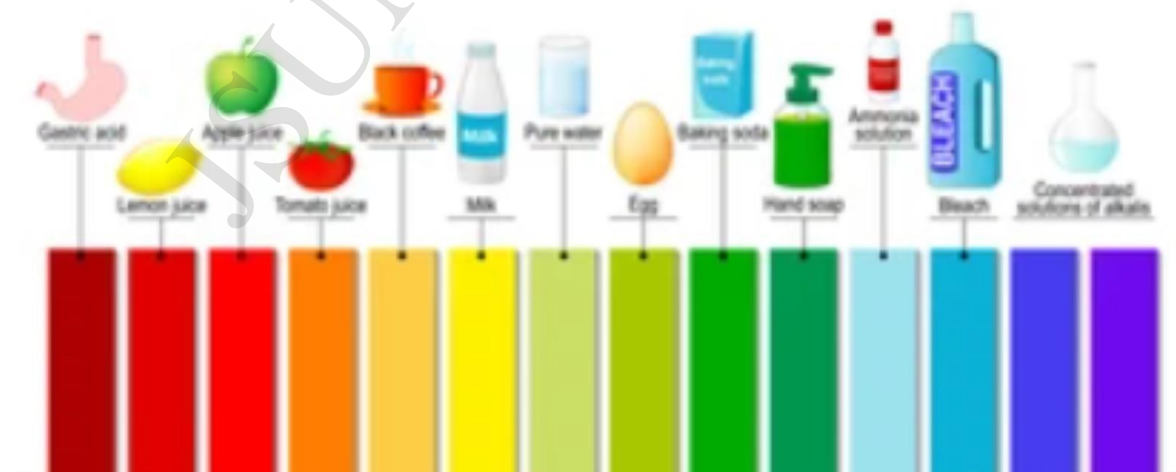


(b) Base

NaCl



(c) Salt



CHAPTER 2

ACIDS, BASES AND SALTS

Acids: Acids are sour in taste, turn blue litmus red, and dissolve in water to release H^+ ions.

Example: Sulphuric acid (H_2SO_4), Acetic Acid (CH_3COOH), Nitric Acid (HNO_3) etc.

Properties of Acids:

- Acids have a sour taste.
- Turns blue litmus red.
- Acid solution conducts electricity.
- Release H^+ ions in aqueous solution.

Types of Acids: Acids are divided into two types on the basis of their occurrence i.e., Natural acids and Mineral acids.

(i) Natural Acids: Acids which are obtained from natural sources are called Natural Acids or Organic Acids. Methanoic acid ($HCOOH$), Acetic acid (CH_3COOH), Oxalic acid ($C_2H_2O_4$) etc.

(ii) Mineral Acids: Acids that are prepared from minerals are known as Mineral Acids Example; Inorganic acids, man-made acids or synthetic acid are also known as Mineral Acids.

Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3), Carbonic acid (H_2CO_3) Phosphoric acid (H_3PO_4) etc.

Chemical Properties of Acid:

(i) Reaction of acids with metal: Acids give hydrogen gas along with respective salt when they react with a metal.

Examples: Hydrogen gas and zinc chloride are formed when hydrochloric acid reacts with zinc metal.



Test for Hydrogen Gas: The gas evolved after reaction of acid with metal can be tested by bringing a lighted candle near it. If the gas burns with a pop sound, then it confirms the evolution of hydrogen gas. Burning with pop sound is the characteristic test for hydrogen gas.

(ii) Reaction of acids with metal carbonate: Acids give carbon dioxide gas and respective salts along with water when they react with metal carbonates.

Examples: Hydrochloric acid gives carbon dioxide gas, sodium chloride along with water when reacts with sodium carbonate.



(iii) Reaction of acid with hydrogen carbonates (bicarbonates): Acids give carbon dioxide gas, respective salt and water when they react with metal hydrogen carbonate.

Example: Sulphuric acid gives sodium sulphate, Carbon dioxide gas and water when it reacts with sodium bicarbonate.



TYPES OF ACIDS:

Strong Acids: An acid which is completely ionized in water and produces (H^+) is called Strong Acid.

Examples: Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3)

Weak Acids: An acid which is partially ionized in water and thus produces a small amount of hydrogen ions (H^+) is called a Weak Acid.

Example: Acetic acid (CH_3COOH), Carbonic acid (H_2CO_3)

Bases: Bases are bitter in taste, have soapy touch, turn red litmus blue and give hydroxide ions (OH^-) in aqueous solution.

Examples: Sodium hydroxide (caustic soda) – $NaOH$, Calcium hydroxide – $Ca(OH)_2$

Potassium hydroxide (caustic potash) – (KOH)

Properties of Bases:

- Have a bitter taste.
- Soapy to touch.
- Turns red litmus blue.
- Conducts electricity in solution.
- Release OH^- ions in Aqueous Solution

Types of bases: Bases can be divided in two types – Water soluble and Water-insoluble.

The hydroxide of alkali and alkaline earth metals are soluble in water. These are also known as alkali. For example $NaOH$, $Mg(OH)_2$, $Ca(OH)_2$

Chemical properties of bases:

(i) Reaction of Base with Metals: When alkali (base) reacts with metal, it produces salt and hydrogen gas.

Examples: Sodium hydroxide gives hydrogen gas and sodium zincate when reacts with zinc metal.



(ii) Reaction of Base with Oxides of Non-metals: when a base reacts with non-metal oxide, both neutralize each other resulting respective salt and water.

Examples: Sodium hydroxide gives sodium carbonate and water when it reacts with carbon dioxide.



(iii) Neutralisation Reaction: An acid neutralizes a base when they react with each other and respective salt and water are formed.

Examples: Sodium chloride and water are formed when hydrochloric acid reacts with sodium hydroxide (a strong base).



(iv) Reaction of Acid with Metal Oxides: Metal oxides are basic in nature. Thus, when an acid reacts with a metal oxide both neutralize each other. In this reaction, the respective salt and water are formed.

Examples: When an acid, such as hydrochloric acid, reacts with calcium oxide, neutralization reaction takes place and calcium chloride, along with water is formed.



Salts: Salts are the ionic compounds which are produced after the neutralization reaction between acid and base. Salts are electrically neutral. There are number of salts but sodium chloride is the most common among them. Sodium chloride is also known as table salt or common salt. Sodium chloride is used to enhance the taste of food.

Acid + Base \rightarrow Salt + Water



Characteristics of salt:

- Most of the salts are crystalline solid.
- Salts may be transparent or opaque.
- Most of the salts are soluble in water.
- Solution of the salts conducts electricity in their molten state also.
- The salt may be salty, sour, sweet, and bitter.
- Neutral salts are odourless.
- Salts can be colourless or coloured.

Example: Sodium chloride (NaCl), Sodium Sulphate (Na₂SO₄), Calcium chloride (CaCl₂), Calcium sulphate (CaSO₄), Zinc chloride (ZnCl₂) and Zinc sulphate (ZnSO₄)

Neutral, Acidic and Basic Salts:

(i) Neutral Salt: Salts produced because of reaction between a strong acid and strong base are neutral in nature. The pH value of such salts is equal to 7, i.e. neutral.

Example: Sodium chloride, Sodium sulphate. Potassium chloride, etc.

Sodium chloride (NaCl): It is formed after the reaction between hydrochloric acid (a strong acid) and sodium hydroxide (a strong base).



Sodium Sulphate (Na₂SO₄): It is formed after the reaction between sodium hydroxide (a strong base) and Sulphuric acid (a strong acid).



Potassium Chloride (KCl): It is formed after the reaction between potassium hydroxide (a strong base) and hydrochloric acid (a strong acid).



(ii) Acidic Salts: Salts which are formed after the reaction between a strong acid and weak base are called Acidic salts. The pH value of acidic salt is lower than 7. For example: Ammonium chloride, Ammonium sulphate etc.

Ammonium chloride is formed after reaction between hydrochloric acid (a strong acid) and ammonium hydroxide (a weak base).



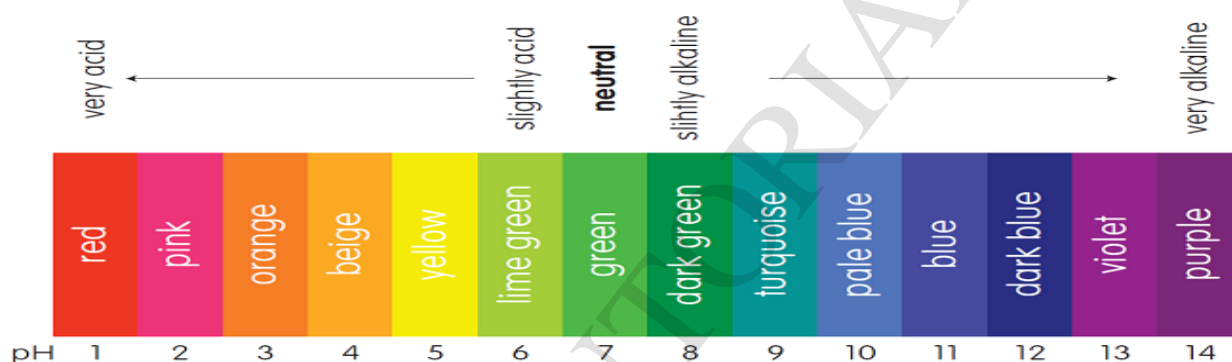
Ammonium sulphate is formed after reaction between ammonium hydroxide (a weak base) and Sulphuric acid (a strong acid).



(iii) Basic Salts: Salts which are formed after the reaction between a weak acid and strong base are called Basic Salts. For example; Sodium carbonates, Sodium acetate, etc. Sodium carbonate is formed after the reaction between sodium hydroxide (a strong base) and carbonic acid (a weak acid).



Sodium acetate is formed after the reaction between a strong base, sodium hydroxide (a strong base) and acetic acid, (a weak acid).



Strength of Acid and Base: Acids in which complete dissociation of hydrogen ion takes place are called Strong Acids. Similarly, bases in which complete dissociation of hydroxide ion takes place are called Strong Bases.

In mineral acid, such as hydrochloric acid, Sulphuric acid, nitric acid, etc. hydrogen ion dissociates completely and hence, they are considered as strong acids. Since inorganic acids hydrogen ions do not dissociate completely, so they are weak acids.

pH is equal to the logarithm to the base 10, inverse of hydrogen ion concentration.

$$\text{pH} = -\log [\text{H}^+] = \log \{1/[\text{H}^+]\} = 10^{-\text{pH}}$$

$$\text{Similarly, } \text{pOH} = -\log [\text{OH}^-] = \log \{1/[\text{OH}^-]\}$$

$$\text{And } \text{pH} + \text{pOH} = \text{pK}_w = 14$$

Higher the hydronium ion concentration present in the solution, lower is its pH value.

For water or neutral solutions: $\text{pH} = 7$

for acidic solutions: $\text{pH} < 7$

for basic solution: $\text{pH} > 7$

Importance of pH everyday life:

(i) pH in our digestive system: Dilute HCl (Hydrochloric acid) helps in digestion of food (proteins) in our stomach. Excess acid in stomach causes acidity (indigestion). Antacids like magnesium hydroxide $[\text{Mg} (\text{OH})_2]$ also known as milk of magnesia and sodium hydrogen carbonate (baking soda) are used to neutralize excess acid.

(ii) Tooth decay caused by acids: The bacteria present in our mouth converts the sugar into acids. When the pH of acid formed in the mouth falls below 5.5, tooth-decaying starts. The excess acid has to be removed by cleaning the teeth with good quality toothpaste because these kinds of toothpaste are alkaline in nature.

(iii) Soil of pH and plant growth: Most of the plants have a healthy growth when the soil has a specific pH (close to 7) range which should be neither alkaline nor highly acidic.

Some Important Chemical Compounds

1. Common Salt (Sodium Chloride): Sodium chloride (NaCl) is also known as Common or Table Salt. It is formed after the reaction between sodium hydroxide and hydrochloric acid. It is a neutral salt. The pH value of sodium chloride is about 7. Sodium chloride is used to enhance the taste of food. Sodium chloride is used in the manufacturing of many chemicals.



2. Sodium Hydroxide (NaOH): Sodium hydroxide is a strong base. It is also known as caustic soda. It is obtained by the electrolytic decomposition of solution of sodium chloride (brine). In the process of electrolytic decomposition of brine (aqueous solution of sodium chloride), brine decomposes to form sodium hydroxide. In this process, chlorine is obtained at anode and hydrogen gas is obtained at cathode as by products. This whole process is known as Chloro – Alkali process.



3. Bleaching Powder (CaOCl₂): Bleaching powder is also known as chloride of lime. It is a solid and yellowish white in colour. Bleaching powder can be easily identified by the strong smell of chlorine.

When calcium hydroxide (slaked lime) reacts with chlorine, it gives calcium oxychloride (bleaching powder) and water is formed.



Aqueous solution of bleaching powder is basic in nature. The term bleach means removal of colour. Bleaching powder is often used as bleaching agent. It works because of oxidation. Chlorine in the bleaching powder is responsible for bleaching effect.

Use of Bleaching Powder:

- Bleaching powder is used as disinfectant to clean water, moss remover, weed killers, etc.

- Bleaching powder is used for bleaching of cotton in textile industry, bleaching of wood pulp in paper industry.
- Bleaching powder is used as oxidizing agent in many industries, such as textiles industry, paper industry, etc.

4. Baking Soda (NaHCO₃): Baking soda is another important product which can be obtained using byproducts of chlor – alkali process. The chemical name of baking soda is sodium hydrogen carbonate (NaHCO₃) or sodium bicarbonate.

Preparation Method: Baking soda is obtained by the reaction of brine with carbon dioxide and ammonia. This is known as Solvay process.



Properties of Sodium Bicarbonate:

- Sodium bicarbonate is white crystalline solid, but it appears as fine powder.
- Sodium hydrogen carbonate is amphoteric in nature.
- Sodium hydrogen carbonate is sparingly soluble in water.
- When baking soda is heated, it decomposes into sodium carbonate, carbon dioxide and water.



- Sodium carbonate formed after thermal decomposition of sodium hydrogen carbonate decomposes into sodium oxide and carbon dioxide on further heating.

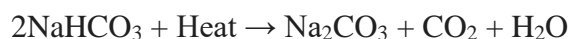


Use of Baking Soda:

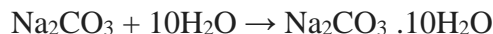
- Baking soda is used in making of baking powder, which is used in cooking as it produces carbon dioxide which makes the batter soft and spongy.
- Baking soda is used as an antacid.
- Baking soda is used in toothpaste which makes the teeth white and plaque free.
- Baking soda is used in cleansing of ornaments made of silver.
- Since sodium hydrogen carbonate gives carbon dioxide and sodium oxide on strong heating, thus, it is used as a fire extinguisher.

4. Washing Soda (Sodium Carbonate)

Preparation Method: Sodium carbonate is manufactured by the thermal decomposition of sodium hydrogen carbonate obtained by Solvay process.



The sodium carbonate obtained in this process is dry. It is called Soda ash or anhydrous sodium carbonate. Washing soda is obtained by rehydration of anhydrous sodium carbonate.



since there are 10 water molecules in washing soda, hence, it is known as Sodium Bicarbonate decahydrate.

Sodium carbonate is a crystalline solid and it is soluble in water when most of the carbonates are insoluble in water.

Use of sodium carbonate:

- It is used in the cleaning of cloths.
- In the making of detergent cake and powder.
- In removing the permanent hardness of water.
- It is used in glass and paper industries.

(v) **Plaster of Paris: Calcium sulphate hemihydrate** [$\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$]



Plaster of Paris



Multiple Choice Questions:

Q1. Which of the following acids is present in sour milk?

- (a) Glycolic acid
- (b) Oxalic acid
- (c) Lactic acid
- (d) Citric acid

Q2. Which of the following statements is not correct?

- (a) All metal carbonates react with acid to give a salt, water and carbon dioxide
- (b) All metal oxides react with water to give salt and acid
- (c) Some metal react with acids to give salt and hydrogen
- (d) Some non-metal oxides react with water to form an acid

Q3. Which of the following statements is incorrect about bases?

- (a) Bases are bitter in taste
- (b) They are soapy to touch
- (c) They are corrosive in nature
- (d) All bases are alkali

Q4. Mixing of acid or base with water results in in the concentration of ions per unit volume.

- (a) Decreases
- (b) Increases
- (c) No change
- (d) Reverse change

Q5. What is pH?

- (a) The positive logarithm of the hydroxide ion concentration
- (b) The positive logarithm of the hydrogen ion concentration
- (c) The negative logarithm of the hydroxide ion concentration
- (d) The negative logarithm of the hydrogen ion concentration

Q6. Which of the following statements is correct about an aqueous solution of an acid and a base?

1. Higher the pH, stronger the acid.
2. Higher the pH, weaker the acid.
3. Lower the pH, stronger the base.
4. Lower the pH, weaker the base.

- (a) 1 and 3
- (b) 2 and 3
- (c) 1 and 4
- (d) 2 and 4

Q7. The chemical formula of washing soda is

- (a) NaHCO_3
- (b) $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
- (c) CaOCl_2
- (d) NaOH

Q8. Baking soda is a mixture of

- (a) Sodium carbonate and acetic acid
- (b) Sodium carbonate and tartaric acid
- (c) Sodium hydrogen carbonate and tartaric acid
- (d) Sodium hydrogen carbonate and acetic acid

Q9. What happens, when a solution of an acid is mixed with a solution of a base in a test tube?

1. The temperature of the solution increases.
2. The temperature of the solution decreases.
3. The temperature of the solution remains the same.
4. Salt formation takes place.

- (a) Only 1
- (b) 1 and 3
- (c) 2 and 3
- (d) 1 and 4

Q10. Which of the following salts does not contain water of crystallization?

- (a) Blue vitriol
- (b) Baking soda
- (c) Washing soda
- (d) Gypsum

ANSWERS

Q1. (c)	Q2. (b)	Q3. (d)	Q4. (a)	Q5. (d)
Q6. (d)	Q7. (b)	Q8. (c)	Q9. (d)	Q10. (b)

Assignment:

Q1. Name the natural source of each of the following acid

- (i) Citric acid (ii) Oxalic acid
- (iii) Lactic acid (iv) Tartaric acid

Answer. (i) Lemon and orange (ii) Tomatoes and Guava

(iii) Sour milk (curd) (iv) Tamarind

Q2. A student detected the pH of four unknown solution A, B, C and D as follows 11, 5, 7 and 2. Predict the nature of the solution.

Answer. A is basic _B_ is acidic _C_ is natural and _D_ is strongly acidic.

Q3. How will you test for the gas which is liberated when hydrochloric acid reacts with an active metal?

Answer. Bring a burning matchstick near the gas. It burns with _pop_ sound showing that it is hydrogen.

Q4. (a) Write the name given to bases that are highly soluble in water. Give an example.

(b) How is tooth decay related to pH? How can it be prevented?

(c) Why does bee sting cause pain and irritation? Rubbing of baking soda on the sting area gives relief. How?

Answer. (a) Alkali, e.g. NaOH (Sodium hydroxide).

(b) Lower the pH more will be tooth decay. Acid reacts with $\text{Ca}_3(\text{PO}_4)_2$ and cause tooth decay. It can be prevented by brushing teeth after every meal.

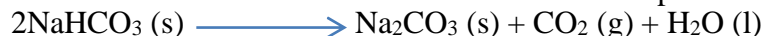
(c) It is due to formic acid. Sodium hydrogencarbonates (Baking soda) neutralizes formic acid giving relief.

Q5. A white powder is added while baking breads and cakes to make them soft and fluffy. Write the name of the powder. Name its main ingredients. Explain the function of each ingredient.

Write the chemical reaction taking place when the powder is heated during baking.

Answer. Baking powder. It consists of sodium hydrogencarbonates and tartaric acid.

Sodium hydrogencarbonates gives CO_2 which makes cake soft and fluffy. Tartaric acid neutralizes the bitterness due to sodium carbonate produced.



Q6. A student dropped few pieces of marble in dilute hydrochloric acid, contained in a test-tube. The evolved gas was then passed through lime water. What change would be observed in lime water? What will happen if excess of gas is passed through lime water? With the help of balanced chemical equations for all the changes explain the observations.

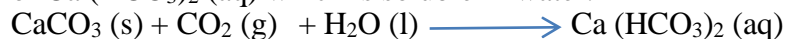
Answer.



Lime water turns milky due to liberation of CO_2 .



If excess of CO_2 gas is passed through lime water, milkiness will disappear due to the formation of $\text{Ca} (\text{HCO}_3)_2 (\text{aq})$ which is soluble in water.



Q7. 15 mL of water and 10 mL of Sulphuric acid are to be mixed in a beaker

(i) State the method that should be followed with reason.

(ii) What is this process called?

Answer.

(i) The acid is to be added slowly in water to prevent the mixture to be splashed. The reaction is highly exothermic; therefore, constant cooling should be done.

(ii) The process is called dilution.

Q8. Choose strong acids and weak acids from the following:

CH_3COOH , H_2SO_4 , H_2CO_3 , HNO_3

Answer. H_2SO_4 and HNO_3 are strong acids.

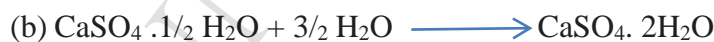
CH_3COOH and H_2CO_3 are weak acids.

Q9. A white coloured powder is used by doctors for supporting fractured bones.

(a) Write chemical name and formula of the powder.

(b) When this white powder is mixed with water a hard solid mass is obtained. Write balanced chemical equation for the change.

Answer. (a) Calcium sulphate hemihydrate ($\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$)



Q10. How will you test for the gas which is liberated when hydrochloric acid reacts with an active metal?

Answer. Bring a burning matchstick near the gas. It burns with 'pop' sound showing that it is hydrogen.

METALS & NON-METALS

Metals



Lead



Gold



Silver



Copper

Non-metals



Diamond



Carbon



Sulfur



Phosphorus



Al



Fe



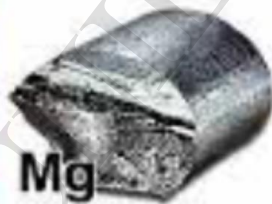
Ca



Na



K



Mg



Au



Pt

Physical properties

metals are Solid at room temperature

Metals has lustrous and can be polished

Metals are generally hard

metals have high density

Non Metals are present in three states solid , liquids and gases

they are not lustrous except diamond

Non Metals are soft

CHAPTER 3

METALS AND NON-METALS

Metals: Elements that are electropositive in nature are called metals. It means metals lose electrons to form positive ions, e.g. copper.

Physical Properties of Metals:

- **Hardness:** Most of the metals are hard, except alkali metals, such as sodium, potassium; lithium, etc. are very soft metals. These can be cut by using a knife.
- **Strength:** Most of the metals are strong and have high tensile strength. Because of this, big structures are made using metals, such as copper (Cu) and iron (Fe). (Except Sodium (Na) and potassium (K) which are soft metals).
- **State:** Metals are solid at room temperature except for mercury (Hg).
- **Sound:** Metals produce ringing sound, so, metals are called Sonorous. Sound of metals is also known as Metallic sound. This is the cause that metal wires are used in making musical instruments.
- **Conduction:** Metals are a good conductor of heat and electricity. This is the cause that electric wires are made of metals like copper and aluminium.
- **Malleability:** Metals are malleable. This means metals can be beaten into a thin sheet. Because of this property, iron is used in making big ships.
- **Ductility:** Metals are ductile. This means metals can be drawn into thin wire. Because of this property, a wire is made of metals.
- **Melting and Boiling Point:** Metals have generally high melting and boiling points. (Except sodium and potassium metals which have low melting and boiling point.)
- **Density:** Most of the metals have a high density.
- **Colour:** Most of the metals are grey in colour. But gold and copper are exceptions.

Chemical Properties of Metals

1. Reaction with oxygen: Most of the metals form respective metal oxides when reacting with oxygen.

Metal + Oxygen \rightarrow Metal Oxide

Examples:

Reaction of Potassium with Oxygen: Potassium metal forms potassium oxide when reacts with oxygen.



Reaction of Sodium with Oxygen: Sodium metal forms sodium oxide when reacts with oxygen.



Lithium, potassium, sodium, etc. are known as Alkali-metals. Alkali metals react vigorously with oxygen.

Reaction of Copper metal with Oxygen: Copper does not react with oxygen at room temperature but when burnt in air, it gives oxide.



Silver, gold and platinum do not combine with the oxygen of air even at high temperature. They are the least reactive.

2. Reaction of metals with water: Metals form respective hydroxide and hydrogen gas when reacting with water.

Metal + Water \rightarrow Metal hydroxide + Hydrogen

Most of the metals do not react with water. However, alkali metals react vigorously with water.

Reaction of Sodium metal with Water: Sodium metal forms sodium hydroxide and liberates hydrogen gas along with lot of heat when reacting with water.



Reaction of Calcium metal with Water: Calcium forms calcium hydroxide along with hydrogen gas and heat when react with water.



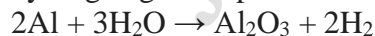
Reaction of Magnesium metal with Water: Magnesium metal reacts with water slowly and forms magnesium hydroxide and hydrogen gas.



When steam is passed over magnesium metal, magnesium oxide and hydrogen gas are formed.



Reaction of Aluminium metal with Water: Reaction of aluminium metal with cold water is too slow to come into notice. But when steam is passed over aluminium metal, aluminium oxide and hydrogen gas are produced.



Reaction of Zinc metal with Water: Zinc metal produces zinc oxide and hydrogen gas when steam is passed over it. Zinc does not react with cold water.



Reaction of Iron with Water: Reaction of iron with cold water is very slow and comes into notice after a long time. Iron forms rust (iron oxide) when reacts with moisture present in the atmosphere. Iron oxide and hydrogen gas are formed by passing of steam over iron metal.



Both calcium (Ca) and magnesium (Mg) are heavier than water but still float over it: Both calcium and magnesium float over water surface because hydrogen gas is evolved when these metals react with water. It is in the form of bubbles which stick on the metal surface. Therefore, they float over it.



Other metals usually do not react with water or react very slowly. Lead, copper, silver and gold do not react with steam. Thus, the order of reactivity of different metals towards water may be written as:



3. Reaction of metals with dilute acid: Metals form respective salts when reacting with dilute acid.



Reaction of Sodium metal with dilute hydrochloric acid: Sodium metal gives sodium chloride and hydrogen gas when react with dilute hydrochloric acid.



Reaction of Magnesium metal with dilute hydrochloric acid: Magnesium chloride and hydrogen gas are formed when magnesium reacts with dilute hydrochloric acid.



Reaction of Zinc with dilute Sulphuric acid: Zinc sulphate and hydrogen gas are formed when zinc reacts with dilute Sulphuric acid. This method is used in the laboratory to produce hydrogen gas.



Hydrogen (H₂) gas is not evolved when metal is treated with nitric acid (HNO₃):

Nitric acid is strong oxidising agent and it oxidizes the hydrogen gas (H₂) liberated into water (H₂O) and itself get reduced to some oxide of nitrogen like nitrous oxide (N₂O), nitric oxide (NO) and nitrogen dioxide (NO₂).

Copper, gold, silver are known as noble metals. These do not react with water or dilute acids. The order of reactivity of metal towards dilute hydrochloric acid or Sulphuric acid is in the order; $K > Na > Ca > Mg > Al > Zn > Fe > Cu > Hg > Ag$

Metal Oxides

Chemical Properties: Metal oxides are basic in nature. The aqueous solution of metal oxides turns red litmus blue.

Reaction of Metal oxides with Water: Most of the metal oxides are insoluble in water. Alkali metal oxides are soluble in water. Alkali metal oxides give strong base when dissolved in water.

Reaction of Sodium oxide with Water: Sodium oxide gives sodium hydroxide when reacts with water.



Reaction of Potassium oxide with Water: Potassium oxide gives potassium hydroxide when reacts with water.



Reaction of Zinc oxide and Aluminium oxide: Aluminium oxide and zinc oxide are insoluble in water. Aluminium oxide and zinc oxide are amphoteric in nature. An amphoteric substance shows both acidic and basic characters. It reacts with base like acid and reacts with an acid like a base.

When zinc oxide reacts with sodium hydroxide, it behaves like an acid. In this reaction, sodium zincate and water are formed.



Zinc oxide behaves like a base when reacts with acid. Zinc oxide gives zinc chloride and water on reaction with hydrochloric acid.



In a similar way, aluminium oxide behaves like a base when reacts with acid and behaves like acid when reacts with a base.

Aluminium oxide gives sodium aluminate along with water when reacts with sodium hydroxide.

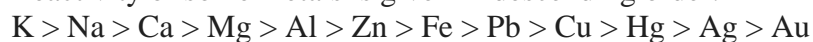


Aluminium oxide gives aluminium chloride along with water when it reacts with hydrochloric acid.

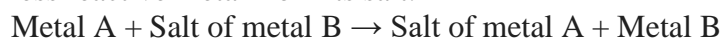


Reactivity Series of Metals: The order of intensity or reactivity of metal is known as Reactivity Series. Reactivity of elements decreases on moving from top to bottom in the given reactivity series.

In the reactivity series, copper, gold, and silver are at the bottom and hence, least reactive. These metals are known as Noble metals. Potassium is at the top of the series and hence, most reactive. Reactivity of some metals is given in descending order:



4. Reaction of metals with solution of other metal salts: Reaction of metals with the solution of other metal salt is displacement reaction. In this reaction, more reactive metal displaces the less reactive metal from its salt.



Examples:

Iron displaces copper from copper sulphate solution.



Similarly, aluminium and zinc displace copper from the solution of copper sulphate.



In all the above examples, iron, aluminium and zinc are more reactive than copper. This is why they displace copper from its salt solution.

When copper is dipped in the solution of silver nitrate, it displaces silver and forms copper nitrate.



In the reaction, copper is more reactive than silver and hence, displaces silver from silver nitrate solution.

Silver metal does not react with copper sulphate solution because silver is less reactive than copper and not able to displace copper from its salt solution.



Similarly, when gold is dipped in the solution of copper nitrate, no reaction takes place because copper is more reactive than gold.



In similar way, no reaction takes place when copper is dipped in the solution of aluminium nitrate because copper is less reactive than aluminium.



Non-Metals: Elements that are electronegative in nature are called non-metals. It means non-metals gain electrons to form negative ions, e.g. iodine

Physical properties of non-metals

- **Hardness:** Non-metals are not hard rather they are generally soft. But the diamond is an exception; it is the hardest naturally occurring substance.
- **State:** Non-metals may be solid, liquid or gas.
- **Luster:** Non-metals have a dull appearance. Diamond and iodine are exceptions.
- **Sonority:** Non-metals are not sonorous, i.e., they do not produce a typical sound on being hit.
- **Conduction:** Non-metals are a bad conductor of heat and electricity. Graphite which is allotrope of carbon is a good conductor of electricity and is an exception.
- **Malleability and ductility:** Non-metals are brittle.
- **Melting and boiling point:** Non-metals have generally low melting and boiling points.
- **Density:** Most of the non-metals have low density.
- **Colour:** Non-metals are in many colours.

Carbon in the form of graphite is non-metal which conduct electricity.

Carbon in the form of diamond is a non-metal which is extremely hard. Diamond is a non-metal which has a very high melting point and boiling point.

Iodine is non-metal which is lustrous having a shining surface.

Chemical properties of Non-metals:

1. Reaction of Non-metals with Oxygen: Non-metals form respective oxide when reacting with oxygen.

Non-metal + Oxygen \rightarrow Non-metallic oxide

when carbon reacts with oxygen, carbon dioxide is formed along with the production of heat.



When carbon is burnt in an insufficient supply of air, it forms carbon monoxide. Carbon monoxide is a toxic substance. Inhaling of carbon monoxide may prove fatal.



Sulphur gives sulphur dioxide when reacting with oxygen. Sulphur catches fire when exposed to air.



When hydrogen reacts with oxygen it gives water.



Non-metallic Oxide: Non-metallic oxides are acidic in nature. The solution of non-metal oxides turns blue litmus red.

Carbon dioxide gives carbonic acid when dissolved in water.



Sulphur dioxide gives sulphurous acid when dissolved in water.



Sulphur dioxide gives Sulphuric acid when reacts with oxygen.



2. Reaction of Non-metal with Chlorine: Non-metal gives respective chloride when they react with chlorine gas.

Non-metal + Chlorine \rightarrow Non-metal chloride

Hydrogen gives hydrogen chloride and phosphorous gives phosphorous trichloride when reacting with chlorine.



3. Reaction of Non-metals with Hydrogen: Non-metals reactive with hydrogen to form covalent hydrides.

Non-metal + Hydrogen → Covalent Hydride

Sulphur combines with hydrogen to form a covalent hydride is called Hydrogen sulphide.



Nitrogen combines with hydrogen in presence of an iron catalyst to form covalent hydride ammonia.



Non-metals do not react with water (or steam) to evolve Hydrogen gas.

Non-metals do not react with dilute acids.

4. Reaction of Metal and Non-metal: Many metals form ionic bonds when they react with non-metals. Compounds so formed are known as Ionic Compounds.

Ions: Positive or negative charged atoms are known as ions. Ions are formed because of loss or gain of electrons. Atoms form ions obtain by the electronic configuration of the nearest noble gas.

Positive ion: A positive ion is formed because of the loss of electrons by an atom.

Following are some examples of positive ions:

Sodium forms sodium ion because of the loss of one electron. Because of the loss of one electron, one positive charge comes over sodium.



Magnesium forms positive ion because of the loss of two electrons. Two positive charges come over magnesium because of loss of two electrons.



Negative ion: A negative ion is formed because of the gain of an electron.

Some examples are given below:

Chlorine gains one electron in order to achieve a stable configuration. After the gain of one electron, chlorine gets one negative charge over it forming chloride ion.



Difference between Metals and Non-metals:

Metals	Non-metals
1. Metals generally occur as hard solid substances.	1. Non-metals generally occur in all the three forms of matter- solid, liquid and gases.
2. Metals are malleable and ductile.	2. Non-metals are not malleable and ductile.
3. Metals produce ringing sound on striking which is called their sonorous property.	3. Non-metals do not show this sonorous property.
4. Metals are good conductors of heat and electricity.	4. Non-metals are poor conductors of heat and electricity with the exception of graphite which is a good conductor of heat and electricity.

Reactivity series: The arrangement of metals in a vertical column in the order of decreasing reactivity is called reactivity series of metals. The most reactive metals are placed at the top and least reactive metals are placed at the bottom of the reactivity series.

The reactivity series is:

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

Ionic Compounds: The compounds formed by transfer of electrons from a metal to a non-metal are known as Ionic Compounds. Sodium Chloride (NaCl), Magnesium chloride (MgCl₂)

Ionic Bonds: Ionic bonds are formed because of transfer of electrons from metal to non-metal. In this course, metals get positive charge because of transfer of electrons and non-metal gets negative charge because of acceptance of electrons. In other words, bond formed between positive and negative ion is called Ionic Bond.

Some examples are given below:

Formation of Sodium Chloride (NaCl): In sodium chloride, sodium is a metal (alkali metal) and chlorine is a non-metal.

Atomic number of sodium = 11

Electronic configuration of sodium: 2, 8, 1
Number of electrons in outermost orbit = 1

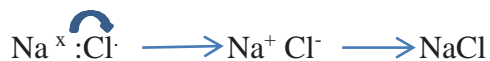
Atomic number of chlorine = 17
Electronic configuration of chlorine: 2, 8, 7
Electrons in outermost orbit = 7



2, 8, 1 2, 8



(2, 8, 7) (2, 8, 8)



Sodium has one valence electron and chlorine has seven valence electrons. Sodium requires losing one electron to obtain stable configuration and chlorine requires gaining one electron in order to obtain stable electronic configuration. Since, sodium chloride is formed because of ionic bond, thus, it is called Ionic compound. In similar way, Magnesium chloride (MgCl_2) is formed.



2, 8, 2 2, 8



(2, 8, 7) (2, 8, 8)

Properties of Ionic Compounds:

Properties of ionic compounds are as follows.

(i) **Physical nature:** Ionic compounds are solids and hard due to the strong attracting force between the positive and negative ions. These compounds are generally brittle and break into pieces on pressure.

(ii) **Melting and boiling point:** Ionic compounds have high melting and boiling points because amount of energy can break the strong inter-ionic attraction.

(iii) **Solubility:** Ionic compounds are soluble in water but insoluble in solvents like kerosene, petrol, etc.

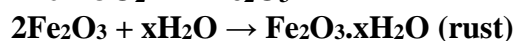
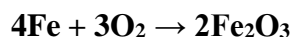
(iv) Conduction of Electricity: Conduction of electricity through a solution is possible when there is movement of charged particles. Ionic compounds in the solid state do not conduct electricity because movement of ions in the solid is not possible due to their rigid structure.

A solution of an ionic compound in water contains ions, which move to the opposite electrodes when electricity is passed through the solution. Ionic compounds conduct electricity in the molten state as in the molten state the electrostatic forces of attraction between the oppositely charged ions overcome due to the heat. Thus, the ions move freely and conduct electricity.

Corrosion and its prevention:

Corrosion is an electrochemical process in which redox reactions occur between the metal and water, oxygen and sulphur dioxide, etc. It is a *spontaneous and irreversible* process in which the metal changes into chemical compounds such as oxide, sulphide and hydroxides, etc.

For example, due to corrosion or rusting, the iron changes into red iron oxide (rust) in the presence of moisture and oxygen present in the air. The rusting of iron when it comes in contact with water and oxygen which leads to the formation of a brown coat over its surface is a type of corrosion. The chemical reaction involved in rusting is shown below;



Methods to prevent corrosion, some of them are described below;

(i) Electroplating:

- In this method, an electric current is used to create a thin layer of metal over another metal. It is done to make cheaper metals more appealing as well as to protect them from corrosion.
- This method requires two different metals, an electrolytic solution, and two electrodes in a tank and a battery or source of current that will pass the required current into the solution to carry out the electrolysis.
- When current is passed one electrode gets a positive charge and another gets the negative charge. The ions of the positively charged metal shift to the surface of the negatively charged metal to create a thin layer. For example, when we take brass and copper for electroplating, the copper metal slowly gets deposited or covers the brass and thus a thin coating of copper covers the surface of the brass. Here, the electrolytic solution must contain copper sulphide.

(ii) Galvanization: In this method, iron is coated with a layer of zinc. The iron is dipped in the molten zinc. The layer of zinc protects the iron from corrosion. This method has been in use for more than 200 years.

(iii) Painting and Greasing: In this method, a layer is created over the metal surface by painting or greasing. This layer of paint or grease protects the metal from corrosion. Carbon fibre coating can be used for this purpose.

(iv) **Selection of Material:** Select the materials that are not affected by corrosion. For example, stainless steel and aluminium are resistant to corrosion.

(v) **Dry and clean:** Keep the metal surface dry and clean.

Multiple Choice Questions:

Q1. Gold is used for making jewellery. What are the properties of gold make it a suitable metal for making jewellery?

- (a) Ductility
- (b) Malleability
- (c) Lustrous
- (d) All of these

Q2. Aluminium is used for making cooking utensils. What are the following properties of Aluminium are responsible for the same?

- 1. Good thermal conductivity
 - 2. Good electrical conductivity
 - 3. Ductility
 - 4. High melting point
- (a) 1 and 2
 - (b) 1 and 3
 - (c) 2 and 3
 - (d) 1 and 4

Q3. Which of the following oxide of iron would be obtained on prolonged reaction of iron with steam?

- (a) Fe O
- (b) Fe₂O₃
- (c) Fe₃O₄
- (d) Fe₂O₃ and Fe₃O₄

Q4. The correct order of increasing chemical reactivity is

- (a) Fe < Zn < Mg < K
- (b) Zn < Fe < Mg < K
- (c) Fe < Mg < Zn < K
- (d) Zn < Fe < K < Mg

Q5. Which of the following metal will not give H₂ (g) with H₂O?

- (a) Na (s) + 2H₂O →
- (b) Mg (s) + H₂O →
- (c) Zn (s) + 2H₂O →
- (d) Cu (s) + 2H₂O →

- Q6. Few particles of Zn are dropped in the CuSO_4 solution, the correct observation is.....
- (a) Blue colour of CuSO_4 solution fades
 - (b) Solution changes to red colour
 - (c) Solution becomes black
 - (d) Solution becomes silvery white
- Q7. Which of the following non-metal is liquid at room temperature?
- (a) Mercury
 - (b) Carbon
 - (c) Phosphorous
 - (d) Bromine
- Q8. The combination of carbon monoxide and hydrogen is known as
- (a) Carbon gas
 - (b) Coal gas
 - (c) Carbonic gas
 - (d) Water gas
- Q9. Which of the following are not ionic compounds?
1. KCl
 2. HCl
 3. CCl_4
 4. NaCl
- (a) 1 and 2
 - (b) 2 and 3
 - (c) 3 and 4
 - (d) 1 and 3
- Q10. Which one of the following properties is not generally exhibited by ionic compounds?
- (a) Solubility in water
 - (b) Electrical conductivity in solid state
 - (c) High melting and boiling points
 - (d) Electrical conductivity in molten state

ANSWERS

Q1. (d)	Q2. (d)	Q3. (c)	Q4. (a)	Q5. (d)
Q6. (a)	Q7. (d)	Q8. (d)	Q9. (b)	Q10. (b)

Assignments:

Q1. Write one example of each of

(i) a metal which is so soft that, it can be cut with knife and a non-metal which is the hardest substance.

(ii) A metal and a non-metal which exist as liquid at room temperature.

Answer.

(i) Sodium, carbon (diamond).

(ii) Mercury is liquid metal, bromine is liquid non-metal.

Q2. Mention the names of the metals for the following:

(i) Two metals which are alloyed with iron to make stainless steel.

(ii) Two metals which are used to make jewellery.

Answer.

(i) Nickel and chromium.

(ii) Gold and platinum.

Q3. Write the electron dot structures for

(a) Potassium and chlorine.

(b) Calcium and sulphur.

(c) Calcium and chlorine.

Answer. (a) KCl (b) CaS (c) CaCl₂

Q4. You are given samples of three metals. Sodium, magnesium and copper. Suggest any two activities to arrange them in order of decreasing activity.

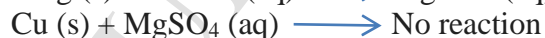
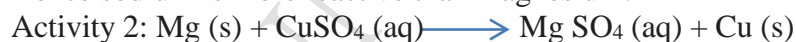
Answer. Activity 1: Sodium reacts with cold water vigorously to form sodium hydroxide and hydrogen gas



Magnesium does not react with cold water but with hot water to form magnesium hydroxide and hydrogen gas.



Hence sodium is more reactive than magnesium.



Q5. Give reason for the following:

(a) School bells are made up of metals.

(b) Electric wires are made up of copper.

Answer.

(a) It is because metals are sonorous, i.e. they produce sound when struck with a hard substance.

(b) It-is because copper is good conductor of electricity.

Q6. (a) Define activity series of metals. Arrange the metals gold, copper, iron and magnesium in order of their increase in reactivity.

(b) What will you observe when:

(i) Some zinc pieces are put in copper sulphate solution.

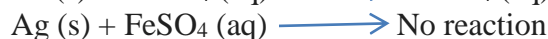
(ii) Some silver pieces are put into green coloured ferrous sulphate solution.

Answer.

(a) The series of metals in which metals are arranged in decreasing order of their reactivity.

Au < Cu < Fe < Mg is increasing order of reactivity.

(b) (i) The blue solution will become colourless and reddish brown copper metal will be deposited.



Reaction will not take place because Ag is less reactive than iron.

Q7. Name the following:

(a) A metal, which is preserved in kerosene.

(b) A lustrous coloured non-metal.

(c) A metal, which can melt while kept on palm.

(d) A metal, which is a poor conductor of heat.

Answer.

(a) Sodium is preserved in kerosene

(b) Iodine is lustrous coloured non-metal

(c) Gallium

(d) Lead

Q8. Give reason for the following:

(a) Aluminium oxide is considered as an amphoteric oxide.

(b) Ionic compounds conduct electricity in molten state.

Answer.

(a) It is because it reacts with acids as well as bases to produce salts and water. Al is less electropositive metal. So, it forms amphoteric oxide which can react with acid as well as base.

(b) Ionic compounds can conduct electricity in molten state because ions become free to move in molten state.

Q9. State reasons for the following:

(i) Sulphur is a non-metal (ii) Magnesium is a metal

Answer: (i) Sulphur is a non-metal because it is a poor conductor of heat and electricity.

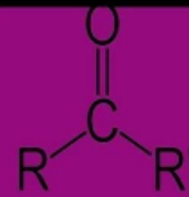
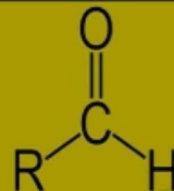
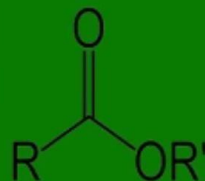
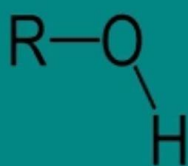
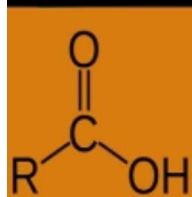
(ii) Magnesium is a metal because it is a good conductor of heat and electricity.

Q10. Write two differences between calcination and roasting.

Answer

Calcination	Roasting
It is carried out by heating ore in the absence of air.	It is carried out by heating ore in the presence of air.
(ii) It converts carbonate ores into oxides.	(ii) It converts sulphide ores into oxides.

CARBON AND ITS COMPOUNDS



Oxygen



Hydrogen

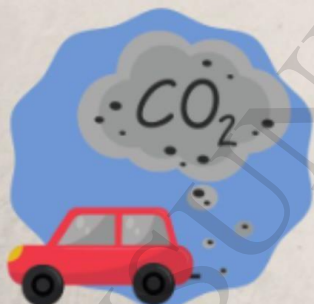


Nitrogen



Carbon

Examples of Carbon Compounds



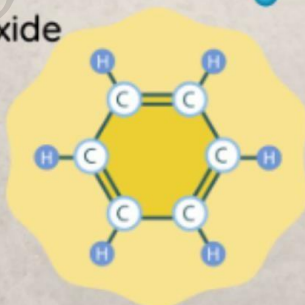
carbon dioxide



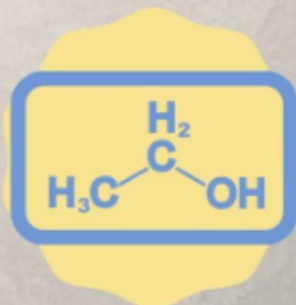
DNA



methane



benzene

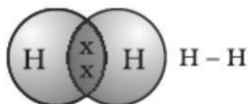


ethanol

CHAPTER 4
CARBON AND ITS COMPOUNDS

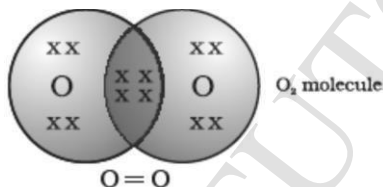
1. BONDING IN CARBON – THE COVALENT BOND

1. Covalent Bond: The chemical bond formed by the sharing of electrons between two atoms is called covalent bond.
- (i) Single covalent bond: A covalent bond formed by sharing of one pair of electrons between two atoms is known as single covalent bond. For example, two hydrogen atoms share their electrons to form a molecule of hydrogen, H₂.



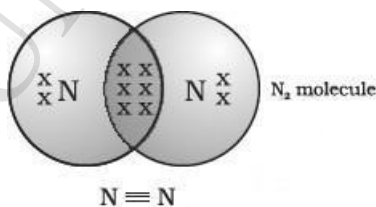
Single bond between two Hydrogen atoms

- (ii) Double covalent bond: The covalent bond formed by sharing of two pairs of electrons between two atoms is known as double covalent bond. For example, the two electrons contributed by each oxygen atom give rise to two shared pairs of electrons. This is said to constitute a double bond between the two atoms.
The electron dot structure of O₂ and its double bond.



Double bond between two oxygen atoms

- (iii) Triple covalent bond: The covalent bond formed by the sharing of three pairs of electrons between two atoms is known as triple covalent bond. In the case of a diatomic molecule of nitrogen, each nitrogen atom in a molecule of nitrogen contributes three electrons giving rise to three shared pairs of electrons. This is said to constitute a triple bond between the two atoms.
The electron dot structure of N₂ and its triple bond.



Triple bond between two nitrogen atoms

Covalent compounds exist as solids, liquids and gases. They are generally soluble in non-polar solvents like ether, benzene etc. and generally insoluble in polar solvents like water. Molecules of covalent compounds are held together by relatively weaker forces as compared to ionic compounds. Therefore, covalent compounds have relatively lower melting and boiling points.

Covalent compounds are poor conductors of electricity because they contain neither the ions nor free electrons necessary for conduction.

2. VERSATILE NATURE OF CARBON

The nature of the covalent bond enables carbon to form a large number of compounds.

Two factors noticed in the case of carbon are –

(i) Catenation: Carbon has the unique ability to form bonds with other atoms of carbon, giving rise to large molecules. The self-linking property of carbon atoms through covalent bonds to form long chains of carbon, branched chains of carbon or even carbon atoms arranged in rings. In addition, carbon atoms may be linked by single, double or triple bonds.

Compounds of carbon, which are linked by only single bonds between the carbon atoms, are called saturated compounds.

Compounds of carbon having double or triple bonds between their carbon atoms are called unsaturated compounds.

(ii) Tetravalency: Carbon has a valency of four, it is capable of bonding with four other atoms of carbon or atoms of some other mono-valent element. Compounds of carbon are formed with oxygen, hydrogen, nitrogen, sulphur, chlorine and many other elements giving rise to compounds with specific properties which depend on the elements other than carbon present in the molecule.

Homologous Series: It is a family of organic compounds having the same functional group in which the formula of successive members differs by $-\text{CH}_2$ group. For example,

For alkanes CH_4 , C_2H_6 , C_3H_8 , C_4H_{10} etc.

For alkenes C_2H_4 , C_3H_6 , C_4H_8 and C_5H_{10} etc.

For alkynes C_2H_2 , C_3H_4 , C_4H_6 and C_5H_8 etc.

For example, the chemical properties of CH_3OH , $\text{C}_2\text{H}_5\text{OH}$, $\text{C}_3\text{H}_7\text{OH}$ and $\text{C}_4\text{H}_9\text{OH}$ are all very similar. Hence, such a series of compounds in which the same functional group substitutes for hydrogen in a carbon chain is called a homologous series.

The melting and boiling points increase with increasing molecular mass.

5. Nomenclature of Carbon Compounds

S.No.	Class of Example compounds	Prefix/Suffix	Example	Structure
1.	Halo alkane	Prefix -Chloro, -Bromo	Chloropropane Bromopropane	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$
2.	Alcohol	Suffix - ol	Propanol	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
3.	Aldehyde	Suffix - al	Propanal	$\text{CH}_3\text{CH}_2\text{CHO}$
4.	Ketone	Suffix - one	Propanone	CH_3COCH_3
5.	Carboxylic acid	Suffix - oic acid	Propanoic acid	$\text{CH}_3\text{CH}_2\text{COOH}$

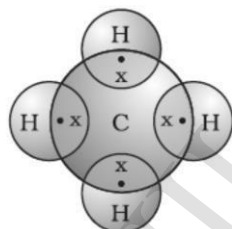
6.	Alkenes	Suffix - ene	Propene	$\text{CH}_3\text{CH} = \text{CH}_2$
7.	Alkynes	Suffix - yne	Propyne	$\text{CH}_3\text{C} \equiv \text{CH}$

Some functional groups in carbon compounds:

Hetero atom	Class of compounds	Formula of functional group	Examples
Cl/Br	Halo- (Chloro/Bromo) alkanes	-Cl, -Br (substitutes for hydrogen atom)	Chloroethane ($\text{C}_2\text{H}_5\text{Cl}$) Bromoethane ($\text{C}_2\text{H}_5\text{Br}$)
Oxygen	1. Alcohol	-OH	Ethanol ($\text{C}_2\text{H}_5\text{OH}$)
	2. Aldehyde	-CHO	Ethanal (CH_3CHO)
	3. Ketone	$>\text{C} = \text{O}$	Propanone (CH_3COCH_3)
	4. Carboxylic acid	-COOH	Ethanoic acid (CH_3COOH)

Saturated and Unsaturated Carbon Compounds

The carbon compounds which contain only carbon and hydrogen are called hydrocarbons. Among these, the saturated hydrocarbons are called alkanes. Methane, Ethane, Propane etc. Methane has a formula CH_4 . Hydrogen has a valency of 1. Carbon is tetravalent because it has four valence electrons. In order to achieve noble gas configuration, carbon shares these electrons with four atoms of hydrogen as shown in Fig. is given below:

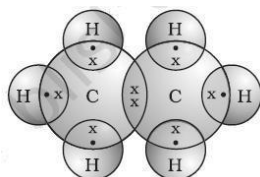


Electron dot structure for methane

Structure of ethane formed between carbon and hydrogen with a formula of C_2H_6 .

The structure of ethane is arrived in the following steps –

- Carbon atoms linked together with a single bond
- Each carbon atom bonded to three hydrogen atoms
- Electron dot structure of ethane



Electron dot structure for ethane

Formulae and structures of unsaturated compounds of carbon and hydrogen (Alkenes)

No. of C atoms	Name	Formula	Structure
1	Ethene	C ₂ H ₄	H ₂ C = CH ₂
2	Propene	C ₃ H ₆	CH ₃ - CH = CH ₂
3	1-Butene	C ₄ H ₈	CH ₃ - CH ₂ - CH = CH ₂
4	1-Pentene	C ₅ H ₁₀	CH ₃ - CH ₂ - CH ₂ - CH = CH ₂

Formulae and structures of unsaturated compounds of carbon and hydrogen (Alkynes)

No. of C atoms	Name	Formula	Structure
1	Ethyne	C ₂ H ₂	H - C ≡ C - H
2	1-Propyne	C ₃ H ₄	CH ₃ - C ≡ C - H
3	1-Butyne	C ₄ H ₆	CH ₃ - CH ₂ - C ≡ C - H
4	1-Pentyne	C ₅ H ₈	CH ₃ - CH ₂ - CH ₂ - C ≡ C - H

CHEMICAL PROPERTIES OF CARBON COMPOUNDS:

1. Combustion: Carbon, in all its allotropic forms, burns in oxygen to give carbon dioxide along with the release of heat and light.

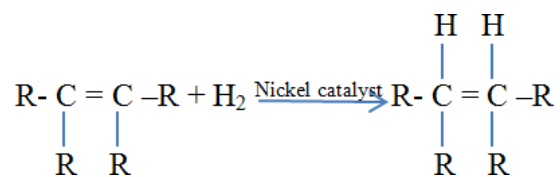


Saturated hydrocarbons will generally give a clean flame while unsaturated hydrocarbons will give a yellow flame with lots of black smoke. Limiting the supply of air results in incomplete combustion of even saturated hydrocarbons giving a sooty flame.

2. Oxidation: Carbon compounds can be easily oxidised on combustion. In addition to this complete oxidation, in which ethyl alcohol is converted to ethanoic acid upon heating in the presence of alkaline potassium permanganate or acidified potassium dichromate (oxidising agents).



3. Addition reaction: Unsaturated hydrocarbons add hydrogen in the presence of catalyst such as palladium or nickel to give saturated hydrocarbons.



4. Substitution reaction: Saturated hydrocarbons are fairly unreactive and are inert in the presence of most reagents. However, in the presence of sunlight, chlorine is added to methane in very fast reaction. Chlorine can replace the hydrogen atoms one by one. It is called a substitution reaction.



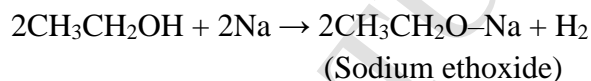
SOME IMPORTANT CARBON COMPOUNDS - ETHANOL AND ETHANOIC ACID

Properties of ethanol:

Ethanol is a liquid at room temperature. Ethanol is commonly called alcohol and is the active ingredient of all alcoholic drinks. Ethanol is also soluble in water in all proportions.

Reactions of Ethanol:

- (i) Reaction with sodium: When ethyl alcohol reacts with sodium leading to the evolution of hydrogen and the other product is sodium ethoxide.



- (ii) Reaction to give unsaturated hydrocarbon: Heating ethanol at 443 K with excess concentrated Sulphuric acid results in the dehydration of ethanol to give Ethene



The concentrated Sulphuric acid can be regarded as a dehydrating agent who removes water from ethanol.

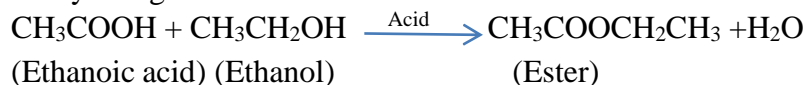
Uses: It is a good solvent; it is also used in medicines such as tincture iodine, cough syrups, and many tonics. Consumption of small quantities of dilute ethanol causes drunkenness. However, intake of even a small quantity of pure ethanol (called absolute alcohol) can be lethal. Also, long-term consumption of alcohol leads to many health problems.

Properties of ethanoic acid:

Ethanoic acid is commonly called acetic acid and belongs to a group of acids called carboxylic acids. Carboxylic acids are obviously characterized by their acidic nature. Carboxylic acids are weak acids. The melting point of pure ethanoic acid is 290 K and hence it often freezes during winter in cold climates. This gave rise to its name glacial acetic acid.

Reactions of ethanoic acid:

- (i) Esterification reaction: Esters are most commonly formed by reaction of an acid and an alcohol. Ethanoic acid reacts with absolute ethanol in the presence of an acid catalyst to give an ester



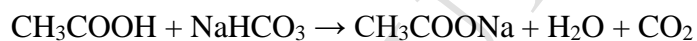
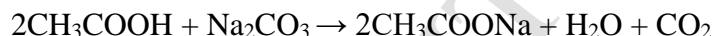
On treating with sodium hydroxide, which is an alkali, the ester is converted back to alcohol and sodium salt of carboxylic acid. This reaction is known as saponification because it is used in the preparation of soap. Soaps are sodium or potassium salts of long chain carboxylic acid.



- (ii) Reaction with a base: Like mineral acids, ethanoic acid reacts with a base such as sodium hydroxide to give a salt (sodium ethanoate or commonly called sodium acetate) and water:



- (iii) Reaction with carbonates and hydrogencarbonates: Ethanoic acid reacts with carbonates and hydrogencarbonates to give rise to a salt, carbon dioxide and water. The salt produced is commonly called sodium acetate.



Uses: Generally, esters are sweet-smelling substances. These are used in making perfumes and as flavouring agents. 5-8% solution of acetic acid in water is called vinegar and is used widely as a preservative in pickles.

SOAPS AND DETERGENTS:

Soaps: They form scum when reacted to hard water. Soaps are derived from natural substances such as vegetable oils and animal fats.

Detergents: They do not form scum. Detergents are generally a derivative of a synthetic compound.

Preparation of soap: On heating with sodium hydroxide, vegetable oil or animal fat forms a sodium salt of fatty acid and glycerol. This process is known as saponification.

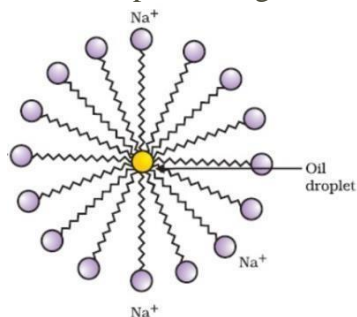


Cleansing action of soaps:

A soap molecule is made up of two chemically distinct parts that interact with water in different ways. It has one polar end with a short head carboxylate group ($-\text{COONa}$) and one non-polar end with a long tail made of the hydrocarbon chain.

Hydrophilic and hydrophobic end: The polar end is **hydrophilic (water-loving)** in nature, and it is drawn to water. The non-polar end is **hydrophobic (hates water)** in nature, and it is attracted to dirt or oil on the cloth but not to water. As a result, the hydrophobic part of the soap molecule traps the dirt while the hydrophilic part makes the entire molecule water-soluble.

When soap or detergent is dissolved in water, the molecules form clusters known as '**micelles**'.



Formation of micelles

Their long hydrocarbon chains bind to the oil and dirt. As a result, the dirt is surrounded by the non-polar end of the soap molecules. The micelles are water-soluble because of the charged carboxylate end of the soap molecules. As a result, the soap washes away the dirt.

Detergents are generally sodium salts of sulphonic acids or ammonium salts with chlorides or bromides ions, etc. Both have long hydrocarbon chain. The charged ends of these compounds do not form insoluble precipitates with the calcium and magnesium ions in hard water. Thus, they remain effective in hard water. Detergents are usually used to make shampoos and products for cleaning clothes.

Multiple Choice Questions:

Q1. Ethane, with the molecular formula C_2H_6 has

- (a) 6 covalent bonds.
- (b) 7 covalent bonds.
- (c) 8 covalent bonds.
- (d) 9 covalent bonds.

Q2. Butanone is a four-carbon compound with the functional group

- (a) Carboxylic acid.
- (b) Aldehyde.
- (c) Ketone.
- (d) Alcohol.

Q3. While cooking, if the bottom of the vessel is getting blackened on the outside, it means that

- (a) The food is not cooked completely.
- (b) The fuel is not burning completely.
- (c) The fuel is wet.
- (d) The fuel is burning completely.

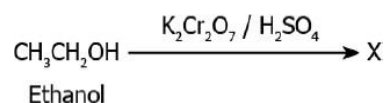
Q4. The chemical reaction shows the addition of chlorine to methane in the presence of sunlight.



What is likely to be the product of the reaction represented by "X"?

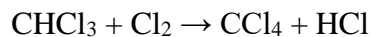
- (a) $\text{CH}_4 + \text{H}_2\text{SO}_4$
- (b) $\text{CH}_3\text{Cl} + \text{HCl}$
- (c) $\text{CHCl}_3 + \text{HCl}$
- (d) $\text{CH}_3\text{Cl} + \text{H}_2\text{SO}_4$

Q5. When ethanol is oxidized using potassium dichromate and Sulphuric acid. Which option represents the product "X"?



- (a) CH_2O
- (b) CH_3CH
- (c) $\text{CH}_3\text{H}_2\text{O}$
- (d) CH_3COOH

Q6. The chemical reaction shows the addition of chlorine gas to hydrocarbon in the presence of sunlight.



How does chlorine react to a hydrocarbon compound in the presence of sunlight?

- (a) It adds hydrogen into the compound
- (b) It adds an oxygen atom into the compound
- (c) It substitutes hydrogen atom from the compound
- (d) It breaks double and triple bonds into a single bond

Q7. A student studies that vinegar, which is a diluted form of ethanoic acid, freezes during winter. What does this suggest about the physical properties of pure ethanoic acid?

- (a) It has a low boiling point
- (b) It has a low melting point
- (c) It has a very high boiling point
- (d) It has a very high melting point

Q8. Which of the following is the molecular formula of Cyclobutane?

- a) C_4H_{10}
- b) C_4H_6
- c) C_4H_8
- d) C_4H_4

Q9. A student studies that a soap molecule has two ends, one of which is an ionic end and the other is the carbonic chain. Which option explains the interaction of a soap molecule with oil?

- (a) Ionic end of the soap interacts with the oil
- (b) The closest end of the soap interacts with the oil
- (c) Carbonic chain end of the soap interacts with the oil
- (d) Ends of the soap randomly interact with the oil

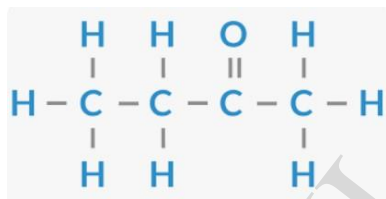
Q10. Methane, ethane and propane are said to form a homologous series because all are-

- (a) Hydrocarbons
- (b) Saturated compounds
- (c) Aliphatic compounds
- (d) Differ from each other by a CH_2 group

Q11. Following is (are) the property (ies) of ionic compounds.

- (a) They have high melting and boiling points
- (b) They conduct electricity in solution or in molten state
- (c) Both (a) and (b)
- (d) None of the above

Q12. The following image represents a carbon compound.



Which functional group is present in the compound?

- (a) Alcohol
- (b) Aldehyde
- (c) Carboxylic acid
- (d) Ketone

Q13. The following represents the formulae of a few hydrocarbon compounds.

- (a) C_2H_2 (b) C_2H_4 (c) C_2H_6 (d) C_3H_4

Which of these compounds can be classified as alkynes?

- (a) Only (a)
- (b) Only (b)

(c) Both (a) and (d)

(d) Both (b) and (c)

Q14. Which of the following is the molecular formula of cyclobutane?

(a) C₄H₁₀

(b) C₄H₆

(c) C₄H₈

(d) C₄H₄

Q15. The number of isomers of pentane is

(a) 2 (b) 3 (c) 4 (d) 5

ANSWERS

Q1. (b)	Q2. (c)	Q3. (b)	Q4. (b)	Q5. (d)
Q6. (c)	Q7. (b)	Q8. (c)	Q9. (c)	Q10. (d)
Q11. (c)	Q12. (d)	Q13. (c)	Q14 (c)	Q15 (b)

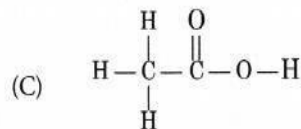
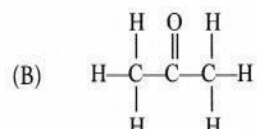
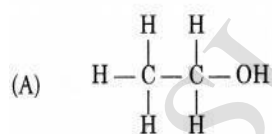
Assignments:

Q1. Give the names of the following functional groups:

(i) —OH (ii) —CHO (iii) —COOH

Answer. (i) Alcohol group (ii) Aldehydic group (iii) Carboxylic acid group

Q2. Write the IUPAC names of the following compounds.



Answer: (A) Ethanol

(B) Propanone

(C) Ethanoic acid.

Q3. Vapours of a hydrocarbon were passed through bromine dissolved in carbon tetrachloride. The yellow colour of bromine got discharged? Predict the nature of the hydrocarbon.

Answer: The hydrocarbon is unsaturated. It is either an alkene or alkyne.

Q4. What is the role of soap in cleansing of clothes?

Answer: Soap helps in forming a stable emulsion between oil drops carrying dirt particles and water. The emulsion is also known as micelle.

Q5. Which organic compound is added to make ethanol unfit for drinking purposes? What is the name of the mixture formed?

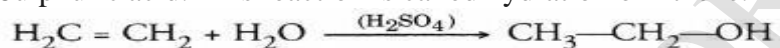
Answer: Methanol which is highly poisonous is added in small amount to ethanol in order to make it unfit for drinking purposes. The mixture is called methylated spirit or denatured alcohol.

Q6. Which element exhibits the property of catenation to maximum and why?

Answer: The element is carbon. This is because of very small size of carbon atom (77 pm) and high strength of C—C bond (355 kJ mol⁻¹).

Q7. How will you convert Ethene into Ethanol? Give the chemical reaction involved.

Answer: Ethene is converted into ethanol by passing its vapours through water in the presence of Sulphuric acid. This reaction is called hydration of Ethene.

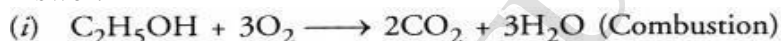


Q08. Explain with the help of chemical equations, the following properties of carbon.

(i) Combustion

(ii) Oxidation.

Answer:



Q9. Give a chemical test to distinguish between:

(i) Ethane and Ethene

(ii) Ethanol and ethanoic acid

(iii) Soaps and detergents.

Answer: (i) Ethene decolorizes the yellow colour of bromine water while ethane does not.

(ii) Ethanoic acid gives a brisk effervescence with sodium hydrogen carbonate while ethanol does not.

(iii) Soaps form curdy white precipitate or scum with hard water while detergents do not form any precipitate.

Q10. Give reasons for the following observations:

(a) The element carbon forms a very large number of compounds.

(b) Air holes of a gas burner have to be adjusted when the heated vessels get blackened by the flame.

(c) Use of synthetic detergents causes pollution of water.

Answer.

(a) Carbon forms large number of compounds since carbon is small in size and can form stable covalent bonds (Catenation) and it shows Tetravalency.

- (b) Air holes of gas burner are made open (adjusted) so that air can pass through, which is needed for complete combustion, so that heated vessels do not get blackened.
- (c) Some synthetic detergents are non-biodegradable, therefore, cause pollution of water.

Q11. What is a homologous series? Which two of the following organic compounds belong to the same homologous?

CH_3 , C_2H_6 , $\text{C}_2\text{H}_6\text{O}$, $\text{C}_2\text{H}_6\text{O}_2$, CH_4O

Answer. Homologous series is a series of organic compounds which has same functional group and similar chemical properties. Each member of this series differs by $-\text{CH}_2-$ in its molecular formula and 14u in its molecular mass.

CH_4O (CH_3OH) and $\text{C}_2\text{H}_6\text{O}$ ($\text{C}_2\text{H}_5\text{OH}$) belong to same homologous series.

Q12. (i) An unknown compound has the smell of vinegar. Identify it.

(ii) What do we get when ethanoic acid reacts with ethanol in the presence of concentrated Sulphuric acid?

(iii) Give a test to identify the presence of ethanoic acid.

Answer: (i) The compound is ethanoic acid (CH_3COOH) also called acetic acid.

(ii) Ethyl ethanoate ($\text{CH}_3\text{COOC}_2\text{H}_5$) is formed by esterification reaction. It has fruity smell.

(iii) Dip a strip of blue litmus paper in the solution of ethanoic acid. Its colour will change to red.

LIFE PROCESSES

All the vital processes which are required by an organism to survive are called life processes.

Nutrition, photosynthesis, transportation, metabolism, respiration, reproduction, and excretion are important life processes.

IMPORTANT LIFE PROCESSES

NUTRITION

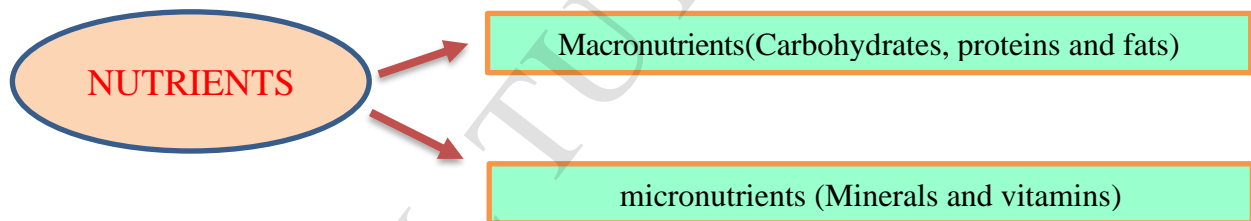
TRANSPORTATION

EXCRETION

NUTRITION

The process, by which an organism takes food and utilizes it, is called nutrition.

Nutrition is essential for the growth and development of organisms. It also provides energy to do different work.



HOW DO LIVING THINGS GET THEIR FOOD?

Autotrophic Nutrition

Perform photosynthesis.

Heterotrophic Nutrition

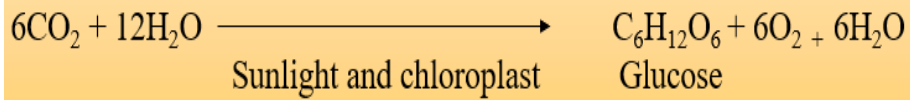
Can not perform photosynthesis.

AUTOTROPHIC NUTRITION

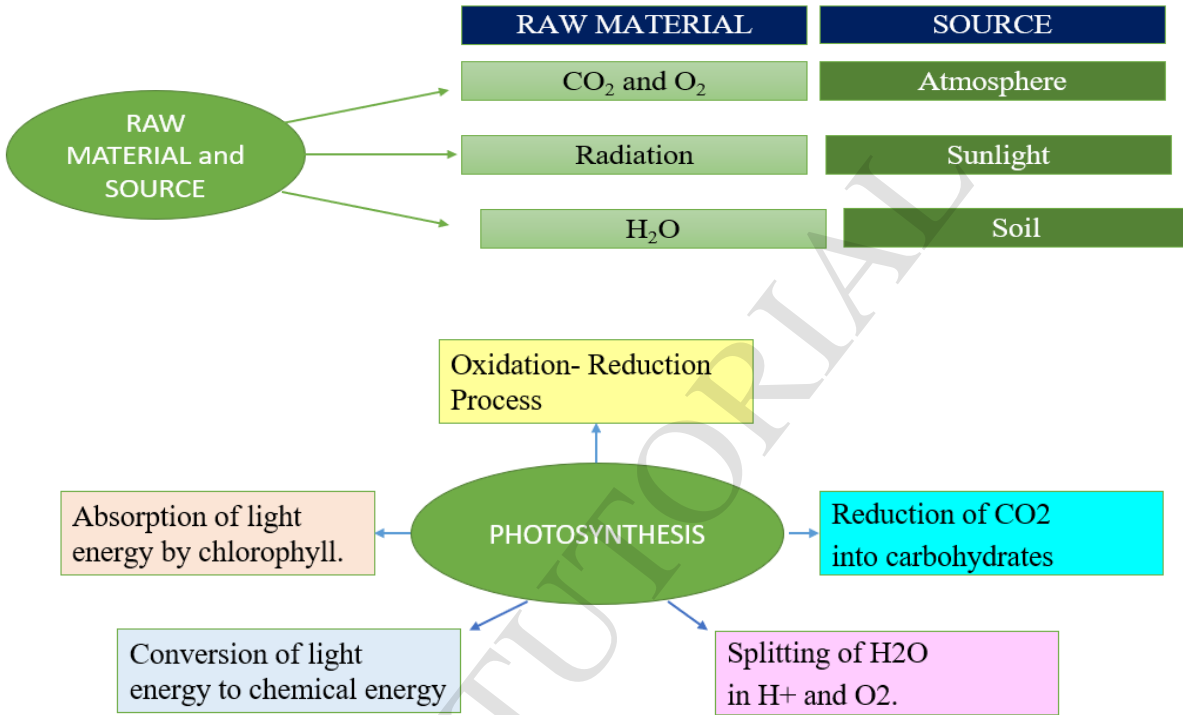
The mode of nutrition in which an organism prepares its own food is called autotrophic nutrition. Green plants and blue-green algae make their food by a process called photosynthesis.

PHOTOSYNTHESIS

- The process by which plants in the presence of pigment, sunlight, water, and carbon dioxide form food and release oxygen is known as photosynthesis.
- The overall reaction occurring in photosynthesis is as follows:

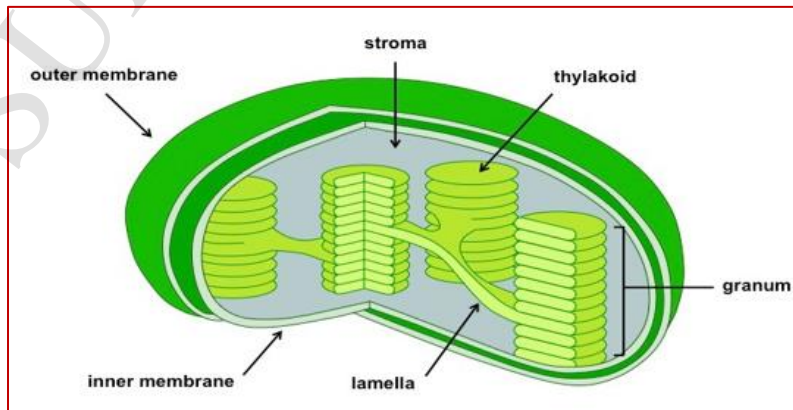


PHOTOSYNTHESIS – Raw Material and Events



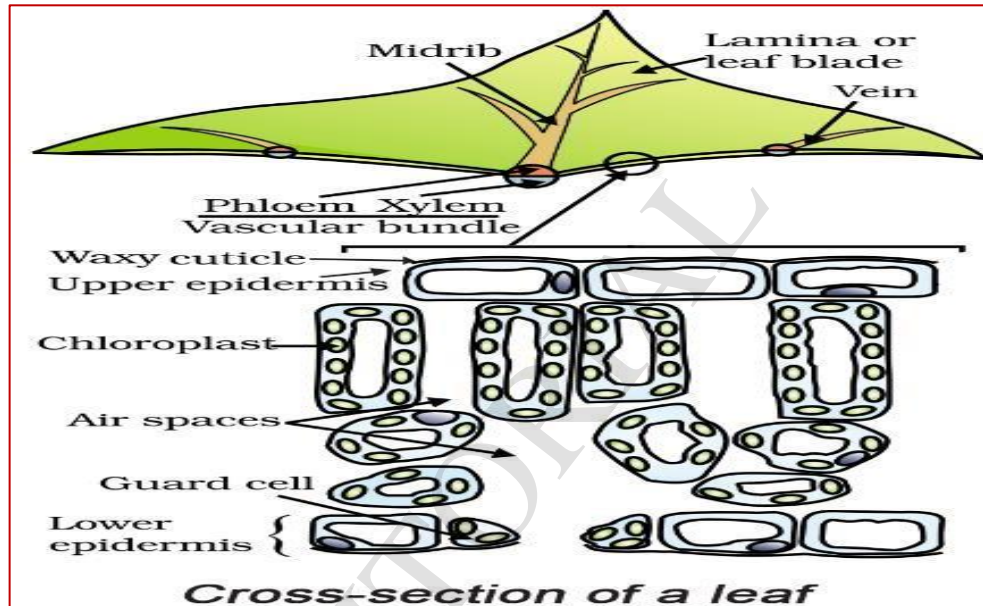
Chloroplast

It contains the main photosynthetic pigment chlorophyll and accessory pigments xanthophyll and carotenoids.



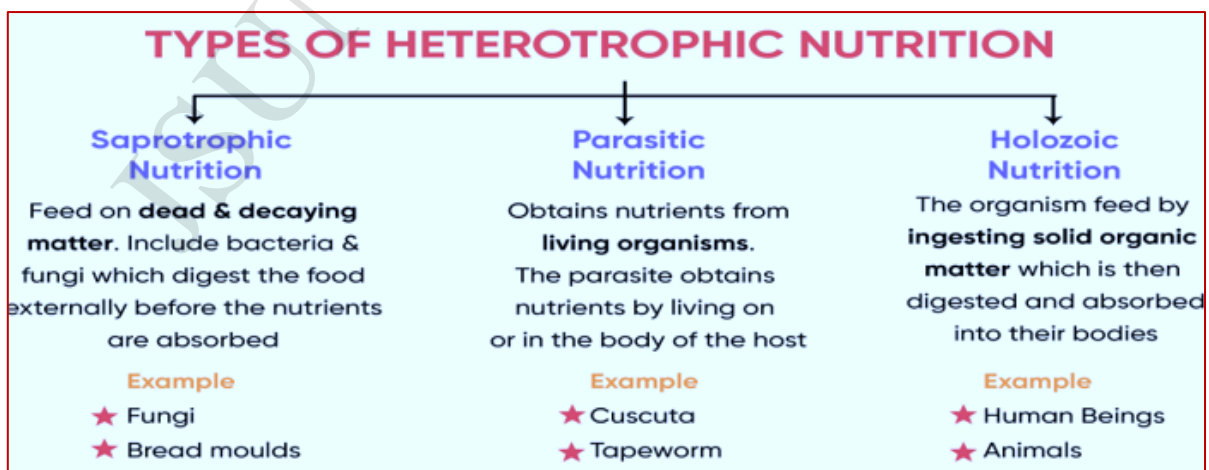
Stomata

Gaseous exchange and transpiration (loss of water as water vapors) take place through minute aperture on the surface of leaves called stomata. Stomata has a pore (stomata pore) guarded by bean shape guard cells (regulate the opening and closing of stomata).

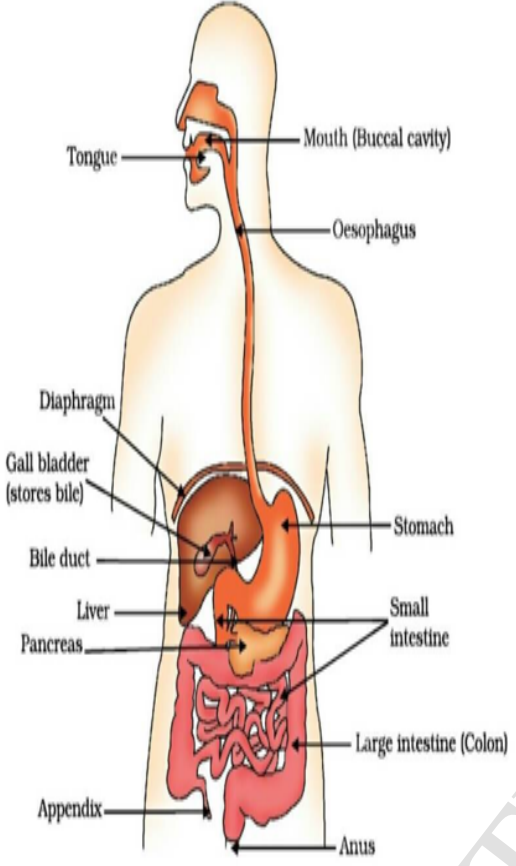


HETEROTROPHIC NUTRITION

In this type of nutrition, organisms obtain their nutrient from other living organisms (parasites) e.g. Animals or dead and decaying objects (saprophytes e.g. Fungi like bread molds, yeast and mushrooms).



HUMAN DIGESTIVE SYSTEM



Food is crushed and mixed with saliva with the help of teeth and tongue.

Saliva contains salivary amylase that breaks down starch.

By peristaltic movement in the oesophagus the food enters the stomach.

In the stomach food is mixed with HCL, Protein digesting enzyme pepsin, and Mucus.

HCL kills the germs in food as well as provides an acidic medium essential for pepsin.

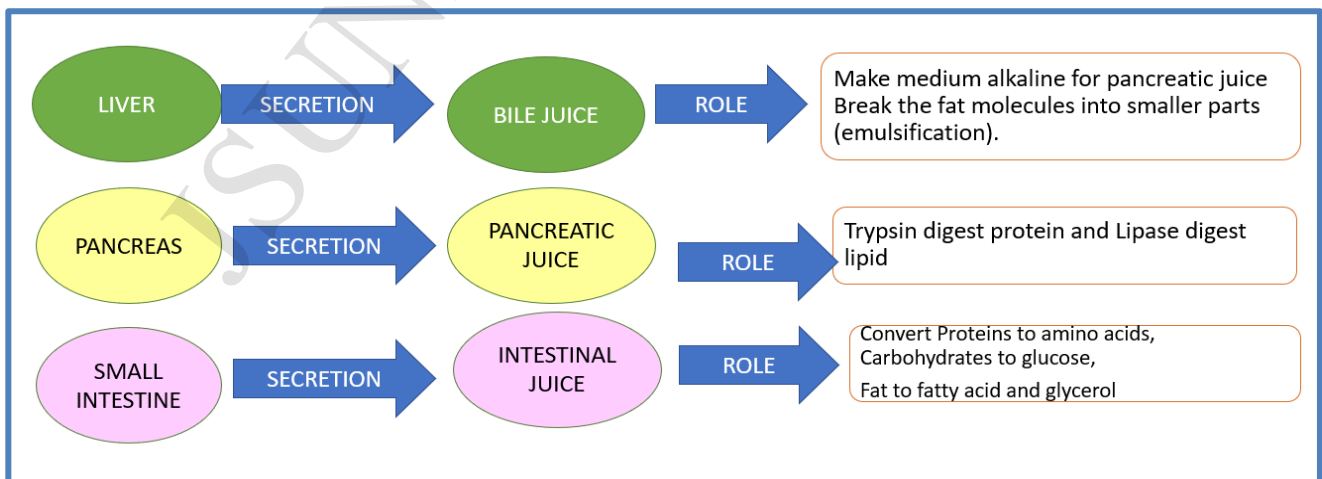
Mucus protects the inner lining of the alimentary canal by HCL.

Small intestine receives secretions from the liver and pancreas through a common duct.

Unabsorbed food enters the large intestine for further absorption of water.

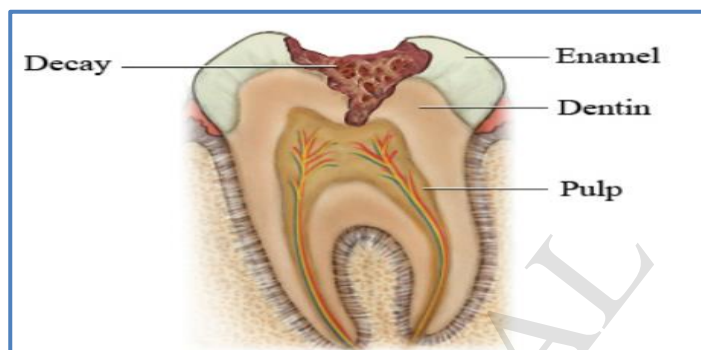
Undigested food is removed from the body via anus.

DIGESTIVE SYSTEM ORGANS AND THEIR ROLES-



DENTAL CARIES (TOOTH DECAY)

It is caused due to acid produced by bacteria. In this enamel softens and may cause dental plaque and cavities.



RESPIRATION

Keywords

Cytoplasm	Fluid part within the cell
Mitochondria	Site of energy production (the powerhouse of the cell)
Pyruvate	The intermediate product of respiration
Ethanol	A type of alcohol (C₂H₅OH)
ATP	Adenosine triphosphate, an energy-rich compound

The process of Breaking complex organic material into a simpler form with the help of enzymes is called respiration.

Types of respiration and site

Type	Definition	Site
Aerobic respiration	It occurs in the presence of oxygen	Cytoplasm and Mitochondria
Anaerobic respiration	It occurs in the absence of oxygen.	Cytoplasm
Fermentation	It is a type of anaerobic respiration occurs in a few microorganisms	Cytoplasm

PROCESS OF RESPIRATION

- Glucose is broken down into pyruvate in the cytoplasm of a the cell.
- In the presence of oxygen, pyruvate enters into mitochondria and completely oxidized there to produce C₂ and energy (ATP).
- In the absence of oxygen pyruvate partially decompose and form. Eg- Ethanol in yeast (fermentation), b- Lactic acid in muscle cells

HUMAN RESPIRATORY SYSTEM

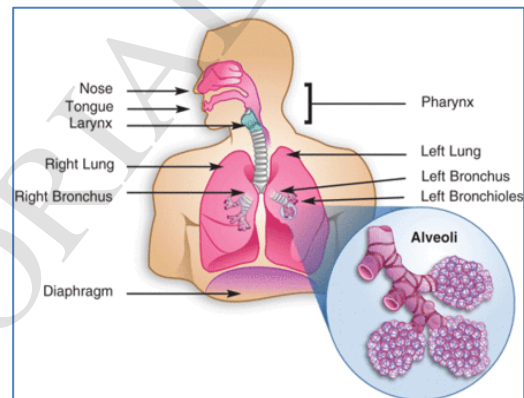
(consists of the nostril, nasal passage, pharynx, larynx, trachea, bronchi, bronchioles, alveoli, diaphragm, and ribcage.)

The inhale of oxygen and exhale of CO₂ is known as breathing. Air is taken into body through nostrils

From nostril air passes through the pharynx, larynx, trachea, bronchi, bronchioles and finally alveoli.

At alveoli exchange of oxygen and CO₂ takes place with blood vessels by process of diffusion.

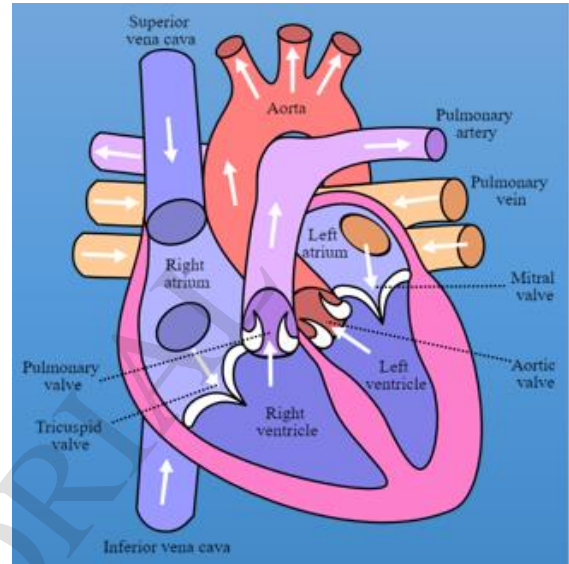
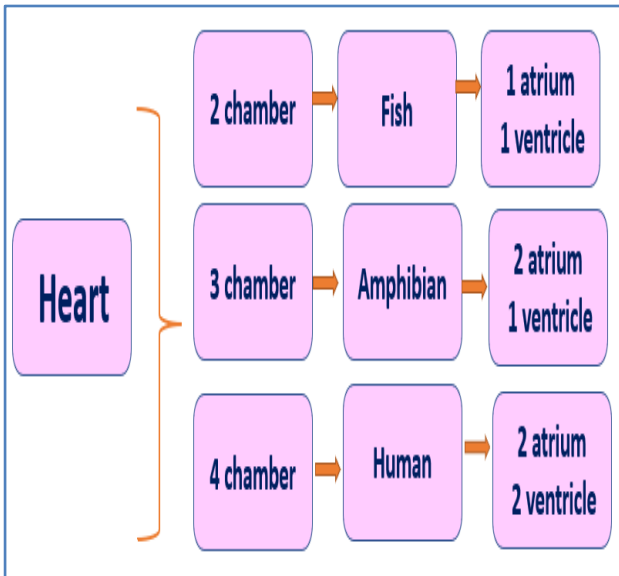
Oxygen enters into blood vessels while CO₂ enters into the alveolar sac. Both oxygen and CO₂ is carried by iron-containing hemoglobin.



TRANSPORTATION IN HUMAN BEINGS

Blood	Connective tissue consists of RBC, WBC, Platelets and plasma.
Plasma	The fluid portion of the blood
Systole	Contraction of heart chambers
Diastole	Relaxation of heart chambers
Double circulation	Blood goes through the heart twice
Arteries	Thick-walled. elastic, Carry blood away from heart to various organs
Veins	Thin-walled, carry blood from different organs to the heart
Platelets	Helps in blood clotting during an injury
Lymph / Tissue fluid	Fluid in intercellular space in the tissues. They carry digested and
Sphygmomanometer	Measure blood pressure

HEART



Human Heart

2 atrium and 2 ventricle

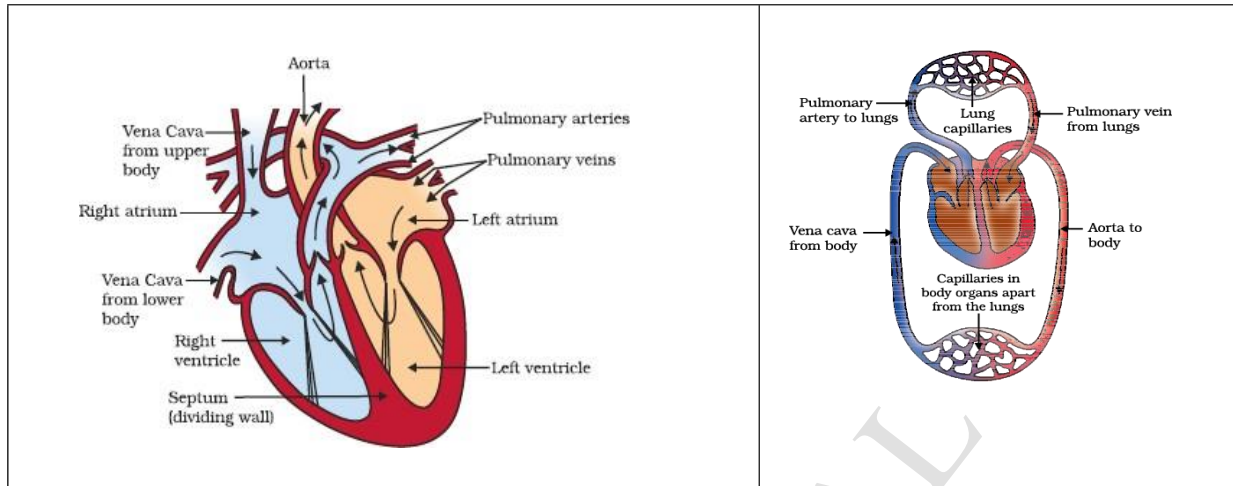
The atrium and ventricles are separated to avoid mixing of oxygenated and deoxygenated blood

The right atrium and right ventricle contain deoxygenated blood while the left atrium and left ventricle contain oxygenated blood.

Oxygenated blood from the lungs enters in left atrium via pulmonary veins. When the left atrium contracts (systole) blood enters to left ventricle. The blood goes outside to different parts of body via the aorta when the left ventricle contracts.

From different parts of the body deoxygenated blood is carried out by the superior and inferior vena cava to the right atrium.

When right atrium contracts the blood enters into right ventricle. The deoxygenated blood goes to the lungs through pulmonary arteries when right ventricle contracts.

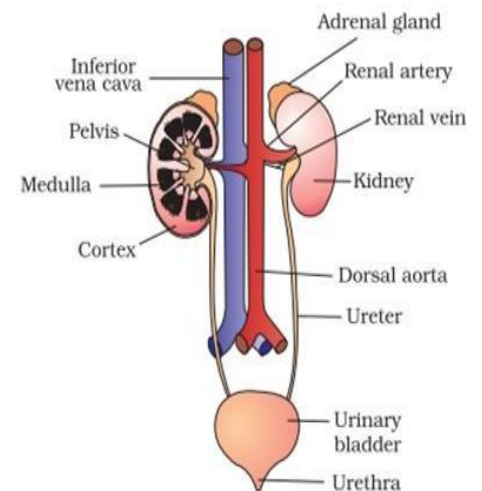


TRANSPORTATION IN PLANTS

Stomata	Gaseous exchange, Transportation (loss of water in form of vapor)
Xylem	Water conduction channels composed of xylem tissue, vessels and tracheid
	Transport water and mineral from root to aerial part (unidirectional)
Phloem	Transport food from the leaves to other part (multidirectional).

EXCRETION

Excretion	Removal of harmful metabolic wastes from the body
Kidney	Excretory organ of human
Nephron	Structural and functional unit of kidney
Urinary bladder	Store urine
Ureter	Connect urinary bladder with kidney
Hemodialysis	Artificial kidney, a device to remove nitrogenous waste products (urea, uric acid) from the blood.



EXCRETION IN HUMAN BEINGS

- Basic filtration units in kidneys are clusters of thin-walled capillaries. These are associated with cup-like structure which collects the filtered urine.

- There is reabsorption of glucose, amino acids, salts, and water in tubules of nephrons.
- The concentrated urine enters into urinary bladder via the ureter and finally passes outside the body through the urethra.

EXCRETION IN PLANTS

- Stomata play an important role as is the site for gaseous exchange and transpiration.
- Some waste products are released in form of resin, gums.
- Falling of leaves also helps in the removal of waste products.

IMPORTANT QUESTIONS

VERY SHORT ANSWER QUESTIONS

1- What is the normal systolic and diastolic pressure in humans-

- a- 120 mm Hg / 80 mm Hg
- b- 80 mm Hg/ 120 mm Hg
- c- 120 mm Hg/ 120 mm Hg
- d- 80 mm Hg/80 mm Hg

Ans: a

2- By which apparatus we can measure blood pressure-

- a- Barometer
- b- Hygrometer
- c- Ammeter
- d- Sphygmomanometer

Ans: d

3- Which conducting tissue is responsible for multidirectional transport in plants-

- a- Xylem
- b- Phloem
- c- Guard Cell
- d- Parenchyma

Ans; b

4- Cuscuta is a special organism as it is-

- a- Animal parasite
- b- Plant parasite
- c- Fungal parasite
- d- Blue green algae and saprophyte

Ans: b

5- Nature of nutrition in fungi are-

- a- Parasite
- b- Autotrophs
- c- Saprotrophs

d- Mixed autotrophs

ans: c

6- Which acid is formed in our muscles after vigorous exercise? Ans: Lactic acid

7- How much energy is released when terminal phosphate linkage in ATP is broken down?

Ans: 30.5 KJ/mol.

SHORT ANSWER TYPE QUESTIONS

8- What is holozoic nutrition? Give one example.

Ans: The nutrition that involves the taking in of solid or liquid particles of food which have to be further broken down into simpler particles inside the organism. Example- Amoeba

9- What is the importance of nutrients?

Ans: i. Energy production

ii- growth and repair

iii- Protection from disease

10- Why do photosynthesis consider a photochemical reaction?

Ans: plants convert the energy of sunlight into stored chemical energy by forming carbohydrates from atmospheric carbon dioxide and water and releasing molecular oxygen as a byproduct.

11- What is the role of the following in photosynthesis- i-Chloroplast ii- Water iii- CO₂

Ans: Chloroplast trap the sunlight (radiation) Water undergoes photolysis to evolve oxygen CO₂ reduces to form carbohydrates.

12- Write the similarity between the heart and phloem.

Ans: Both are conduction tissues. The heart is responsible for the conduction of blood while the phloem for food in plants.

13- Mention the importance of Double circulation and Voles in the human heart.

Ans: Double circulation importance: helps keep oxygenated (blood rich in oxygen) separate from deoxygenated (blood rich in carbon dioxide). This results in a more efficient circulation of blood.

14- Specify the role of the conducting tissues in plants.

Ans: phloem is food-conducting tissue and xylem is water-conducting tissue.

Phloem transports food in many directions from leaves to other parts of plants like another leaf, flower, stem, root, and storage part.

Xylem conducts water only in one direction from the root to the aerial parts of the plant.

15-What is saliva? State its role in the digestion of food.

Ans: Saliva contains salivary amylase enzymes that help digest the starches in our food.

An enzyme called amylase breaks down starches (complex carbohydrates) into sugars, which your body can more easily absorb.

It helps in moistens the food for easy swallowing.

16- (a) What is the peristaltic movement?

(b) 'Stomata remain closed in desert plants during daytime'. How do they do photosynthesis?

Ans: (a) The relaxation of gut muscles to move the partially digested food downwards throughout the alimentary canal is called peristaltic movement.

(b) In desert plants, stomata open at night and take in carbon dioxide (CO₂). Stomata remain closed during the daytime to prevent the loss of water by transpiration. They store the CO₂ in their cells until

the sun comes out so that they can carry on with photosynthesis during the daytime.

LONG ANSWER TYPE QUESTIONS

17- Differentiate the followings-

- I. Vena cava and Aorta II- Pulmonary artery and Pulmonary vein III- Anaerobic respiration and fermentation IV- Bronchi and bronchiole

Ans:

- Vena cava: carries deoxygenated blood from body parts to the heart
Aorta: carries oxygenated blood from the heart to the body parts
- Pulmonary artery: carries deoxygenated blood from the heart to the lungs
Pulmonary vein: carries oxygenated blood from the lungs to the heart
- Anaerobic respiration: respiration without oxygen
Fermentation: respiration without oxygen in microorganisms
- Bronchi: extends from the trachea, have incomplete cartilage ring
Bronchioles: extended from bronchi

18-Draw a cross-section of the leaf and label the stomata. Also mention any two roles of stomata in plants.

Ans: Fig 6.1, page 96, NCERT

19-Draw a labeled diagram of the structural and functional unit of the kidney. Also, mention its role.

Ans: Fig: 6.14, page 111, NCERT

Filtration of blood, reabsorption, secretion and excretion of useful and harmful substances present in the blood.

20-Give reasons:

- Ventricles have thicker muscular walls than atria.**
- The transport system in plants is slow.**
- Blood circulation differs in aquatic vertebrates from that in terrestrial vertebrates.**
- During the daytime, water and minerals travel faster through the xylem as compared to the night.**
- Veins have valves whereas arteries do not.**

Ans:

- Ventricles pump blood into various organs with high pressure so they have thicker walls.
- Plants are non-motile, less active, and require less energy so their cells do not need to be supplied with materials so quickly.

(iii) The aquatic vertebrates like fish have gills to oxygenate blood. Fishes have single circulation. Terrestrial vertebrates like birds and humans have four-chambered hearts and show double circulation.

(iv) it is due to a high transpiration rate in day time.

(v) The lumen of veins has valves, which allow the blood in them to flow in only one direction. Thus preventing the backflow of blood.

21- Describe the double circulation of blood in human beings. Why is it necessary?

Ans: In the human heart, blood passes through the heart twice in one cardiac cycle. This type of circulation is called double circulation. Double circulation ensures complete segregation of oxygenated and deoxygenated blood.

It includes - Pulmonary circulation and Systemic circulation.

In Pulmonary circulation: The right ventricle pumps deoxygenated blood into the lungs where it is oxygenated. The oxygenated blood is brought back to the left atrium, and from there it is pumped into the left ventricle and finally, blood goes into the aorta for systemic circulation.

In Systemic circulation: The oxygenated blood is pumped to various parts of the body from the left ventricle. The deoxygenated blood from different parts of the body passes through the vena cava to reach the right atrium. The right atrium transfers the blood into the right ventricle.

22-Mention the location of four major glands associated with the digestive system of humans and explain the function of each.

Ans:

i- Salivary Glands- There are three pairs of salivary glands (Parotid, submaxillary and sublingual) that secrete saliva. Saliva moistens the food, disinfects food by lysozyme and digests starch by salivary amylase.

ii-Gastric Glands- these are present inside the stomach. Gastric glands secrete HCl- disinfect food, provide an acidic medium for digestive juices.

Pepsin - for partial digestion of proteins to form peptones and proteases

iii-Liver- secretes bile, which neutralizes the acidity of chyme and emulsifies fat.

iv-Pancreas- Lies in the loop of the duodenum below the stomach.

It secretes trypsin (digest protein), lipase (break down of fat)

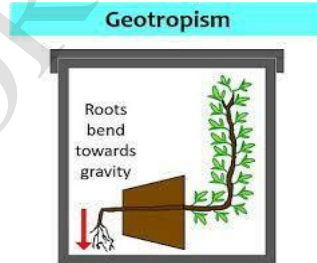
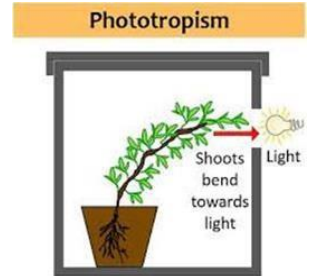
TROPIC MOVEMENTS IN PLANTS

Tropic movement is the movement of the plant in response to stimulus present in the surroundings. Tropic movements can be either toward the stimulus or away from it. The important tropic movements are listed below-

PHOTOTROPISM	Movement is response to light. Ex- shoot bending toward the light, root bending away from light, movement of sunflower
CHEMOTROPISM	Movement in response to certain chemicals Ex- Growth of pollen tubes toward ovary
GEOTROPISM	The movement of plants in response to the gravity. Ex- Roots of plant grow downwards, shoots usually grow upward
HYDROTROPISM	Movement in response to water. Ex- Roots of plant grow towards water
THIGMOTROPISM	The reflex movement in response to touch. Ex- touch sensitive Mimosa pudica leaves.



Fig 11.4: hydrotropism



INTRODUCTION OF PLANT HORMONES

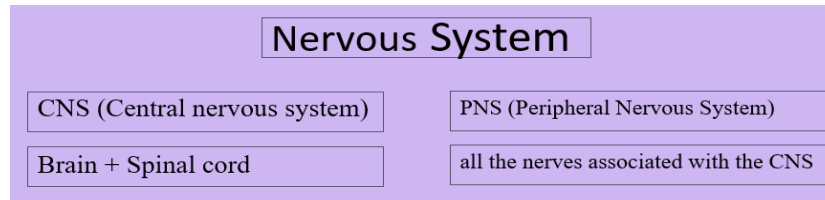
Growth and differentiation in plants depend on a few hormones called as plant growth regulators/ plant growth hormones/ Phytohormones. These are organic substances that are synthesized in minute quantities in one part of the plant body and transported to another part where they show specific physiological processes.

Phytohormones	Growth promoter/ growth inhibitor	Explanation
Auxin	Growth promoter	Stem elongation
Gibberellins		Growth of stem
Cytokinin		Cell division
Ethylene	Growth inhibitor	Wilting of leaves
Abscisic acid		Fruit ripening

CONTROL AND CO-ORDINATION IN ANIMALS

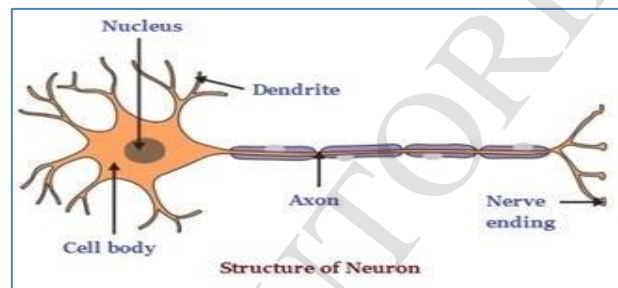
In animals control and coordination is carried out with the help of -

- Nervous system
- Muscular tissue
- Endocrine system: Hormones
- Nervous system



NEURONS

Neurons are composed of cell body, dendrite, axon and nerve ending.

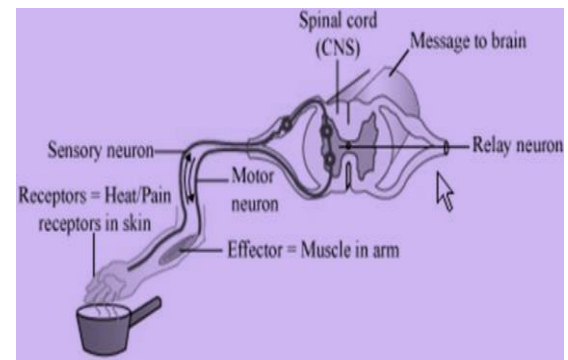


HOW NERVOUS IMPULSE TRAVELS IN BODY

- Dendritic tips receive stimulus and an electrical impulse is generated in neurons.
- This impulse travels from the dendrite to the cell body and then along the axon to its end.
- At the axon ending some chemicals are released that cross the synapse and start a similarelectrical impulse in next neuron.

REFLEX ACTION

- Reflex action is a sudden and involuntary response to any stimuli.
- It originates in the spinal cord.
- Ex- Drawing hand away from the hot plate, watering of mouth in response to food etc.
- The neural pathway that controls thereflex action is called as a reflex arch



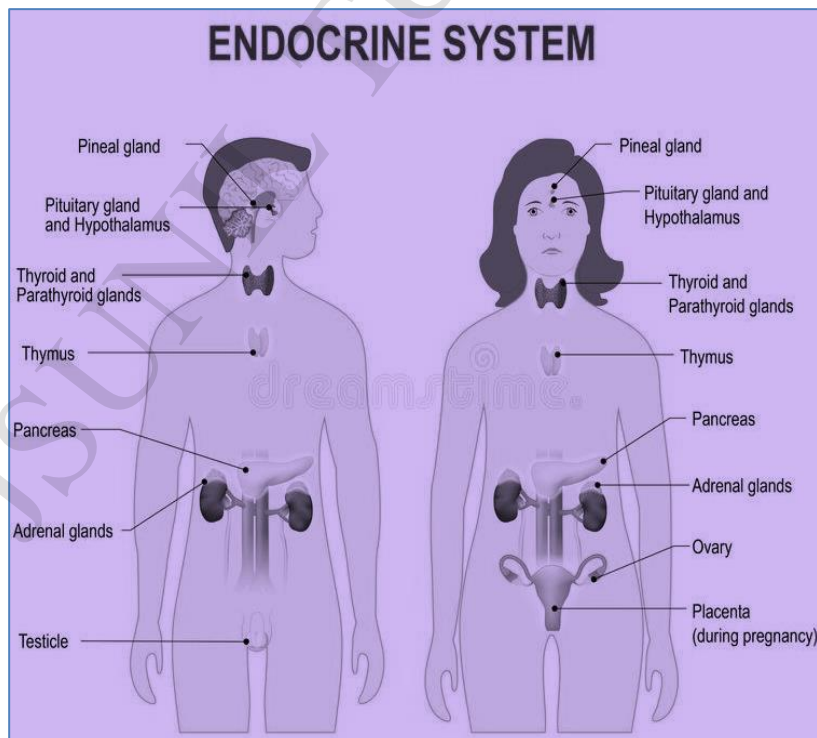
- In these sensory neurons, spinalcord, relay neuron, motor neuron and effector muscles are involved.

- Stimulus is received by sensory neurons. The sensory neurons transfer sensory impulses to the spinal cord (CNS). Spinal cord process the stimulus. The motor nerve fiber relays the motor impulses from the nervous system to the effector organs like muscles.

HORMONES IN ANIMALS-

Hormones are chemical messengers which are secreted by the ductless endocrine gland into the blood. Hormones control the activity of certain cells and organs. Hormones can be peptides and steroid hormones. Some of the main endocrine glands are the pituitary gland, adrenal gland, thyroid gland, pancreas, testes, ovary etc.

Endocrine gland	Hormone	Role
PITUITARY GLAND	Growth hormone	Regulate growth and development
ADRENAL GLAND	Adrenaline	Stress hormones (enable the body ready to deal with the stressed condition), Increase heartbeat, Increase breathing rate
THYROID GLAND	Thyroxine	Regulate carbohydrate, protein and fat metabolism
PANCREAS	Insulin	Regulate blood sugar level
TESTES	Testosterone	Changes associated with puberty in male
OVARY	Oestrogen	Changes associated with puberty in female



- **GOITER-** Iodine is necessary for the formation of thyroxin hormone. If Iodine is in low concentration the thyroid gland swells and causes goiter.

- **GIGANTISM and DWARFISM**- Excess secretion of growth hormone from the pituitary gland causes excess growth of the body (gigantism) and less secretion results in dwarfism.

IMPORTANT QUESTIONS

Very Short Answer Type Questions-

1- Find out the plant growth inhibitor phytohormone

- a- Auxin b- 2,4 D c- Cytokinin d- Abscisic acid

Ans: d

2- A deficiency of Iodine may result in the-

- a- Goiter
b- Scurvey
c- Beri Beri
d- All of these

3- Testosterone comes under which of the following-

- a- Estrogen
b- Progesterone
c- Androgen
d- Both a and c

Ans: c

4- Pancreas is responsible for the secretion of

- a- Pancreatic juice
b- Pancreatic amylase
c- Insulin
d- All of these

Ans: d

5- Apical dominance and bolting in plants are due to-

- a- Auxin and gibberellin
b- Auxin and cytokinin
c- Auxin and ethylene
d- Auxin and ABA

Ans: a

6- Name the hormone which helps in the regulation of glucose in the blood.

Ans: Insulin

7- Name two tissues that provide control and coordination in multicellular animals.

Ans: Nervous tissue and Endocrine tissue

Short Answer Type Questions-

8- Describe how the cells on the dark side of the shoot grow longer as the concentration of Auxin increases.

Ans: Auxin is a hormone that is found in plants and plays a key role in the growth and development of shoots and roots. Specifically, auxin helps regulate cell elongation, which is the process of cells growing longer as they move away from a source of light. Auxin increases the concentration of molecules in cells on the side of the shoot that is away from the light, which causes the cells to elongate. The increased concentration of auxin molecules signals the cells to grow longer, resulting in the shoot bending toward the light. This process is known as phototropism and is essential for plants to grow in the direction of light. Without auxin, plants would not be able to orient themselves properly and would not be able to survive.

9- Describe the structure of neurons.

Ans: A neuron is the basic unit of the nervous system. At the core of a neuron is the cell body, which houses the nucleus, the control center of the cell. Extending from the cell body are long, thread-like projections called dendrites, which receive signals from other neurons. The axon is a long, thin projection that transmits signals away from the cell body to other neurons or to effector organs. At the end of the axon are the synaptic terminals, which form connections with other neurons.

10- When our body receives a sudden stimulus, our body shows a strong reaction. Explain the process.

Reflex action is a type of involuntary, rapid and automatic response to stimuli. It is a basic physiological process that all animals possess and is characterized by its speed and lack of conscious thought. The reflex action mechanism involves the coordination of the sensory and motor systems and is based on the concept of stimulus and response. When the body receives strong and sudden stimuli like pressure, temperature or chemicals, then the sensory neuron sends a message to the spinal cord. The relay neuron sends the signal to the motor neuron and the latter sends a signal to the effectormuscle to respond.

11- Compare chemotropism and Hydrotropism.

Ans: chemotropism: Movement due to chemicals. E.g.- pollen tube growth on stigma and style. Hydrotropism: Movement due to water. E.g. growth of root toward water

Long Answer Type Questions

12- What are endocrine glands? Locate any four endocrine glands of humans by drawing suitable diagram.

Ans: endocrine glands are ductless glands that secrete hormones to control and coordinate bodyfunction.

Fig 7.7, page124, NCERT

13- (a) A person is advised by a doctor to take less sugar in his diet. Name the disease from which the man is suffering. For the disease which hormone is responsible?

Name the endocrine gland which secretes growth hormone.

Which glands secretes growth hormone? What will be the consequences of Deficiency and Excess secretion of growth hormone?

ANS: (a)Disease- Diabetes mellitus, Hormone – Insulin, Gland- Pancreas

Gland- Pancreas

Gland- Pituitary Gland, Excess secretion: Gigantism, Deficiency: Dwarfism

14- How does chemical coordination occur in plants?

Ans: In plants, chemical coordination occurs with the help of plant hormones/ Plant growthregulators. (Phytohormones). Examples- Auxin, Cytokinin, Gibberellin, Absciscic acid, and ethylene. These hormones help to coordinate growth, development, and responses to the environment.Plant hormones are synthesized at different and diffuse to the area where they act.

Auxin promotes cell growth, Gibberellins promote stem elongation, Cytokinin promotes cell division, and Absciscic acid inhibits growth.

15- What events take place between the synapse of two neurons?

Ans. A synapse is a gap between two neurons. In between synapses, nerve impulses are conducted by a chemical process with the help of neurotransmitters (acetylcholine). within the axon, a nerve impulsetravel by an electric signal. When it reached to synapse, the neurotransmitters are released in the synaptic cleft. These neurotransmitters act as stimuli for the next neuron.

HOW DO ORGANISMS REPRODUCE

- Reproduction is the biological process by which living organisms produce new individuals (Offspring) similar to themselves.
- It ensures continuity species generation of generation.

Content:

Reproduction in animals and plants (asexual and sexual), Reproductive health - need and methods of family planning, Safe sex vs HIV/AIDS, Child bearing and women's health

TYPES OF REPRODUCTION

- 1- Asexual reproduction
- 2- Sexual reproduction

Asexual reproduction	Sexual reproduction
In this single parent is involved.	In this two parents are involved.
It does not involve fusion of gametes	Fusion of gamete is involved.
There is no meiosis	Meiosis occurs
No variation in offspring	variation occur

ASEXUAL REPRODUCTION AND VEGETATIVE REPRODUCTION

Fission

In this organism divide two or more equal part and each develops into identical new individuals. Ex. Amoeba

Regeneration

If an individual's body is cut into several pieces, each of its parts regrows into a new individual. Ex- Planaria

Budding

In this new organism develops on the bud (outgrowth on the parent body). The new organism remains attached to the parent body till it gets matures. Ex- Hydra, Yeast

Adventitious Bud

Small buds in the notches of the leaf. These have the ability to grow into new individuals. Ex – Bryophyllum

Spore formation

Spores are propagules produced in sporangia and germinate to produce new individuals. Rg. Rhizopus (bread mould)

SEXUAL REPRODUCTION

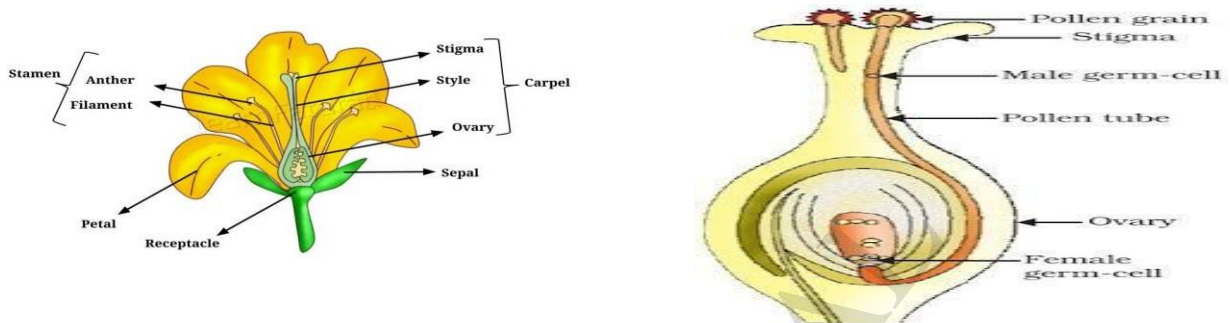
The sexual life cycle can be grouped into –

- i- Pre-reproductive phase- development to attain sexual maturity (puberty)
- ii- Reproductive phase- sexually mature, able to reproduce, able to produce fertile gametes
- iii- Post reproductive phase- after fertilization, development of embryo into new individual

SEXUAL REPRODUCTION IN FLOWERING PLANTS

- Reproductive part of plant is flower. Flower consists sepals, petals, stamens and carpels.
- Stamen and carpel contain anther and ovary respectively.
- Anther produces male gamete pollen and ovary contains female gamete egg.
- After pollination pollen fuses with egg to form zygote.

- Zygote develops in embryo and within ovule.
- Ovule develops into seed that contains future plant and ovary ripens in fruit.



REPRODUCTION IN HUMAN BEINGS

Male reproductive system –

- It consists of one pair of testes where sperm formation takes place.
- Testes also secrete hormones like testosterone.
- Testosterone brings about changes in appearance of boys at the time of puberty.
- Sperm is delivered through the vas deferens where secretions of the prostate gland and seminal vesicles add their secretions. These secretions help in transportation and provide nutrition to sperm.

Female reproductive system

- It consists of mainly a pair of ovaries and a uterus.
- On puberty the ovary starts producing eggs and releases one egg each month.

Fertilization

- Fertilization is a fusion of sperm and egg. It takes place in the fallopian tube. The fertilized egg is called a zygote which develops into an embryo.
- Uterus is for implantation purposes which hold the developing embryo in its layer through the placenta and umbilical cord.
- When egg is not fertilized the inner lining of uterus breaks and comes out through the vagina as blood and mucus (menses). This cycle repeats every month and is called menstrual cycle.

REPRODUCTIVE HEALTH

STDs (Sexually transmitted diseases)- Spread from infected person to healthy person due to unprotected sex. E.g.- HIV-AIDS, Gonorrhoea, Syphilis, and Warts.

Population control methods

- Mechanical barrier- Condom
- Hormonal methods- Pills
- Chemical method- Cut, Loops

- Surgical method- Vasectomy and Tubectomy

IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- Amoeba shows which type of asexual reproduction-

- a- Binary fission b- Spore formation c- Budding d- All of these

Ans: a

2- The nature of DNA molecule is-

- a- Positively charged b- Negatively charged c-Neutral d- Either a or b

Ans: b

3- Which of the following is not a pollinating agent-

- a- Human
b- Lion
c- Leopard
d- All are a pollinating agent

Ans: d

4- Sexually reproducing are different form asexually reproducing organisms in-

- a- Mitosis
b- Meiosis
c- Offsprings
d- All of these

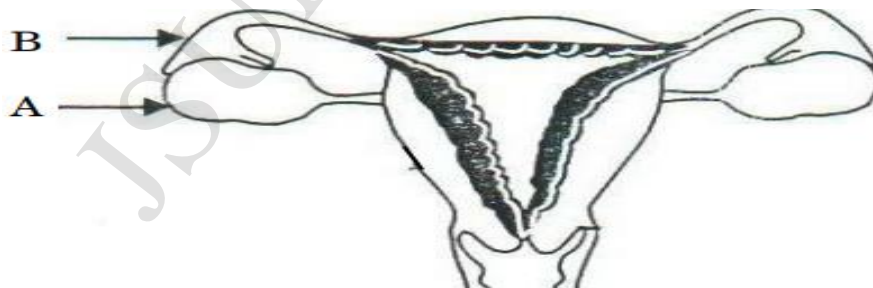
Ans: b

5- If a human male produces sperm and a human female produces an egg, what will be the product of anther-

- a- Ovule
b- Egg
c- Pollen
d- Ovary

Ans: c

6- Write the name and function of A and B



Ans: A- Ovary- by oogenesis produces eggs

B- Fallopian tube: site of fertilization

7- What are testes? List two functions performed by testes in human beings.

Ans: Testes are male gonad.

By process of spermatogenesis, the testes produce sperms.

It also helps in the production of male hormone androgens.

8- Mention modes of reproduction in Leishmania, Rhizopus, Planaria, Plasmodium and hydra.

Ans: Leishmania- Binary fission, Rhizopus- Spore, Planaria- Regeneration, Hydra- Budding

9- When a cell reproduces, what happens to its DNA?

Ans: When a cell reproduces, DNA replication occurs which forms two similar copies of DNA

10- What is pollination? Give an example of any two pollinating agents.

Ans: The transfer of pollen from the anther to the stigma of a flower is known as pollination. Examples of pollinating agents: Insects, Wind, Water

Short Answer Type Questions

11- What are sexually transmitted diseases? Give any three examples.

Ans: are infections transmitted from an infected person to an uninfected person through sexual contact. Example- HIV- AIDS, Syphilis, Genital wart

12- Differentiate asexual and sexual mode of reproduction. Which one shows variation and why?

Ans:

Asexual reproduction	Sexual reproduction
In this single parent is involved.	In this two parents are involved.
It does not involve fusion of gametes	Fusion of gamete is involved.
There is no meiosis	Meiosis occur
No variation in Offsprings	variation occur

- Genetic material from both the parents mixed by fertilization.
- Hence Offsprings get both the information and produce mixed characters which are not exactly the same as only mother or father.

13- Explain vegetative propagation with the help of two examples. List two advantages of vegetative propagation.

Ans: Vegetative reproduction is any form of asexual reproduction occurring in plants in which a new plant grows from vegetative propagules like-cutting, buds, eyes etc.

Importance

- Vegetative propagation takes less time
- No variation occur
- No requirement of fusion of gametes
- Can be done artificially in garden

14- Write the role of the followings-

I. Placenta II- Ovary III- Uterine wall IV-Egg

Ans:

- I. Placenta: provides oxygen and nutrients to a growing baby. It also removes waste products from the baby's blood.
- II. Ovary: produce egg by process of ovulation
- III. Uterine wall: implantation, formation of placenta and umbilical cord, helps in contraction

during child birth

IV. Egg fuses with sperm to form zygote

15- What could be the reasons for adopting contraceptive methods?

Ans: To prevent -

Unwanted pregnancy, STDs (sexually transmitted diseases)

Long Answer Type Questions

16- a-How do Plasmodium and Leishmania reproduce? Write one difference in their mode of reproduction.

b- Explain the formation of buds in hydra.

Ans: a- Plasmodium and Leishmania are both single-celled parasites that are able to reproduce asexually. Plasmodium reproduces through a process known as schizogony, in which a single cell is divided into multiple daughter cells. These daughter cells then undergo further division, creating more daughter cells, until a certain number of parasites is reached. Leishmania, on the other hand, reproduces through a process known as binary fission, in which a single cell divides into two daughter cells. The main difference between the two is that in schizogony, multiple daughter cells are produced per division, while in binary fission only two daughter cells are produced.

b- Hydra create buds by a process known as budding. During this process, the parent hydra will form an outgrowth, or bud, from the body wall of its column. This bud is an extension of the hydra's body, and contains some of the same genetic material as the parent. The bud will then grow into a new hydra, which can eventually become independent from the parent.

17- What are STDs? Give five examples of it. Write the methods to prevent the STDs.

Ans: Sexually transmitted diseases (STDs) are illnesses that are passed from one person to another through intimate contact. STDs can be caused by bacteria, viruses, or parasites. Some STDs, such as HIV, cannot be cured and can only be managed through treatment.

Five examples of STDs include chlamydia, gonorrhea, syphilis, herpes, and HIV. Chlamydia is a bacterial infection that is usually transmitted through unprotected sex. Gonorrhea is a bacterial infection that can be spread through contact with the genitals, anus, or throat. Syphilis is a bacterial infection that is usually spread through sexual contact. Herpes is a viral infection that can be spread through contact with the genitals, anus, or mouth. HIV is a virus that can be spread through contact with infected body fluids, such as blood, semen, or breast milk.

The best way to prevent STDs is to practice safe sex. This includes using condoms every time you have sex, avoiding sex with multiple partners, and getting tested for STDs regularly. It's also important to get vaccinated for certain STDs, such as hepatitis B. Additionally, it's important to avoid sharing needles and to practice proper hygiene.

18- List five advantages of vegetative propagation.

Ans: 1. Vegetative propagation is a cost-effective and efficient way to propagate a variety of plants. It does not require any special equipment, and the cost of propagating plants is much lower than that of purchasing new plants.

2. It is a quick and easy way to propagate a plant species. It takes much less time to propagate a plant through vegetative propagation than it does to grow a plant from a seed.

3. It allows for the propagation of plants that do not reproduce through seeds, such as many fruit trees.

4. It is a reliable way to propagate a plant. The plants that are propagated through vegetative propagation are clones of the parent plant, so they will have the same characteristics as the parent plant.

5. It allows for the propagation of plants that may be difficult to propagate through seeds, such as many ornamental and medicinal plants.

HEREDITY AND EVOLUTION

- The process of transmission of characters from parents to offspring is known as inheritance. This is the basis of heredity.
- Genetics is the science that deals with heredity and variation.
- Variation: Small changes / modifications in a particular character that are visible between parents and Offsprings
- **Gregor Johann Mendel** is known as the **-father of genetics**||.

Heterozygous	Two different alleles are present together. E.g.- Tt
Genotype	It is the genetic makeup of an individual. E.g.- TT, tt, Tt
Phenotype	It is an observable feature. E.g.- tall, dwarf
Monohybrid cross	Cross to observe a single character. E.g.- height of the plant
Dihybrid cross	Cross to observe two characters at the same time. E.g. colour and shape of seed

Types of Variation-

1- Somatic- occur in vegetative cell and not ionherited

E.g. Boring of pinna by Indian women, hair style etc.

II- Germinal variations:

Occur in special gamete forming cells only

Inherit in next generation

E.g.: Human skin colour, shape of nose, etc.

Importance of variations

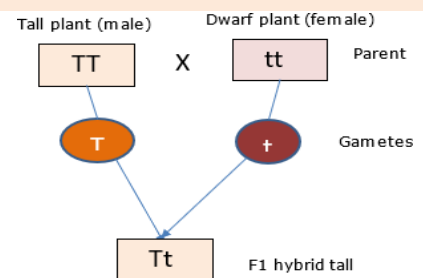
- Variation enables organisms to adjust and adapt better according to the changing conditions of the environment (Survival advantage),.
- Different kinds of variations in organisms lead to the development of new species.

- Mendel worked on Pea plant (*Pisum sativum*).
- Advantages of using pea plant are- availability of pure line plant, clearly visible observable characters, contrast characters of same features, easily pollinated (self and cross) etc.
- He worked on 7 contrasting features of pea plant. E.g. Height of plant, flower colour, seed colour, seed shape, pod colour, pod shape and position of flower.
- He conducted monohybrid and Dihybrid cross.

MENDEL'S LAW OF INHERITANCE

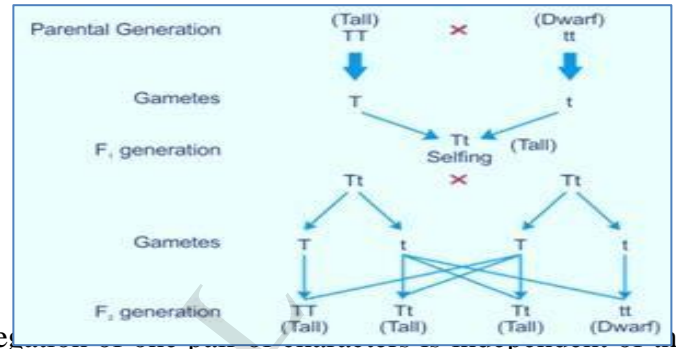
- The Law of Dominance
- The Law of Segregation
- The Law of Independent Assortment.

Law of Dominance: When parents having pure contrasting characters are crossed then only one character expresses itself



the F1 generation. This character is the dominant character and the character/factor which cannot express itself is called the recessive character.

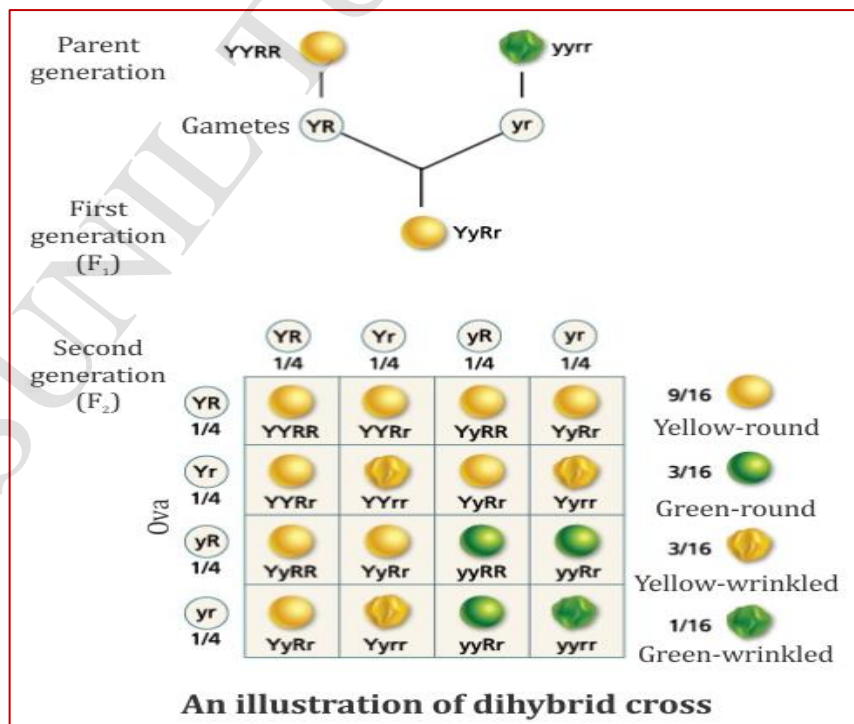
Law of segregation: The phenomenon of separation of the two alternating factors of one character, during gamete formation so that one gamete receives only one factor of a character is called as Law of Segregation.



Law of Independent Assortment-

'When two pairs of traits are combined in a hybrid, segregation of one pair of characters is independent of other pair of characters'.

- **Dihybrid cross.** He cross breed pea plants bearing round green seed (RRyy) with plants bearing wrinkled and yellow seeds (rrYY).
- In the F1 generation he obtained all round and yellow seeds it means round and yellow traits of seeds are dominant features while wrinkled and green are recessive.
- He self-crossed the plants of F1 and found that in F2 generation four different types of seeds round yellow, round green, wrinkled yellow and wrinkled green in the ratio of **9 : 3 : 3 : 1** are present.



HOW DO TRAITS GET EXPRESSED?

DNA is regulating the authority to making of proteins in the cell.

- Gene provides information for one particular protein.
- E.g. the height of a plant depends upon the growth hormone which is in turn controlled by the gene.
- Both parents contribute equally to the DNA of next-generation during sexual reproduction.

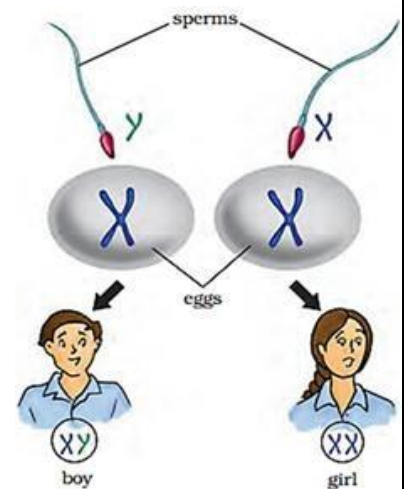
SEX DETERMINATION IN HUMAN

The process of determining the sex of an individual, based on the composition of the genetic makeup is called sex determination.

- Human has 23 pair of chromosomes.
- Autosome: 22 pairs (44)
- Sex chromosomes: 01 pair (02). They may be either-i- Homogametic – XX for female (44 +XX)
ii- Heterogametic XY for male (44 +XY)

In some organism-environment also plays a crucial role in the determination of sex-

- In some Reptiles: The temperature at which a fertilized egg is incubated governs the gender.
- Snails: A particular animal can change gender within one's lifetime.



IMPORTANT QUESTIONS

Very Short answer Questions

- 1- Gene is a short segment of
- a- protein
 - b- Carbohydrate
 - c- DNA
 - d- Polypeptides

Ans: c

- 2- Which feature is considered as dominant by Mendel-

- a- Purple/ violet flower
- b- Long plant
- c- Yellow seed
- d- All of these

Ans: d

- 3- In human which one of the following is heterogametic –

- a- Male
- b- Female
- c- Baby Girl Child
- d- All of these

Ans: a

4- Which of the following is not associated with sex determination-

- a- Autosome
- b- Allosome
- c- Sex chromosome
- d- XX and XY

Ans: b

5- Mendel's dihybrid cross ratio is-

- a- 1:2:1
- b- 9:3:3:1
- c- 1:2:2:1
- d- 3:9:9:1

Ans: b

6- The sex of the children is determined by what they inherit from their father and not their mother.”

Justify

Ans: because Y sex chromosome is inherited only from the father

7- Name the scientist who established the laws of inheritance.

Ans: Gregor Johann Mendel

8- Where genes are located?

Ans: Genes are located over the chromosomes/DNA as linear segments

Short Answer Questions

9- Why did Mendel select Pea plant for his experiment?

Ans: availability of pure line plant, clearly visible observable characters, contrast characters of same features, easily pollinated (self and cross) etc.

10- Describe genotype and phenotype with one example of each.

Ans: The genotype of an organism is its complete set of genetic material. Eg- TT, Tt, tt The phenotype is observable feature. E.g.- tall, dwarf

11- What is the significance of variation?

Ans: Variation enables organisms to adjust and adapt better according to the changing conditions of the environment (Survival advantage).

Different kinds of variations in organisms lead to the development of new species. .

12- Mention the difference between the inherited and the acquired characters. Give one example of each of the characters that are inherited and the ones that are acquired in humans.

Ans: Inherited trait: obtain from parents (since the time of his birth and are passed on from one generation to another.

Acquired trait: gain after birth (person develops during his lifetime) Inherited: attached ear lobe, baldness

Acquired: obesity, reading skill

13- (a) Write full form of DNA.

(b) Why are variations essential for the species?

Ans: (a) Deoxyribonucleic acid

(b) Genetic variation in a group of organisms enables some organisms to survive better than others in the environment in which they live.

Long Answer Questions

14- Make a representation of a Dihybrid cross showing a phenotypic ratio of 9:3:3:1.

Fig. 9.5; page:145, NCERT

15- Describe law of dominance, the law of segregation and the law of segregation.

Law of dominance: - When parents having pure contrasting characters are crossed then only one character expresses itself in the F1 generation. This character is the dominant character and the character/factor which cannot express itself is called the recessive character.

Law of segregation: - The phenomenon of separation of the two alternating factors of one character, during gamete formation so that one gamete receives only one factor of a character is called as Law of Segregation.

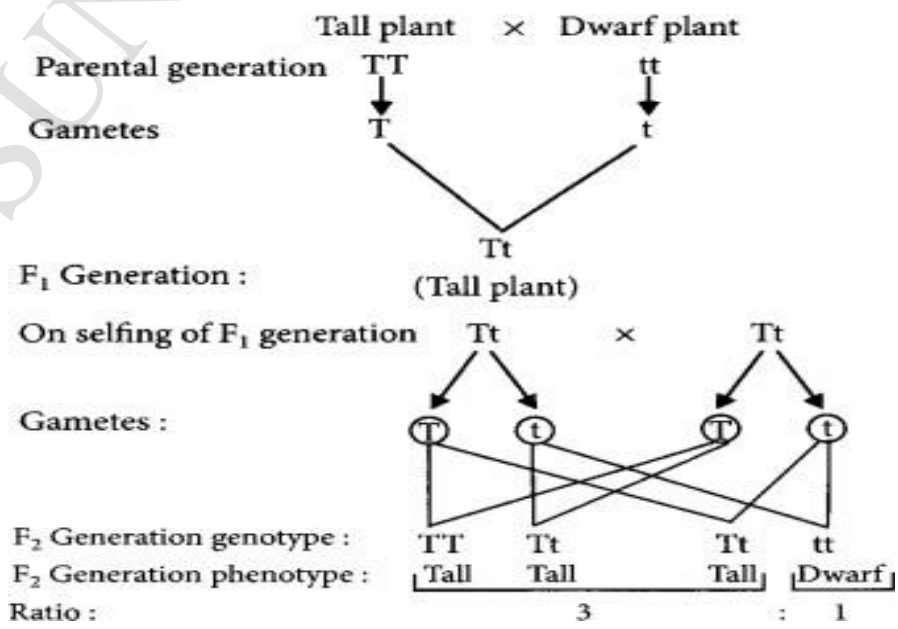
Law of independent assortment: the alleles of two (or more) different genes get sorted into gametes independently of one another

16- In a monohybrid cross of tall Pea plants denoted by TT and short pea plants denoted by tt, Vaibhav obtained only tall plants (denoted by Tt) in F1 generation. However, in F2 generation she obtained both tall and short plants. Using the above information, explain the law of dominance.

TT x tt Parents
 T t
 Tt..... F1
 Tt x Tt self cross
 T t T t..... Gametes

F2

	T	t
T	TT, Tall	Tt Tall
t	Tt, Tall	tt Dwarf



19- Mendel crossed tall pea plants with dwarf pea plants in his experiment. Write his observations giving reasons for the F1 and F2 generations.

In the F1 generation only tall plants are visible therefore tall (T) is dominant whereas dwarf (t) is recessive.

In F2 generation both tall and dwarf are visible. The dwarf is visible only in homozygous conditions.

18- How do the following provide evidence in favour of evolution in organisms? Explain with an example for each.

(i) Homologous organs

(ii) Analogous organs

(iii) Fossils

- i- Homologous organs are structures that are similar in form and function but originate from different evolutionary origins. This means that two different organisms may have the same organs, like a human arm and a bat's wing, which have the same structure, but their origin is different. This is evidence in favour of evolution since it shows that two different organisms have adapted in different ways to the same environment.
- ii- Analogous organs are similar in function, but have different structures. For example, a bat's wing and a bird's wing have different structures, but both enable the organism to fly. This is also evidence in favour of evolution, as it shows that two different organisms have adapted differently to similar environments.
- iii- Fossils are the preserved remains of organisms that existed in the past. By studying fossils, it is possible to determine how organisms have changed over time. This provides evidence in favour of evolution, as it shows how organisms have adapted and changed to survive in the environment.

Class 9 Science

Light Reflection and Refraction

REFLECTION

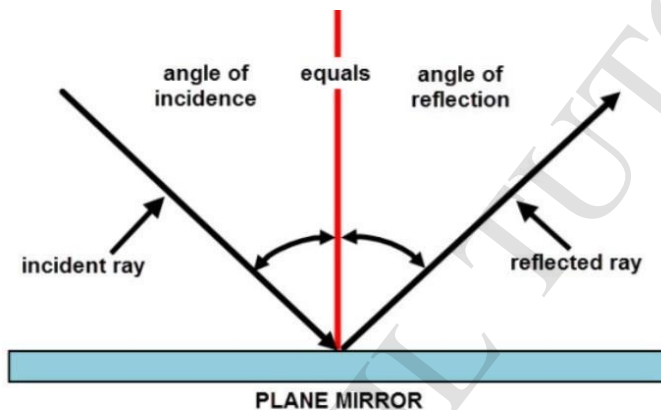
Reflection of Light: The phenomenon of bouncing back of light into the same medium by the smooth surface is called reflection.

Incident light: Light which falls on the surface is called incident light.

Reflected light: Light which goes back after reflection is called reflected light.

The angle of incidence: The angle between the incident ray and the normal.

An angle of reflection: The angle between the reflected ray and the normal.



Laws of reflection: There are two laws of reflection

- (i) The incident ray, the reflected ray and the normal at the point of incidence, all lie in the same plane.
- (ii) Angle of incidence is always equal to the angle of reflection i.e. $\angle i = \angle r$

Image: If light rays coming from a point after reflection meet at another point or appear to meet at another point, then second point is called image of the first point. There are two types of image, i.e.

Real image: When the rays of light, after reflection from a mirror, actually meet at a point, then the image formed by these rays is said to be real. Real images can be obtained on a screen.

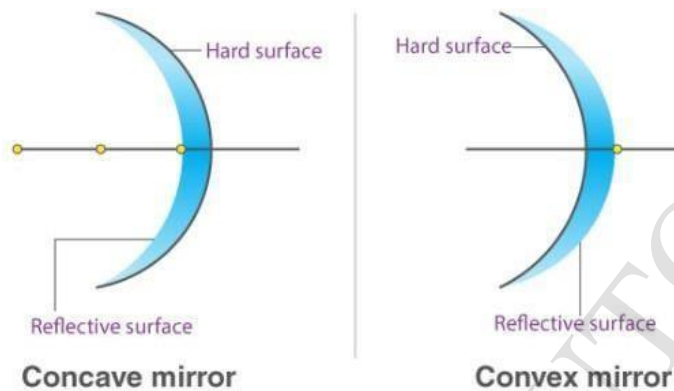
Virtual image: When the rays of light, after reflection from a mirror, appear to meet at a point, then the image formed by these rays is said to be virtual. Virtual images can't be obtained on a screen.

Mirror: The surface which can reflect the light is a mirror.

Plane Mirror: If the reflecting surface is a plane then the mirror is plane.

Spherical Mirror: If the reflecting surface is part of the hollow sphere then the mirror is a spherical mirror.

The spherical mirror is of two types:



Convex mirror: In this mirror reflecting surface is convex. It diverges the light so it is also called a diverging mirror.

Concave mirror: In this mirror reflecting surface is concave. It converges the light so it is also called converging mirror.

Some definitions related to Spherical Mirror:

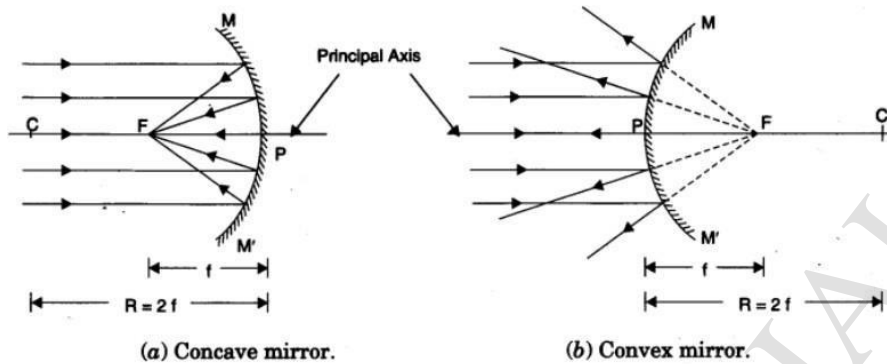
Pole (Vertex): The central point of a mirror is called its pole.

Centre of curvature: The centre of the sphere of which the mirror is a part is called the centre of curvature. It is denoted by C.

Radius of curvature: The radius of the sphere of which the mirror is a part is called the radius of curvature. It is denoted by R.

Principal axis: The straight line passing through the pole and the centre of curvature of the mirror is called the principal axis.

Principal focus: It is a point on the principal axis at which the rays parallel to the principal axis meet after reflection or seem to come from. For a concave mirror, the focus lies in front of the mirror and for a convex mirror, it lies behind the mirror. In short, a concave mirror has a real focus while a convex mirror has a virtual focus.



Focal plane: A plane, drawn perpendicular to the principal axis and passing through the principal focus.

Focal length: The distance between the pole and the focus is called the focal length. It is represented by f . The focal length is half the radius of curvature.

$$F = R/2$$

Reflection by Spherical mirror:

A ray of light which is parallel to the principal axis of a spherical mirror, after reflection converges or diverges from focus.

A ray of light passing through or appearing from the center of curvature of spherical mirror is reflected back along the same path.

A ray of light passing through or appearing from the focus of spherical mirror becomes parallel to the principal axis.

A ray of light which is incident at the pole of a spherical mirror is reflected back making same angle with principal axis.

Image formation by Concave mirror

S.No.	Position of object	Position of image	Nature of image	Uses
1.	Between the pole and the principal focus	Behind the mirror	Virtual, erect and magnified	Shaving mirror, dentist mirror
2.	At the principal focus	At infinity	Extremely magnified	In torches, head lights
3.	Between focus and the centre of curvature	Beyond centre of curvature	Real, inverted and bigger than object.	In flood lights
4.	At the centre of curvature	At the centre of curvature	Real, inverted and equal to the size of the object	Reflecting mirror for projector lamps
5.	Beyond the centre of curvature	Between the principal focus and centre of curvature	Real, inverted and diminished	
6.	At infinity	At the principal focus or in the focal plane	Real, inverted and extremely diminished in size	To collect heat radiations in solar devices

Image formation by Convex mirror

S.No.	Position of object	Position of image	Nature of image	Uses
1.	At infinity	Appears at the principal focus	Virtual, erect and extremely diminished	Used as a rear view mirror
2.	Between infinity and the pole	Appears between the principal focus and the pole	Virtual, erect and diminished	Used as a rear view mirror

Sign Conventions of Spherical Mirror

- All the distances are measured from the pole of the mirror as the origin.
- Distances measured in the direction of incident rays are taken as positive.
- Distances measured opposite to the direction of incident rays are taken as negative.
- Distances measured upward and perpendicular to the principal axis are taken as positive.
- Distances measured downward and perpendicular to the principal axis are taken as negative.

Mirror formula: $1/f=1/v+1/u$

Where f , v and u are focal length, image distance, and object distance

Magnification by Spherical Mirror:

This is the ratio of the height of the image to the height of the object. Magnification,

$$m=h_i/h_o$$

Where m = magnification, h_i = height of image, h_o = height of object

REFRACTION

Refraction of Light: The bending of light at the interface of two different mediums is called Refraction of light.

If the velocity of light in medium is more, then medium is called optical rarer.

Example, air or vacuum is more optical rarer.

If the velocity of light in medium is less, then medium is called optical denser.

Example, glass is denser than air.

Laws of refraction:

The incident ray, the refracted ray and the normal at the point of incidence all lie in the same plane.

The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant.

$$\sin i/\sin r = n \text{ (constant)}$$

This constant is called the index of refraction or refractive index.

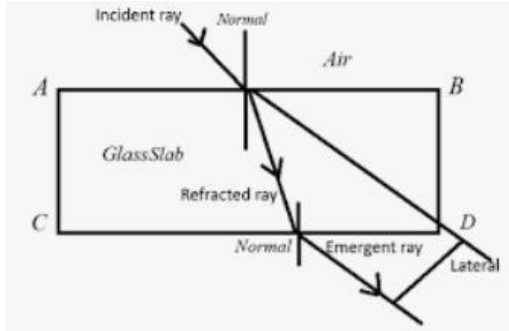
Refractive Index: If c is the speed of light in air and v is the speed of light in medium, then the refractive index of the medium is

$$n = \frac{\text{speed of light in vacuum}}{\text{speed of light in the medium}} = \frac{c}{v}$$

Refractive index of medium with respect to air or vacuum is called Absolute Refractive Index.

Refraction through a Rectangular Glass Slab:

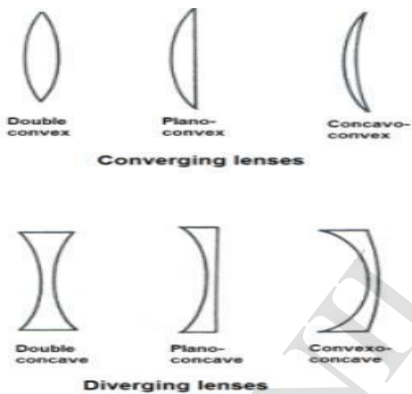
When light ray enters into a glass slab, then the emergent ray is parallel to the incident ray. This perpendicular distance between the emergent ray and incident ray when the light passes out of a glass slab is called **lateral displacement**.



i = angle of incidence, r = angle of refraction and e = angle of emergence

Angle of incidence = Angle of emergence, i.e. $\angle i = \angle e$

Lens: The transparent refracting medium bounded by two surfaces in which at least one surface is curved is called lens. Lenses are mainly two types: Convex lens and Concave lens.



Difference between Convex and Concave Lenses

Convex Lens	Concave Lens
On passing the light through the lens, it bends the light rays towards each other (i.e., it converges the rays). So due to this, it is called a converging lens.	On passing the light through the lens, it bends the light rays away from each other (i.e., it diverges the rays). So due to this, it is called a diverging lens.
A convex lens is thicker at the centre and thinner at the edges.	A concave lens is thicker at the edges and thinner at the centre.

Due to the converging rays, it is called a converging lens.	Due to the diverging rays, it is called a diverging lens.
Use for correction of long-sightedness.	Use for correction of short-sightedness.
It is also called a positive lens due to positive focal length nature.	It is also called a negative lens due to negative focal length nature.
e.g. Human Eye, Camera, etc.	e.g. Lights, Flashlights, etc.

Center of Curvature: The centers of two spheres, of which lens is part is called the centre of curvature.

Radii of Curvature: The radii of spheres, of which lens is part is called radius of curvature.

Principal Axis: The line joining the centers of curvature of two surfaces of lens is called principal axis.

Optical Center: It is a special point on the principal axis. Light incident on the optical centre passes through the lens without deviation.

Principal Focus: The point on the principal axis at which all incident rays parallel to the principal axis converge or appear to diverge after refraction through the lens.

Refraction through a Lens:

- An incident ray, parallel to the principal axis, after refraction passes through (or appears to come from), second focus of the lens.
- An incident ray, passing through the optical center of the lens, goes undeviated from the lens.
- An incident ray, passing through the (first) principal focus of the lens, or directed toward it, becomes parallel to the principal axis after refraction through lens.

Image formation by a convex lens

S.No.	Position of object	Position of image	Nature of image	Uses
1.	At infinity	At the principal focus or in the focal plane	Real, inverted and extremely diminished in size	Telescopes
2.	Beyond 2F	Between F and 2F	Real, inverted and diminished	In a camera, In eye while reading
3.	At 2F	At 2F	Real, inverted and equal to the size of the object	Photocopier
4.	Between F and 2F	Beyond 2F	Real, inverted and bigger than object	Projector, microscope objective
5.	At the principal focus	At infinity	Real, inverted and extremely magnified	Spotlights
6.	Between the optical centre and the principal focus	On the same side as that of object	Virtual, erect and magnified	Magnifying glass, eye lenses spectacles for short sightedness

Image formation by a concave lens

S.No.	Position of object	Position of image	Nature of image	Uses
1.	At infinity	Appears at the principal focus on the same side as that of the object	Virtual, erect and extremely diminished	Spectacles for short sightedness
2.	Between infinity and the lens	Appears between the principal focus and the lens	Virtual, erect and diminished	Spectacles for short sightedness

Sign conventions:

- All distances, object distance (u), image distance (v) and focal length (f) are measured from the optical centre.
- The distances measured in the direction of incident ray are taken as positive and distances measured against the direction of incident ray are taken as negative.
- All distances (heights) of objects and images above principal axis are taken as positive and those below the principal axis are taken as negative.

Lens formula:

$$1/v - 1/u = 1/f$$

Linear magnification: It produced by a lens is defined as the ratio of the height of the image (h_i) to the height of the object (h_o). It is represented by m

$$m = i/o \quad \text{or} \quad m = v/u$$

- If the magnification of a lens is negative, then the image formed is inverted and real.
- If the magnification of a lens is positive, then the image formed is erect and virtual.

Power of a Lens: The ability of a lens to converge or diverge light rays is called power of the lens. It is defined as the reciprocal of the focal length. Power is measured in diopetre.

$$\text{Power [in diopetre (D)]} = 1/f \text{ (in m)}$$

For combination of lenses,

$$P = P_1 + P_2 + P_3 + \dots$$

Remember the following points to solve any numerical for mirrors

MIRROR FORMULA

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

Where u = position of object , v = position of image and f = focal length of the mirror

Take u = always negative

Focal length f = +ve for convex mirror , -ve for concave mirror

Position of image v = +ve for virtual image, -ve for real image

$$\text{MAGNIFICATION (m)} = \frac{\text{size of image}}{\text{size of object}} = -\frac{v}{u} = \frac{f-v}{f} = \frac{f}{f-u}$$

m = -ve for real image

= +ve for virtual image

FOR LENS

$$\text{LENS FORMULA} \quad \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

Where u = position of object , v = position of image and f = focal length of the mirror

Take u = always negative

Focal length f = +ve for convex lens , -ve for concave lens

Position of image v = +ve for virtual image, -ve for real image

$$\text{MAGNIFICATION (m)} = \frac{\text{size of image}}{\text{size of object}} = \frac{v}{u} = \frac{f-v}{f} = \frac{f}{f+u}$$

m = -ve for real image

= +ve for virtual image

QUESTIONS FROM PREVIOUS BOARD EXAMS

Question 1.

The laws of reflection hold true for

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- (a) plane mirror only
- (b) concave mirror only
- (c) convex mirror only
- (d) all reflecting surface

Answer:

(d) The laws of reflection hold true for all reflecting surface.

Question 2.

List four characteristics of the images formed by plane mirror. (Delhi 2015, AI2011)

Answer:

Characteristics of the image formed by a plane mirror are

- (i) image distance is same as that of object distance
- (ii) image formed is virtual and erect
- (iii) image formed is of the same size as that of the object
- (iv) image formed is laterally inverted (left appears right and right appears left).

Question 3.

State the two laws of reflection of light. (Delhi 2011)

Answer:

Laws of reflection of light states that

- (i) The angle of incidence is equal to the angle of reflection.
- (ii) The incident ray, the reflected ray and the normal to the mirror at the point of incidence all lie in the same plane.

Question 4.

When an object is kept within the focus of a concave mirror, an enlarged image is formed behind the mirror. This image is

- (a) real
- (b) inverted
- (c) virtual and inverted
- (d) virtual and erect (2020)

Answer:

(d) When an object is placed between the principal focus and pole of a concave mirror, an enlarged virtual and erect image is formed behind the mirror.

Question 5.

What is the magnification of the images formed by plane mirror and why? (Delhi 2015)

Answer:

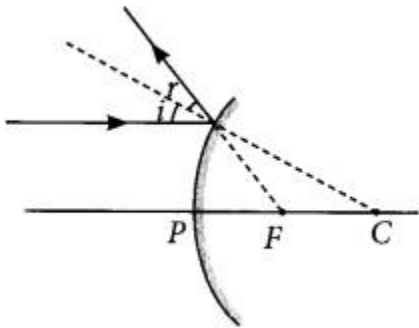
Magnification of images formed by plane mirror is unity because for plane mirror, the size of the image formed is equal to that of the object.

Question 6.

Draw a labelled ray diagram to show the path of the reflected ray corresponding to an incident ray of light parallel to the principal axis of a convex mirror. Mark the angle of incidence and angle of

reflection on it. (AI 2019)

Answer:

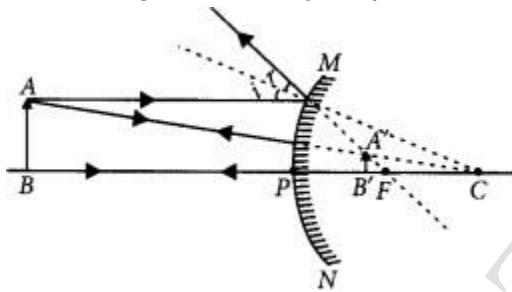


Question 7.

If the image formed by a spherical mirror for all positions of the object placed in front of it is always erect and diminished, what type of mirror is it? Draw a labelled ray diagram to support your answer. (2018)

Answer:

If the image formed by a spherical mirror is always erect and diminished then it is convex mirror.



Question 8.

An object is placed at a distance of 30 cm in front of a convex mirror of focal length 15 cm. Write four characteristics of the image formed by the mirror. (Delhi 2017)

Answer:

Four characteristics of the image formed by the given convex mirror are :

- (i) Virtual
- (ii) Erect
- (iii) Diminished
- (iv) Image is always formed behind the mirror between pole and focus.

Question 9.

An object is placed at a distance of 12 cm in front of a concave mirror of radius of curvature 30 cm. List four characteristics of the image formed by the mirror. (Delhi 2017)

Answer:

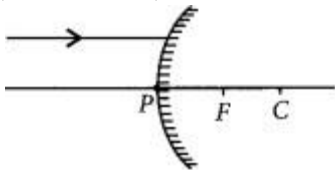
Radius of curvature (R) = 30 cm, object distance is 12 cm in front of the mirror. Thus, we can say that object is placed between focus and pole. Four characteristics of the image formed by the given concave mirror when object is placed between pole and focus are:

- (i) Virtual

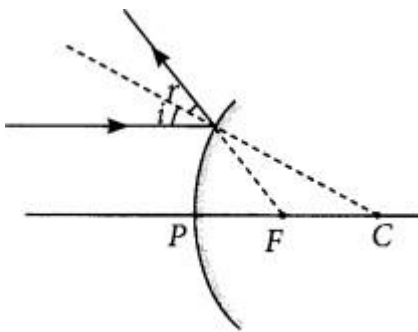
- (ii) Erect
- (iii) Enlarged
- (iv) Image is formed behind the mirror

Question 10.

A ray of light is incident on a convex mirror as shown. Redraw the diagram and complete the path of this ray after reflection from the mirror. Mark angle of incidence and angle of reflection on it. (Delhi 2016)



Answer:



Question 11.

Name the type of mirror used in the design of solar furnaces. Explain how high temperature is achieved by this device. (AI 2016)

Answer:

Concave mirror is used in the designing of solar furnaces.

When a solar furnace is placed at the focus of a large concave mirror, it focuses a parallel beam of light on the furnace. Therefore, a high temperature is attained at the point after some time.

Question 12.

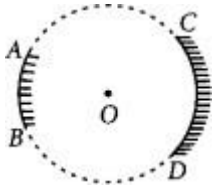
"The magnification produced by a spherical mirror is -3". List four information you obtain from this statement about the mirror/ image. (AI 2016)

Answer:

Negative sign of magnification indicates that the image is real and inverted. Since the image is real and inverted, the mirror is concave and magnification of -3 indicates that the image is magnified.

Question 13.

AB and CD, two spherical mirrors, from parts of a hollow spherical ball with its centre at O as shown in the diagram. If $AB = 12$ and CD , what is the ratio of their focal lengths? State which of the two mirrors will always form virtual image of an object placed in front of it and why? (Foreign 2016)



Answer:

Focal length of a mirror is given by

Focal length = Radius of curvature/2

Since both the mirrors have same radius of curvature, therefore focal length of the two mirrors will be same, i.e.,

$$f_1/f_2 = 1/1$$

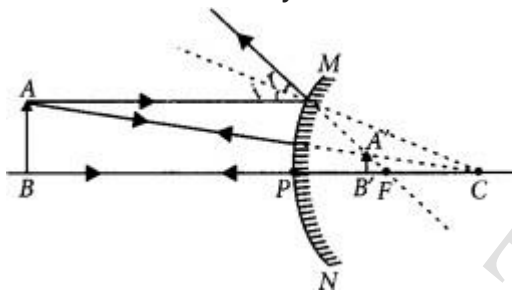
Since virtual image is always formed by convex mirror. The mirror AB will always form virtual image.

Question 14.

List two properties of the images formed by convex mirrors. Draw ray diagram in support of your answer. (Foiegn 2016)

Answer:

Convex mirrors always form diminished, virtual and erect images.



Question 15.

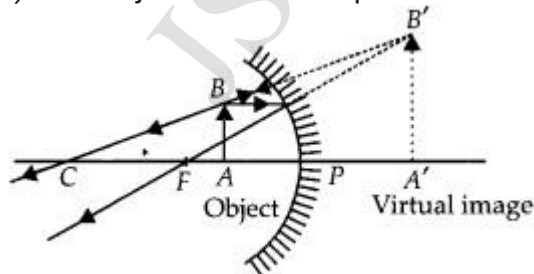
The linear magnification produced by a spherical mirror is +3. Analyse this value and state the (i) type of mirror and (ii) position of the object with respect to the pole of the mirror. Draw a ray diagram to show the formation of image in this case. (Foiegn 2016)

Answer:

Positive value of the magnification indicates that image is virtual and erect.

(i) Since the image is magnified, the mirror is concave.

(ii) The object is between pole and focus of the mirror as shown

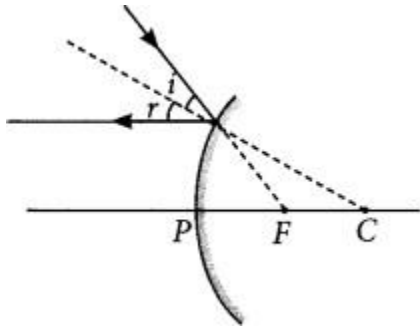


The image produced in second case will be real and inverted.

Question 16..

Díaw a íay diagíam to show the path of the íeflected íay coíesponding to an incident íay which is dírected towards the píncipal focus of a convex míííóí. Maík on it the angle of incidence and the angle of íeflection. (Delhi 2014)

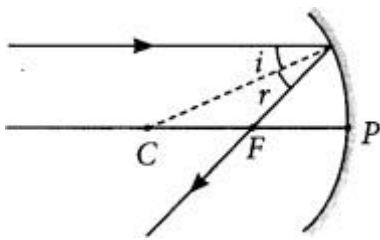
Answeí:



Question 17.

Díaw a íay diagíam to show the path of the íeflected íay coíesponding to an incident íay of light párallel to the píncipal axis of a concave míííóí. Maík the angle of incidence and angle of íeflection on it. (Delhi 2014)

Answeí:



Question 18.

List two possible ways in which a concave míííóí can píoduce a magnified image of an object placed in fíront of it. State the dífférence if any between these two images. (AI2014)

Answeí:

A concave míííóí can píoduce a magnified image of an object when object is placed:

- (1) In between its pole and its focus
- (2) In between its focus and its centíe of cuívatuíe.

Dífférence, between these two images:

Íhe image píoduced in fírst case will be vírtual and eéct.

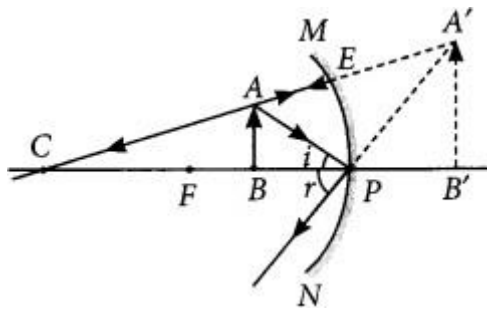
Íhe image píoduced in second case will be íeal and inveíteđ.

Question 19.

Íhe image foímed by a concave míííóí is obseéved to be vírtual, eéct and lágeí than the object. Wheíe should the position of the object be íelative to the míííóí? Díaw íay diagíam to justify your answeí. (AI 2014)

Answeí:

Íhe position of the object should be between P and F

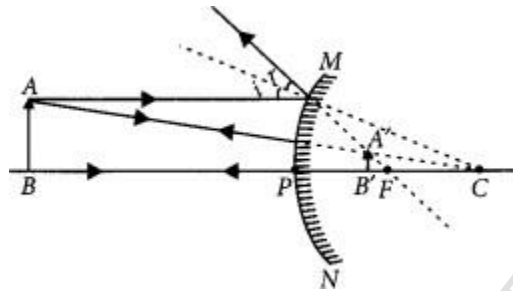


Question 20.

The linear magnification produced by a spherical mirror is $+1/3$. Analysing this value state the (i) type of mirror and (ii) position of the object with respect to the pole of the mirror. Draw any diagram to justify your answer. (AI 2014, Foiegn 2014)

Answer:

- (i) Convex mirror
- (ii) Between infinity and the pole of the mirror.

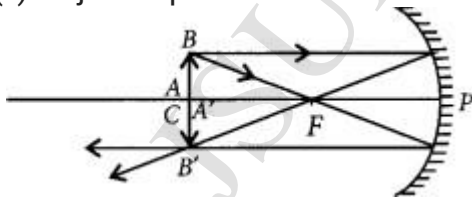


Question 21.

The linear magnification produced by a spherical mirror is -1 . Analysing this value state the (i) type of mirror and (ii) position of the object with respect to the pole of the mirror. Draw any diagram to justify your answer. (Foiegn 2014)

Answer:

- (i) Concave mirror because the image is real, inverted.
- (ii) Object is placed at C.



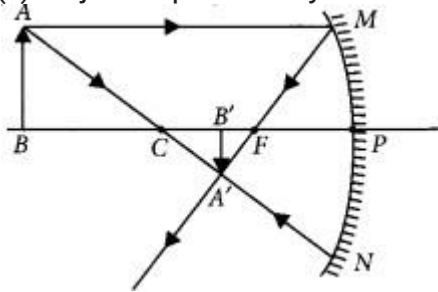
Question 22.

The linear magnification produced by a spherical mirror is $-1/5$. Analysing this value state the (i) type of spherical mirror and (ii) the position of the object with respect to the pole of the mirror. Draw any diagram to justify your answer. (Foiegn 2014)

Answer:

- (i) Concave mirror

(ii) Object is placed beyond C.



Question 23.

Díaw íay diagrams foí the following cases when a íay of light:

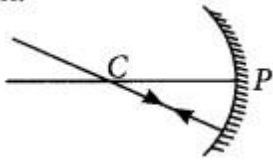
(i) passing thóugh centíe of cuívatuíe of a concave míífoí is incident on it.

(ii) páíallel to píncípall axis is incident on convex míífoí.

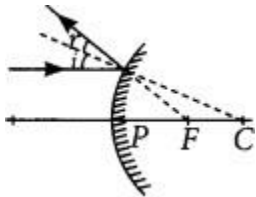
(iii) is passing thóugh focus of a concave míífoí incident on it. (2020)

Answeí:

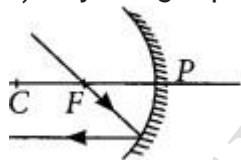
(i) Ray of light passing thóugh centíe of cuívatuíe of concave míífoí, afteí íeílection



(ii) Ray of light páíallel to the píncípall axis is incident on a convex míífoí afteí íeílection appeaí to díveíge from the píncípall focus of a convex míífoí.



(iii) Ray of light passing thóugh focus of a concave míífoí afteí íeílection will emeíge páíallel



Question 24.

A concave míífoí is used foí image foímatíon foí díffeíent posítíon of an object. What ínfereínces can be díawn about the following when an object is placed at a dístance of 10 cm fírom the pole of a concave míífoí of focal length 15 cm?

(a) Posítíon of the image

(b) Síze of the image

(c) Natuíe of the image

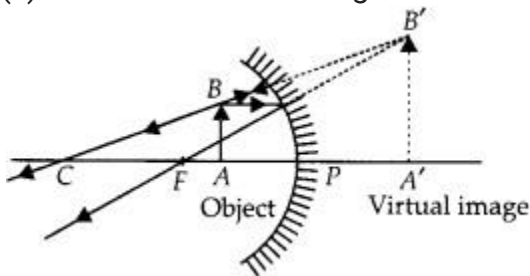
Díaw a labelled íay díagram to dístífy youí ínfereínces. (2020)

Answeí:

Given, $f = -15$ cm, $u = -10$ cm.

Thus the object is placed between the principal focus and pole of the mirror.

- (a) The position of the image will be behind the mirror.
- (b) The size of the image will be highly enlarged.
- (c) The nature of the image will be virtual and erect.



Question 25.

A concave mirror has a focal length of 20 cm. At what distance from the mirror should a 4 cm tall object be placed so that it forms an image at a distance of 30 cm from the mirror? Also calculate the size of the image formed. (AI 2019)

Answer:

Given $f = -20$ cm $v = -30$ cm $u = ?$

Using $1/v + 1/u = 1/f$

$$1/u = 1/f - 1/v = 1/-20 - 1/-30 = -3+260$$

$$\Rightarrow u = -60 \text{ cm}$$

\therefore Object placed at 60 cm from the mirror.

Also magnification, $m = h'/h = -v/u$

$$\Rightarrow h' = -(-30)/(-60) \times 4 = -2 \text{ cm}$$

\therefore The size of the image is 2 cm.

Question 26.

The image of a candle flame placed at a distance of 30 cm from a mirror is formed on a screen placed in front of the mirror at a distance of 60 cm from its pole. What is the nature of the mirror? Find its focal length. If the height of the flame is 2.4 cm, find the height of its image. State whether the image formed is real or inverted. (Delhi 2017)

Given:

Object distance, $u = -30$ cm, image size, $h' = ?$

Image distance, $v = -60$ cm,

Object size, $h = 2.4$ cm,

Focal length, $f = ?$

Using mirror formula,

$$1/f = 1/v + 1/u \text{ OR } 1/f = -1/60 - 1/30 = -360 = -120$$

$$\text{or } f = -20 \text{ cm}$$

Hence, focal length is 20 cm

Also, magnification, $m = h'/h = -v/u$

$$\text{or, } m = -(-60)/(-30) = -2 \text{ or } h'/h = -2$$

$$h' = -2 \times 2.4 = -4.8 \text{ cm}$$

As the image formed is real, therefore the mirror is concave.

The height of the image is 4.8 cm.

The image formed is enlarged and inverted.

Question 27.

An object 4 cm in height, is placed at 15 cm in front of a concave mirror of focal length 10 cm. At what distance from the mirror should a screen be placed to obtain a sharp image of the object. Calculate the height of the image. (Delhi 2017)

Answer:

Given : object distance, $u = -15$ cm,
object height, $h = 4$ cm, focal length $f = -10$ cm;

Image distance, $v = ?$

Using mirror formula,

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} + \frac{1}{(-15)} = \frac{1}{-10} \Rightarrow \frac{1}{v} = \frac{1}{15} - \frac{1}{10}$$

$$\text{or } \frac{1}{v} = \frac{10 - 15}{150} = \frac{-5}{150} = \frac{-1}{30} \text{ or } v = -30$$

In order to obtain a sharp image of the object on the screen, screen should be placed at a distance of 30 cm in front of the mirror.

Also, magnification, $m = \frac{h'}{h} = -\frac{v}{u}$

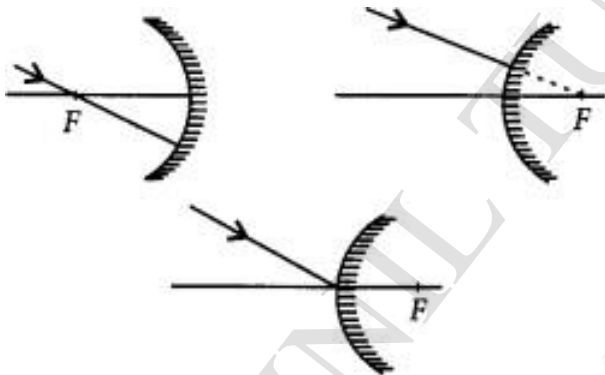
$$\text{or } h' = -\left(\frac{-30}{-15}\right) \times 4 = -\left(\frac{30}{15}\right) \times 4 = -2 \times 4$$

$$\text{or } h' = -8 \text{ cm}$$

Thus, the height of the image is 8 cm.

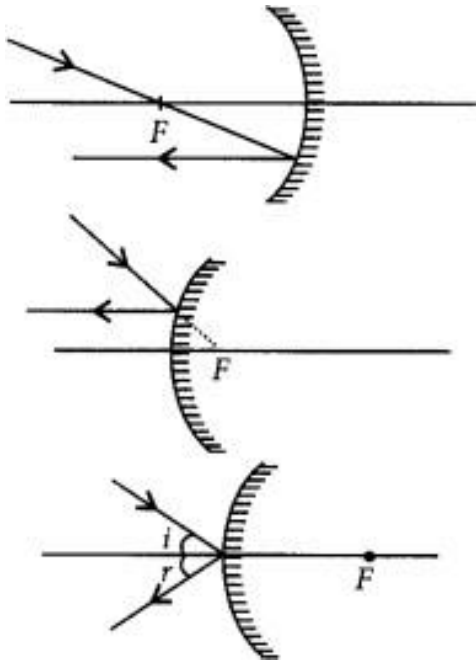
Question 28.

Draw the following diagram in which a ray of light is incident on a concave/convex mirror, on your answer sheet. Show the path of this ray, after reflection, in each case.



Answer:

The path of the rays are shown in figure.



Question 29.

The image of an object formed by a mirror is real, inverted and is of magnification -1. If the image is at a distance of 40 cm from the mirror, where is the object placed? Where would the image be if the object is moved 20 cm towards the mirror? State reason and also draw ray diagram for the new position of the object to justify your answer. (AI 2016)

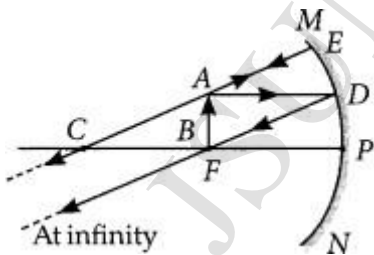
Answer:

Since the image formed by the mirror is real and inverted, therefore the mirror is concave and magnification of the mirror will be

$$m = -v/u \Rightarrow -1 = -v/u \Rightarrow v = u$$

i.e., object and image both are formed at the centre of curvature, i.e., 40 cm from the mirror.

Now, if the object is moved 20 cm towards the mirror, the object will be at the focus of the mirror and therefore the image will be formed at infinity.



Question 30.

The image formed by a spherical mirror is real, inverted and its magnification is -2. If the image is at a distance of 30 cm from the mirror, where is the object placed? Find the focal length of the mirror. List two characteristics of the image formed if the object is moved 10 cm towards the mirror. (AI 2016)

Answer:

Since the image formed is real and inverted, the mirror is concave.

Magnification, $m = -v/u \Rightarrow -2 = -v/u \Rightarrow v = 2u$

Now, if $v = -30$ cm then $u = -15$ cm

As focal length of the mirror is

$$f = uv/u+v = -15 \times -30 / -15 - 30 = f = 450 / -45 = -10 \text{ cm}$$

If the object is shifted 10 cm towards the mirror, then the object is between principal focus and the optical centre and the image formed will be virtual and erect.

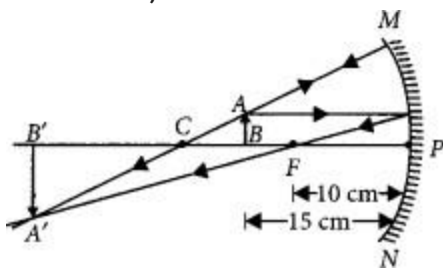
Question 31.

To construct a ray diagram we use two rays of light which are so chosen that it is easy to determine their directions after reflection from the mirror. Choose these two rays and state the path of these rays after reflection from a concave mirror. Use these two rays to find the nature and position of the image of an object placed at a distance of 15 cm from a concave mirror of focal length 10 cm. (Delhi 2015, AI 2012)

Answer:

We use two rays of light, one passing through the centre of curvature of a concave mirror, and another is parallel to the principal axis. After reflection, the ray passing through the centre of a concave mirror is reflected back along the same path and the ray parallel to the principal axis will pass through the principal focus.

$u = -15$ cm, $f = -10$ cm



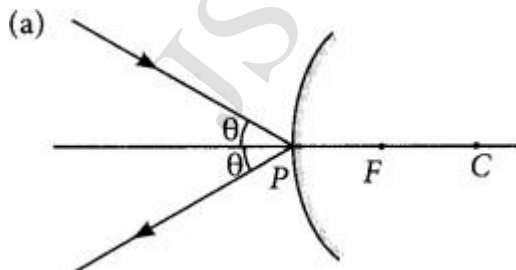
From ray diagram, $v = -30$ cm, i.e., beyond C. Nature of image is real, inverted and magnified. Question

32.

Draw a ray diagram to show the path of the reflected ray in each of the following cases. A ray of light incident on a convex mirror:

- strikes at its pole making an angle θ from the principal axis.
- is directed towards its principal focus.
- is parallel to its principal axis. (Foreign 2015)

Answer:



- Refer to answer 17.
- Refer to answer 6.

Question 33.

A spherical mirror produces an image of magnification -1 on a screen placed at a distance of 50 cm from the mirror.

- (a) Write the type of mirror.
- (b) Find the distance of the image from the object.
- (c) What is the focal length of the mirror?

(Delhi 2014, AI 2014)

Answer:

(a) Concave mirror

(b) Magnification, $m = -v/u$ or $v = u$

\therefore Distance of the image from the object is, $v - u = 0$

(c) As the image is formed at centre of curvature i.e., $v = R$.

\therefore focal length of the mirror, $f = -R/2 = -25$ cm

Question 34.

A spherical mirror produces an image of magnification -1 on a screen placed at a distance of 40 cm from the mirror.

- (i) Write type of mirror.
- (ii) What is the nature of the image formed?
- (iii) How far is the object located from the mirror?

(Delhi 2014)

Answer:

(i) This is a concave mirror.

(ii) The image is real and inverted and of same size.

(iii) As $m = -1$

$\therefore m = -v/u \Rightarrow -1 = -v/u \Rightarrow u = v$

Hence, object is located at centre of curvature i.e., at distance of 40 cm from the pole of the mirror,

Question 35.

A spherical mirror produces an image of magnification -1.0 on a screen placed at a distance of 30 cm from the pole of the mirror.

- (i) Write the type of mirror in this case.
- (ii) What is the focal length of the mirror?
- (iii) What is the nature of the images formed?(Delhi 2014)

Answer:

(i) The mirror is concave mirror.

(ii) Distance the image from the mirror = -30 cm

Magnification, $m = -v/u$

Here $m = -1$ and $v = -30$ cm

$-1 = -(-30)/u$

$\therefore u = -30$ cm

As $v = u$, object is placed at centre of curvature. Therefore, focal length of the mirror,

$f = -u/2 = -15$ cm

(iii) Image formed is real and inverted and of the same size of the object.

Question 36.

A student wants to project the image of a candle flame on a screen 48 cm in front of a mirror by

keeping the flame at a distance of 12 cm from its pole.

(a) Suggest the type of mirror he should use.

(b) Find the linear magnification of the image produced.

(c) How far is the image from its object?

(d) Draw a ray diagram to show the image formation in this case. (AI 2014)

Answer:

(a) Concave mirror

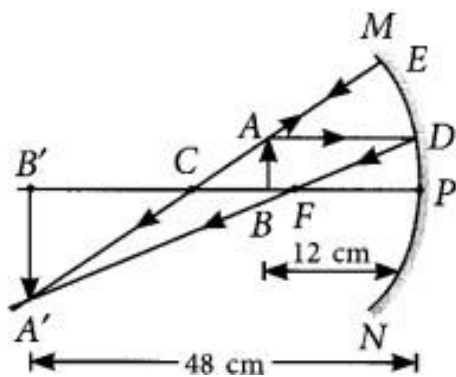
(b) Linear magnification,

$$m = -v/u = -(-48)/12 = -4$$

(c) The distance between the image and the object

$$= 48 - 12 = 36 \text{ cm}$$

(d)



Question 37.

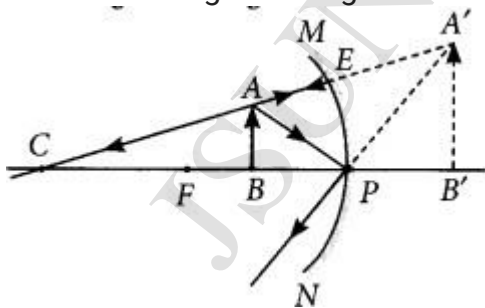
A student wants to obtain an erect image of an object using a concave mirror of 12 cm focal length. What should be the range of distance of the candle flame from the mirror? State the nature and size of the image he is likely to observe. Draw a ray diagram to show the image formation in this case. (Foreign 2014)

Answer:

To obtain an erect image, the object is placed in between pole and the focus of the concave mirror. So range of distance of the candle flame from the mirror is in between 12 cm.

Nature of the image = Virtual and erect.

Size of the image = Enlarged



Question 38.

Mention the types of mirrors used as (i) rear view mirrors, (ii) shaving mirrors. List two reasons to justify your answer in each case. (Delhi 2013, Delhi 2012)

Answer:

(i) Convex mirror is used as rear view mirror because

- (a) it gives erect image.
 (b) it gives diminished image thus provides wide view of traffic behind the vehicle.
- (ii) Concave mirror is used as shaving mirror because
 (a) it gives erect image when mirror is close to the face.
 (b) it gives enlarged image of the face so that a person can shave safely.

Question 39.

Calculate the magnification of the image of an object placed perpendicular to the principal axis of a concave mirror of focal length 15 cm. The object is at a distance of 20 cm from the mirror. (Delhi 2013)

Answer:

Given, focal length of concave mirror,
 $f = -15$ cm

Object distance, $u = -20$ cm

Image distance, $v = ?$

Using mirror formula,

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

$$\text{or } \frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-15} - \frac{1}{-20} = \frac{-4+3}{60}$$

$$\frac{1}{v} = \frac{-1}{60} \quad \text{or } v = -60 \text{ cm}$$

Using magnification formula,

$$m = -v/u = -(-60/-20) \text{ or } m = -3$$

So, the magnification, $m = -3$.

Question 40.

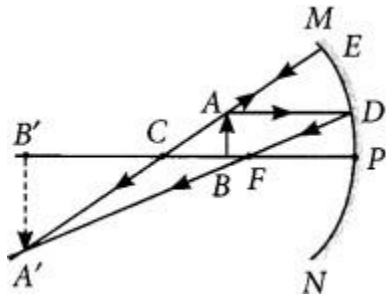
To construct ray diagram we use two light rays which are so chosen that it is easy to know their directions after reflection from the mirror. List these two rays and state the path of these rays after reflection. Use these rays to locate the image of an object placed between centre of curvature and focus of a concave mirror. (AI2012)

Answer:

A ray parallel to the principal axis, after reflection, will pass through the principal focus in case of a concave mirror or appear to diverge from the principal focus in case of a convex mirror.

A ray passing through the centre of curvature of a concave mirror or directed in the direction of the centre of curvature of a convex mirror, after reflection, is reflected back along the same path.

The light rays come back along the same path because the incident rays fall on the mirror along the normal to the reflecting surface.



Question 41.

State the types of mirrors used for (i) headlights and (ii) rear view mirrors, in motorcycles. Give reason to justify your answer in each case. (AI 2012)

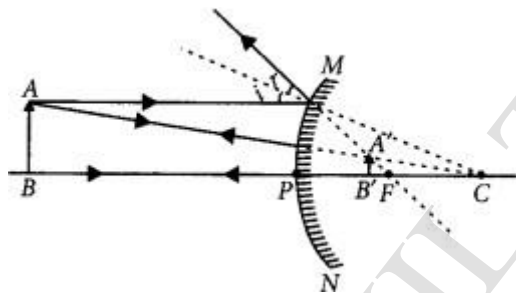
Answer:

- (i) Concave mirror is used in headlights of cars to get powerful beams of light.
- (ii) Convex mirror is used as rear-view mirror of vehicle to get a wide field of view and erect image of traffic behind.

Question 42.

An object is placed between infinity and the pole of a convex mirror. Draw a ray diagram and also state the position, the relative size and the nature of the image formed. (AI 2011)

Answer:



Position: Image is formed between pole and principal focus of the mirror.

Relative size : Image formed is diminished.

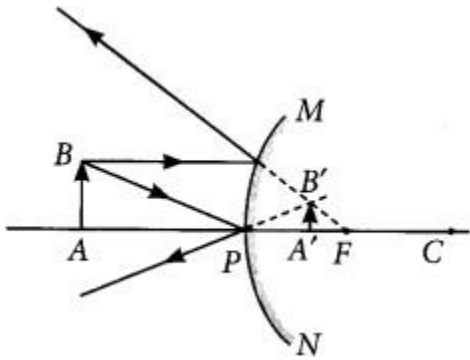
Nature : Image formed is virtual and erect.

Question 43.

With the help of a ray diagram explain why a convex mirror is preferred for rear view mirrors in the motor cars. (Foreign 2011)

Answer:

Convex mirror is preferred for rear view mirrors in motor cars because no matter where the object is located in front of convex mirror, it always gives erect and diminished image of the object, so that driver is able to see the large traffic view in small area and the image is erect. This can be interpreted from the following diagram.



Question 44.

An object 4.0 cm in size, is placed 25.0 cm in front of a concave mirror of focal length 15.0 cm.

(i) At what distance from the mirror should a screen be placed in order to obtain a sharp image?

(ii) Find the size of the image.

(iii) Draw a ray diagram to show the formation of image in this case. (2020)

Answer:

(i) Given, $h = 4 \text{ cm}$,

$u = -25 \text{ cm}$ (concave mirror), $f = -15 \text{ cm}$

Using mirror formula,

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \text{ or } \frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

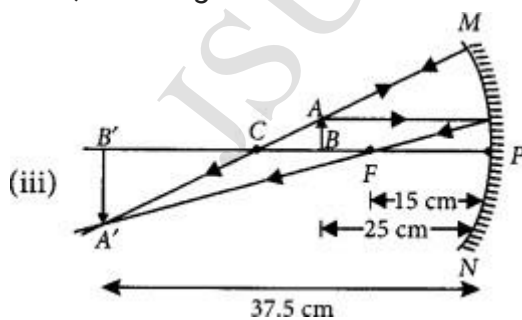
$$= \frac{1}{-15} - \frac{1}{-25} = \frac{-25 + 15}{15 \times 25}$$

$$\therefore v = \frac{15 \times 25}{-10} = -37.5 \text{ cm}$$

$$(ii) \text{ Magnification, } m = \frac{h'}{h} = \frac{-v}{u}$$

$$\therefore h' = \frac{-v}{u} \times h = \frac{37.5}{-25} \times 4 = -6 \text{ cm}$$

Thus, the image is real and inverted.



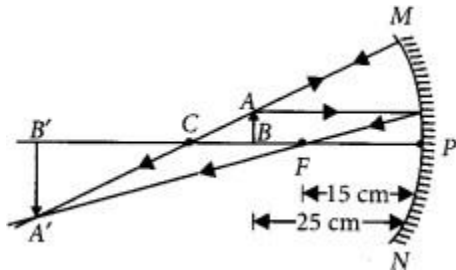
Question 45.

(a) A concave mirror of focal length 10 cm can produce a magnified real as well as virtual image

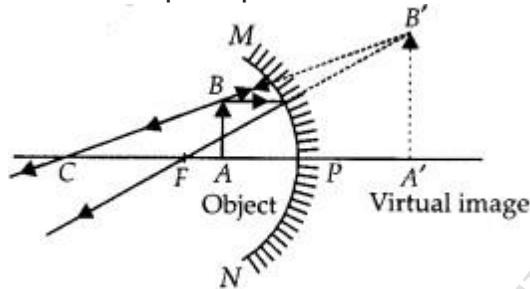
of an object placed in front of it. Draw ray diagrams to justify this statement,
 (b) An object is placed perpendicular to the principal axis of a convex mirror of focal length 10 cm. The distance of the object from the pole of the mirror is 10 cm. Find the position of the image formed. (2020)

Answer:

(a) A magnified real image is produced in a concave mirror when the object is placed between principal focus and centre of curvature.



A magnified virtual image is produced in a concave mirror when the object is placed between the pole and the principal focus of the mirror.



(b) Given, $f = +10$ cm (convex mirror) and $u = -10$ cm
 From mirror formula,

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \quad \text{or} \quad \frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$\text{or} \quad \frac{1}{v} = \frac{1}{10} - \frac{1}{-10} = \frac{-10-10}{-100}$$

$$\therefore v = \frac{-100}{-20} = 5 \text{ cm behind the mirror.}$$

Question 46.

(a) A security mirror used in a big showroom has radius of curvature 5 m. If a customer is standing at a distance of 20 m from the cash counter, find the position, nature and size of the image formed in the security mirror.

(b) Neha visited a dentist in his clinic. She observed that the dentist was holding an instrument fitted with a mirror. State the nature of this mirror and reason for its use in the instrument used by dentist. (2020)

Answer:

(a) Given radius of curvature of the mirror,

$$R = 5 \text{ m}$$

∴ Focal length, $f = R/2 = 2.5 \text{ m}$ (convex mirror) and $u = -20 \text{ m}$

From mirror formula,

$$\begin{aligned} \frac{1}{f} &= \frac{1}{v} + \frac{1}{u} \text{ OR } \frac{1}{v} = \frac{1}{f} - \frac{1}{u} \\ &= \frac{1}{2.5} - \frac{1}{-20} = \frac{-20 - 2.5}{-20 \times 2.5} \\ \therefore v &= 2.22 \text{ m} \end{aligned}$$

Thus, the image is formed 2.22 m behind the mirror. The image is diminished, virtual and erect.

(b) Concave mirror is used by dentist. Dentist uses it as it is a converging mirror and when used at close range forms a highly enlarged, virtual and erect image of the object.

Question 47.

(a) To construct a ray diagram we use two rays which are so chosen that it is easy to know their directions after reflection from the mirror. Use these two rays and draw ray diagram to locate the image of an object placed between pole and focus of a concave mirror.

(b) A concave mirror produces three times magnified image on a screen. If the object is placed 20 cm in front of the mirror, how far is the screen from the object? (Delhi 2017)

Answer:

(a) Two light rays whose path of reflection are primarily known are :

(i) When the incident ray passes through the centre of curvature of a concave mirror, it gets reflected in the same path.

(ii) When the ray is incident obliquely to the principal axis, towards the pole of mirror, it gets reflected back by making equal angles with the principal axis (laws of reflections).

Suppose an object is placed between focus and pole of the concave mirror. Then by using the above two rays, the image of the object can be located as

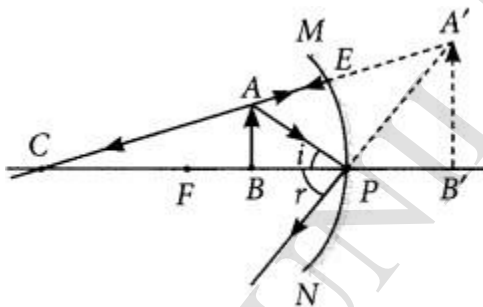


Image formed is virtual, erect, magnified and it is formed behind the mirror.

(b) Given : Magnification, $m = -3$

Object distance, $u = -20 \text{ cm}$

Magnification, $m = -v/u$ or $-3 = -v/-20$

or $v = -60 \text{ cm}$

The screen is placed in front of the mirror at a distance of 60 cm from the pole.

Thus, the screen is placed 40 cm ($= 60 \text{ cm} - 20 \text{ cm}$) away from the object.

Question 48.

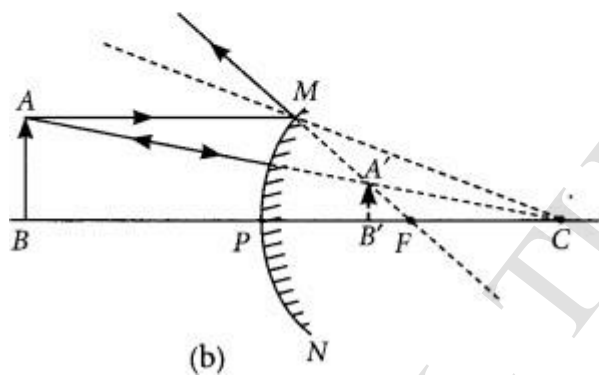
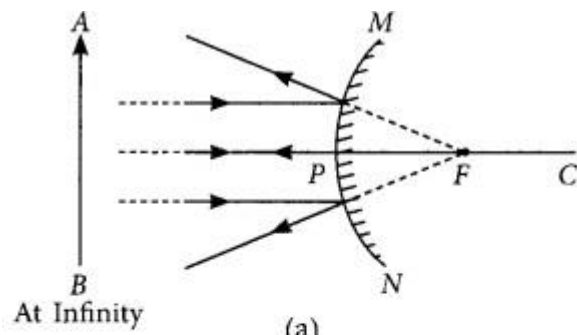
(a) If the image formed by a mirror for all positions of the object placed in front of it is always diminished, erect and virtual, state the type of the mirror and also draw a ray diagram to justify your answer. Write one use such mirror is put to and why?

(b) Define the radius of curvature of spherical mirrors. Find the nature and focal length of a spherical mirror whose radius of curvature is +24 cm. (AI2017)

Answer:

(a) If the image formed by a mirror for all positions of the object placed in front of it is always diminished, erect and virtual then the mirror is convex mirror.

The ray diagrams for the formation of image by a convex mirror for the first position when the object is at infinity and the second position when the object is at a finite distance from the mirror are shown.



Use of Convex Mirrors

Convex mirrors are commonly used as rear-view (wing) mirrors in vehicles because they always give an erect, though diminished image. Also, they have a wide field of view as they are curved outwards. Thus, convex mirrors enable the driver to view a large area.

(b) Radius of Curvature: The radius of the sphere of which the reflecting surface of a spherical mirror forms a part, is called the radius of curvature of the mirror. It is represented by the letter R.

∴ The radius of curvature is equal to twice the focal length.

$$\therefore R = 2f$$

$$\text{If } R = +24 \text{ cm } \therefore f = \frac{R}{2} = \frac{24}{2} = 12 \text{ cm}$$

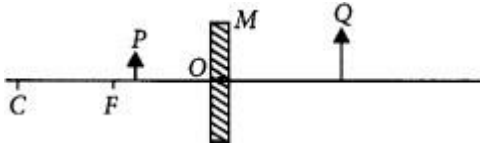
Since the radius of curvature is positive, the mirror is convex mirror. Hence the nature of the image is virtual and erect.

Question 49.

(a) Define the following terms in the context of spherical mirrors:

- (i) Pole
- (ii) Centre of curvature

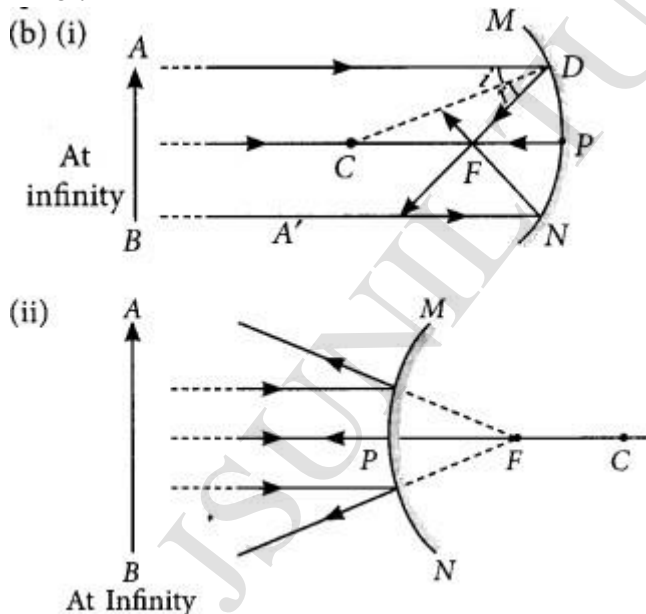
- (iii) Píncipal axis
- (iv) Píncipal focus
- (b) Dáw íay diagráms to show the píncipal focus of a
- (i) Concave miíóí (ii) Convex miíóí
- (c) Consider the following diagráam in which M is a miíóí and P is an object and Q is its magnified image foímed by the miíóí.



State the type of the miíóí M and one chaáctereístic píopeíty of the image Q. (Delhi 2016)

Answer:

- (a) (i) Pole : The centíe of the íeflecting suíface of a speheícal miíóí is a point called the pole. It lies in the suíface of the miíóí and its íepíesented by the letteí P.
- (ii) Centíe of cúvatuíe: The íeflecting suíface of a speheícal miíóí is a paít of a speheé which has a centíe. This point is called the centíe of cúvatuíe of speheícal miíóí and is íepíesented by the letteí C.
- (iii) Píncipal axis : An imaginaíy line passing thúgh the pole and the centíe of cúvatuíe of a speheícal miíóí and nórmal to the miíóí at its pole is called píncipal axis.
- (iv) Píncipal focus : Incident íays páallel to píncipal axis, afteí íeflection eitheí conveíge to as appeaí to díveíge fírom a fixed point on the píncipal axis known as píncipal focus of the speheícal miíóí.



(c) The object is placed between focus and pole of the miíóí and a magnified image is foímed behind the miíóí.

∴ The miíóí is concave and image foímed is vírtual and eíect.

Question 50.

It is desired to obtain an eíect image of an object, using concave miíóí of focal length of 12 cm.

(i) What should be the íange of distance of a , object placed in fíront of the miíóí?

(ii) Will the image be smaller or larger than the object? Draw ray diagram to show the formation of image in this case.

(iii) Where will the image of this object be, if it is placed 24 cm in front of the mirror? Draw ray diagram for this situation also to justify your answer.

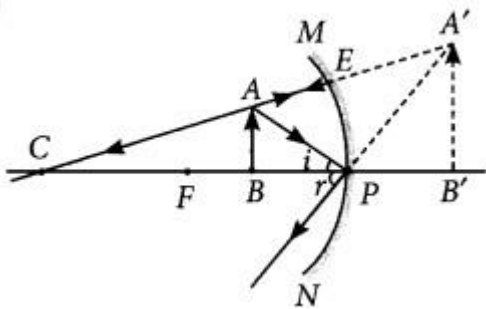
Show the positions of pole, principal focus and the centre of curvature in the above ray diagrams. (AI2016)

Answer:

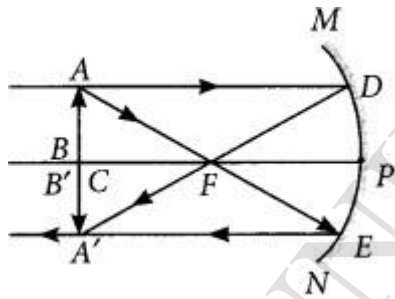
Given : focal length of the concave mirror $f = 12$ cm

(i) If the object is placed between the pole and focus of the concave mirror, then the image formed is virtual and erect. Therefore, the range of distance of the object should be $0 < u < 12$ cm.

(ii) The image formed will be enlarged as shown below.



(iii) If the object is placed 24 cm in front of the mirror i.e., at the centre of the curvature then the image will also be formed at the centre of the curvature.



Question 51.

Suppose you have three concave mirrors A, B and C of focal lengths 10 cm, 15 cm and 20 cm. For each concave mirror you perform the experiment of image formation for three values of object distances of 10 cm, 20 cm and 30 cm. By giving reason, answer the following:

(a) For the three object distances, identify the mirror/mirrors which will form an image of magnification -1.

(b) Out of the three mirrors, identify the mirror which would be preferred to be used for shaving purposes/make up.

(c) For the mirror B draw ray diagram for image formation for object distances 10 cm and 20 cm. (Fóiegn 2016)

Answer:

Given $f_a = 10$ cm, $f_b = 15$ cm, $f_c = 20$ cm

$$u_a = 10 \text{ cm}, u_b = 20 \text{ cm}, u_c = 30 \text{ cm}$$

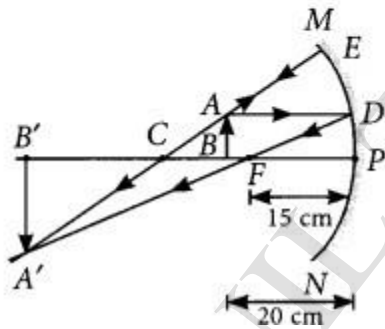
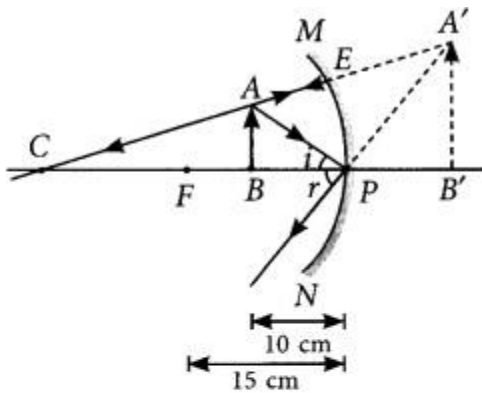
(a) Magnification of -1 implies that size of image is same as that of object or image is formed at the same distance as of the object. This is the case when the object distance, $u = 2f$, i.e., when the object is at the centre of the curvature.

For f_a , u_b and for f_b , u_c , we get magnification - 1.

(b) Concave mirror forms virtual, erect and magnified image when the object is between focus and pole of the mirror, i.e., object distance should be less than the focal length of the mirror.

For object distance 10 cm, mirrors of focal length $f_b = 15 \text{ cm}$ and $f_c = 20 \text{ cm}$ can be used.

(c)



Question 52.

A student has focused the image of a candle flame on a white screen using a concave mirror. The situation is as given below:

Length of the flame = 1.5 cm

Focal length of the mirror = 12 cm

Distance of flame from the mirror = 18 cm

If the flame is perpendicular to the principal axis of the mirror, then calculate the following:

(a) Distance of the image from the mirror

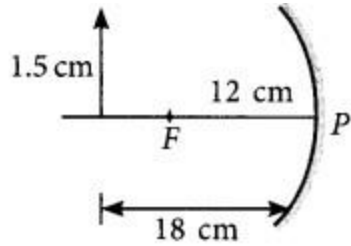
(b) Length of the image

If the distance between the mirror and the flame is reduced to 10 cm, then what would be observed on the screen? Draw a ray diagram to justify your answer from this situation. (Foreign 2015)

Answer:

Given: focal length of the concave mirror, $f = -12 \text{ cm}$

Length of the flame, $h = 1.5 \text{ cm}$
 Distance of flame from the mirror, $u = -18 \text{ cm}$



(a) As, $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

or $\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-12} - \frac{1}{-18} = \frac{-3+2}{36} = \frac{-1}{36}$

or $v = -36 \text{ cm}$

(b) Let h' be the length of the image.

\therefore Magnification, $m = h'/h = -v/u$

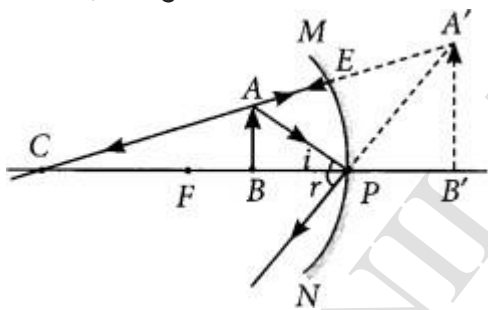
$\therefore h' = -v \times h/u = -(-36) \times 1.5 / -18 = -3 \text{ cm}$

If the distance between the mirror and the flame is reduced to 10 cm, then

$1/v = 1/f - 1/u = 1/-12 - 1/-10 = -1/60$

$\therefore v = -60 \text{ cm}$

Hence, image is formed behind the mirror.



Question 53.

A student wants to project the image of a candle flame on the walls of school laboratory by using a mirror.

(a) Which type of mirror should he use and why?

(b) At what distance in terms of focal length 'f' of the mirror should he place the candle flame so as to get the magnified image on the wall?

(c) Draw a ray diagram to show the formation of image in this case.

(d) Can he use this mirror to project a diminished image of the candle flame on the same wall?

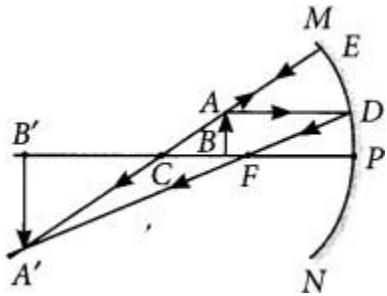
State 'how' if your answer is 'yes' and 'why not' if your answer is 'no' (Delhi 2014)

Answer:

(a) He should use concave mirror to get image of candle flame on the walls of school laboratory. Because concave mirror is a converging mirror and produce real image.

(b) He should place the candle flame in between centre of curvature C and principal focus F of the mirror to get the magnified image on the wall.

(c)



(d) Yes, he can use concave mirror to project a diminished image of the candle flame on the same wall. He has to place the candle flame beyond centre of curvature to get diminished image.

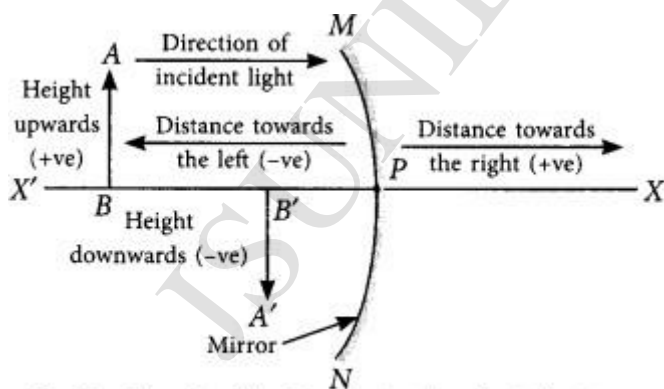
Question 54.

List the sign conventions for reflection of light by spherical mirrors. Draw a diagram and apply these conventions in the determination of focal length of a spherical mirror which forms a three times magnified real image of an object placed 16 cm in front of it. (Delhi 2012)

Answer:

Sign Convention for Reflection by Spherical Mirrors : While dealing with the reflection of light by spherical mirrors, we shall follow a set of sign conventions called the New Cartesian Sign Convention, the conventions are as follows:

- (i) 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.
- (ii) All distances parallel to the principal axis are measured from the pole of the mirror.
- (iii) All the distances measured to the right of the origin (along + x-axis) are taken as positive while those measured to the left of the origin (along - x-axis) are taken as negative.
- (iv) Distances measured perpendicular to and above the principal axis (along +y-axis) are taken as positive.
- (v) Distances measured perpendicular to and below the principal axis (along -y-axis) are taken as negative.



The New Cartesian Sign Convention for spherical mirrors

Given that $m = -3$ (real image), $u = -16$ cm

Magnification, $m = -v/u$

$$\therefore -3 = \frac{-v}{-16} \quad \text{or} \quad v = -48 \text{ cm}$$

Mirror formula: $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\therefore \frac{1}{(-48)} + \frac{1}{(-16)} = \frac{1}{f}$$

$$\text{or} \quad \frac{-1-3}{48} = \frac{1}{f} \quad \text{or} \quad \frac{-4}{48} = \frac{1}{f} \quad \text{or} \quad f = -12 \text{ cm}$$

Question 55.

What is meant by power of a lens? (Delhi 2015)

Answer:

Power is the degree of convergence or divergence of light rays achieved by a lens.

It is defined as the reciprocal of its focal length.

i.e., $P = 1/f$

Question 56.

An object is placed at a distance of 15 cm from a convex lens of focal length 20 cm. List four characteristics (nature, position, etc.) of the image formed by the lens. (AI2017)

Answer:

Given : Object distance, $u = -15 \text{ cm}$

Focal length, $f = +20 \text{ cm}$

Using lens formula, As $|u| < |f|$

The object is placed between F and optical centre of lens.

Thus, the four characteristics of the image formed by the convex lens are:

- (i) Erect
- (ii) Virtual
- (iii) Enlarged image,
- (iv) Image is formed on the same side of the lens as the object.

Question 65.

What is meant by power of a lens? What does its sign (+ve or -ve) indicate? State its S.I. unit related to focal length of a lens. (Delhi 2016)

Answer:

Refer to answer 57.

Positive sign (+) of power indicates that lens is convex and negative sign (-) of power indicates that lens is concave.

If focal length (f) is expressed in metres, then, power is expressed in dioptres. The SI unit of power is dioptre. Thus, 1 dioptre is the power of lens whose focal length is 1 metre. $1 \text{ D} = 1 \text{ m}^{-1}$

Question 58.

The refractive indices of glass and water with respect to air are $3/2$ and $4/3$ respectively. If speed of light in glass is $2 \times 10^8 \text{ m/s}$, find the speed of light in water. (AI 2016)

Answer:

$$\text{Given: } {}_a n_g = \frac{3}{2}, \quad {}_a n_w = \frac{4}{3}$$

Speed of light in glass, $v = 2 \times 10^8$ m/s

$$\text{We know, } {}_a n_g = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$$

$$\Rightarrow \frac{3}{2} = \frac{c}{2 \times 10^8} \Rightarrow c = 3 \times 10^8 \text{ m/s}$$

$$\text{Now, } {}_a n_w = \frac{\text{speed of light in air}}{\text{speed of light in water}}$$

$$\Rightarrow \frac{4}{3} = \frac{3 \times 10^8}{v}$$

$$\Rightarrow v = \frac{9}{4} \times 10^8 \text{ m/s} = 2.25 \times 10^8 \text{ m/s}$$

Question 59.

The absolute refractive indices of glass and water are $\frac{4}{3}$ and $\frac{3}{2}$ respectively. If the speed of light in glass is 2×10^8 m/s, calculate the speed of light in (i) vacuum, (ii) water. (AI 2015)

Answer:

Given that: $n_g = \frac{4}{3}$, $n_w = \frac{3}{2}$, $v_g = 2 \times 10^8$ m/s

Absolute refractive index of a medium, $n_m = \frac{c}{v}$

where, c is the speed of light in vacuum and v is the speed of light in medium.

$$(i) \quad \therefore n_g = \frac{c}{v_g}$$

$$\text{or } c = n_g \times v_g = \frac{4}{3} \times 2 \times 10^8 = \frac{8}{3} \times 10^8 \text{ m/s}$$

$$(ii) \quad \text{As, } n_{gw} = \frac{n_g}{n_w} = \frac{v_w}{v_g}$$

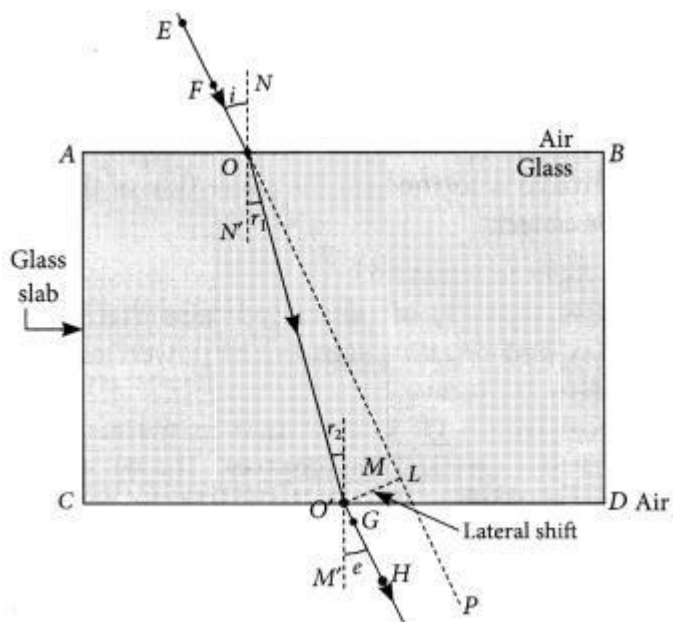
$$\therefore \frac{4/3}{3/2} = \frac{v_w}{2 \times 10^8} \text{ or } v_w = \frac{8}{9} \times 2 \times 10^8$$

$$\Rightarrow v_w = \frac{16}{9} \times 10^8 \text{ m/s}$$

Note: The values given in question are not correct as the speed of light in vacuum is 3×10^8 m/s

Question 60.
"A ray of light incident on a rectangular glass slab immersed in any medium emerges parallel to itself." Draw labelled ray diagram to justify the statement". (Delhi 2013)

Answer:



Question 61.

The absolute refractive indices of glass and water are 1.5 and 1.33 respectively. In which medium does light travel faster? Calculate the ratio of speeds of light in the two media. (Delhi 2013 C)

Answer:

Given : refractive index of glass, $n_g = 1.5$

Refractive index of water, $n_w = 1.33$

Since, refractive index of medium,

$$n = \frac{\text{speed of light in air } (c)}{\text{speed of light in medium } (v)}$$

For glass $n_g = cv_g$ (i)

For water $n_w = cv_w$ (ii)

Since velocity of light in medium is inversely proportional to its refractive index, the light will travel faster in optically rarer medium i.e., water.

Dividing (i) by (ii),

$$\frac{n_g}{n_w} = \frac{v_w}{v_g} \quad \text{or} \quad \frac{v_g}{v_w} = \frac{n_w}{n_g}$$

$$\frac{v_g}{v_w} = \frac{1.33}{1.5}$$

So, the ratio of v_g and v_w is 1.33 : 1.5.

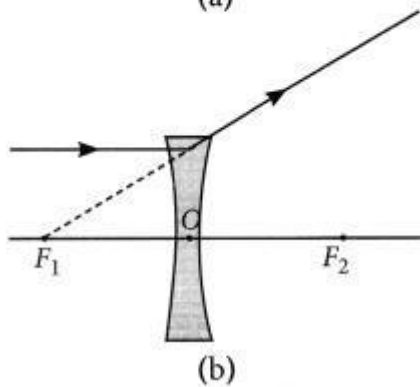
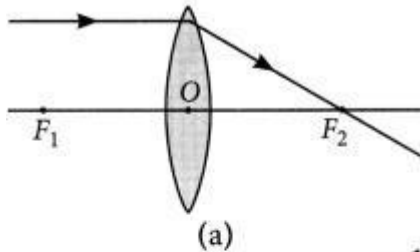
Question 62.

To construct a ray diagram we use two light rays which are so chosen that it is easy to know their directions after refraction from the lens. List these two rays and state the path of these rays after refraction. Use these two rays to locate the image of an object placed between 'f' and '2f' of a convex lens. (Fóieign 2012)

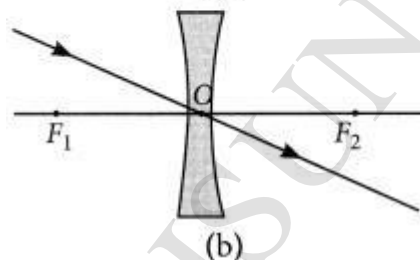
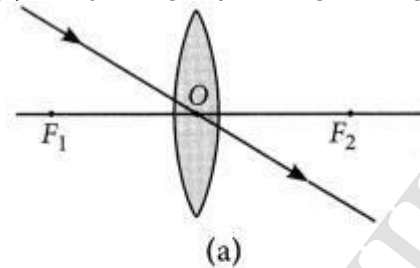
Answer:

The two rays are:

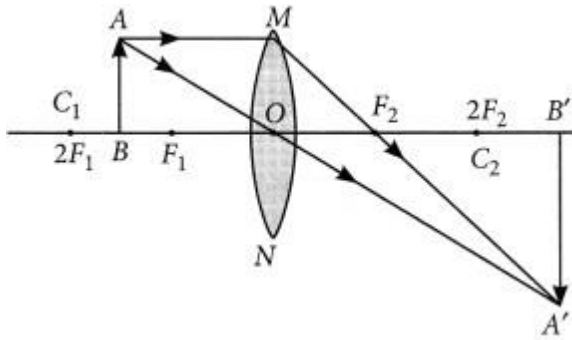
(i) A ray of light from the object, parallel to the principal axis, after refraction from a convex lens, passes through the principal focus on the other side of the lens and in case of concave lens, a ray appears to diverge from the principal focus located on the same side of the lens.



(ii) A ray of light passing through the optical centre of a lens will emerge without any deviation.



When object is placed between F and $2F$.

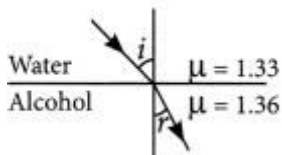


Question 63.

- (a) Water has refractive index 1.33 and alcohol has refractive index 1.36. Which of the two medium is optically denser? Give reason for your answer.
 (b) Draw a ray diagram to show the path of a ray of light passing obliquely from water to alcohol.
 (c) State the relationship between angle of incidence and angle of refraction in the above case. (2020)

Answer:

- (a) Here, alcohol is optically denser medium as its refractive index is higher than that of water. When we compare the two media, the one with larger refractive index is called the optically denser medium than the other as the speed of light is lower in this medium.
 (b) Since light is travelling from water (rarer medium) to alcohol (denser medium), it slows down and bends towards the normal.



where i = angle of incidence and r = angle of refraction.

(c) According to Snell's law,

$$\sin i \sin r = \mu_{\text{alcohol}} \mu_{\text{water}} = 1.36 \times 1.33 = 1.0225$$

$$\therefore \sin i = 1.0225 \times \sin r$$

Question 64.

The refractive index of a medium 'V' with respect to a medium 'y' is $\frac{2}{3}$ and the refractive index of medium 'y' with respect to medium 'z' is $\frac{4}{3}$. Find the refractive index of medium 'z' with respect to medium 'V'. If the speed of light in medium 'x' is $3 \times 10^8 \text{ m s}^{-1}$, calculate the speed of light in medium 'y'. (2020)

Answer:

Given, refractive index of medium x with respect to y,

$${}_y\mu_x = \frac{2}{3}$$

Refractive index of medium y with respect to z,

$${}_z\mu_y = \frac{4}{3}$$

\therefore Refractive index of medium x with respect to z,

$${}_z\mu_x = {}_y\mu_x \cdot {}_z\mu_y = \frac{2}{3} \times \frac{4}{3} = \frac{8}{9}$$

\therefore Refractive index of medium z with respect to x,

$${}_x\mu_z = \frac{1}{{}_z\mu_x} = \frac{9}{8}$$

Now speed of light in x = 3×10^8 m/s

Speed of light in y, $v_y = ?$

$$\therefore \mu_x = \frac{\text{Speed of light in y}}{\text{Speed of light in x}} = \frac{v_y}{3 \times 10^8 \text{ m/s}}$$

$$\Rightarrow v_y = \frac{2}{3} \times 3 \times 10^8 = 2 \times 10^8 \text{ m/s}$$

$$\Rightarrow v_y = 23 \times 3 \times 10^8 = 2 \times 10^8 \text{ m/s}$$

Question 65.

A real image $\frac{2}{3}$ rd of the size of an object is formed by a convex lens when the object is at a distance of 12 cm from it. Find the focal length of the lens. (AI 2019)

Answer:

Given, $h' = \frac{2}{3}h$, $u = -12$ cm

$$\text{Magnification, } m = \frac{h'}{h} = \frac{v}{u}$$

$$\Rightarrow v = \frac{h'}{h} \times u = \frac{-\frac{2}{3}h}{h} \times (-12) = 8 \text{ cm}$$

$$\text{Using lens formula, } \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\Rightarrow \frac{1}{f} = \frac{1}{8} - \frac{1}{-12} = \frac{3+2}{24} \Rightarrow f = 4.8 \text{ cm}$$

\therefore Focal length of the convex lens = 4.8 cm

Question 66.

State the laws of refraction of light. Explain the term 'absolute refractive index of a medium' and write an expression to relate it with the speed of light in vacuum. (2018)

Answer:

(a) Laws of refraction of light:

(i) The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.

(ii) The ratio of sine of angle of incidence to the sine of the angle of refraction is constant, for the light of a given colour and for the given pair of media.

This law is also known as Snell's law of refraction.

$$\frac{\sin i}{\sin r} = \text{constant},$$

where i is the angle of incidence and r is the angle of refraction.

This constant value is called refractive index of the second medium with respect to the first when the light travels from first medium to second medium.

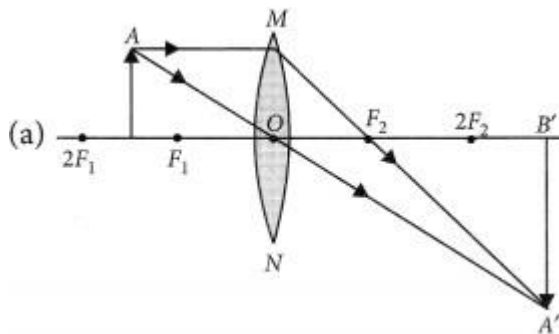
$$\Rightarrow \text{constant} = n_{21} = \frac{v_1 v_2}{c} \therefore \frac{\sin i}{\sin r} = \frac{v_1 v_2}{c}$$

If n is the absolute refractive index of the medium, c is the velocity of light in vacuum and v is the speed of light in a given medium, then $n = \frac{c}{v}$.

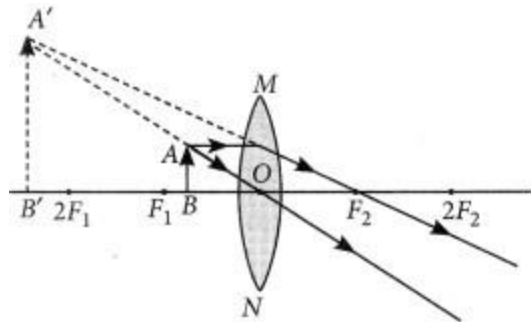
Question 67.

Draw ray diagrams to show the formation of three times magnified (a) real, and (b) virtual image of an object by a converging lens. Mark the positions of O, F and 2F in each diagram. (AI 2017)

Answer:



(b) Ray diagrams of an object placed between F_1 and optical centre O of lens can be drawn as follows:



- (i) The image formed is virtual and erect.
- (ii) Image is formed in front of the lens.
- (iii) Image formed is enlarged.

Question 68.

(a) Draw a diagram to show the refraction of light through a glass slab and mark angle of refraction and the lateral shift suffered by a ray of light while passing through the slab.

(b) If the refractive index of glass for light going from air to glass is $3/2$, find the refractive index of air for light going from glass to air. (Delhi 2016)

Answer:

(a) Refer to answer 68.

(b) Refractive index of glass w.r.t air is 3

$${}_g n_a = 3/2$$

Now, refractive index of air w.r.t glass will be

$${}_a n_g = 1/{}_g n_a = 1/(3/2) = 2/3$$

Question 69.

The image of an object formed by a lens is of magnification -1 . If the distance between the object and its image is 60 cm, what is the focal length of the lens? If the object is moved 20 cm towards the lens, where would the image be formed? State reason and also draw a ray diagram in support of your answer. (AI2016)

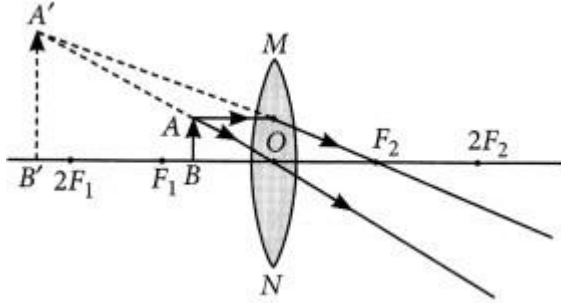
Answer:

Magnification of -1 indicates that the image is real and inverted and is of the same size as of the object. The object must be at $2f$ and image also at $2f$ on the other side.

Total distance between image and object

$$\text{Also } 4f = 60 \text{ cm} \Rightarrow f = 15 \text{ cm}$$

If object is moved 20 cm towards the lens, then the object will be between focus and optical centre of the lens and image formed will be virtual and erect and on the same side of the lens.



Question 70.

(a) Define focal length of a spherical lens.

(b) A divergent lens has a focal length of 30 cm. At what distance should an object of height 5 cm from the optical centre of the lens be placed so that its image is formed 15 cm away from the lens? Find the size of the image also.

(c) Draw a ray diagram to show the formation of image in the above situation. (AI 2016)

Answer:

(a) Distance between the optical centre and the focus of the lens is known as the focal length of the lens.

(b) Given $f = -30$ cm, $v = -15$ cm, $h = 5$ cm From the lens formula,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{-1}{15} - \frac{1}{u} = \frac{-1}{30}$$

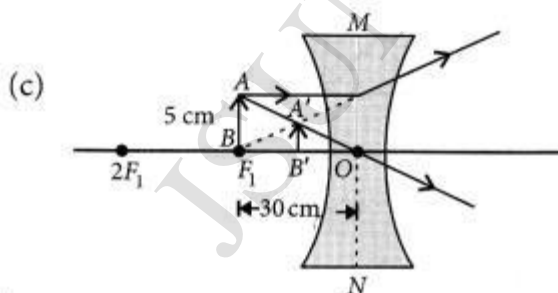
$$\Rightarrow \frac{-1}{u} = \frac{-1}{30} + \frac{1}{15} = \frac{-1+2}{30} = \frac{1}{30} \Rightarrow u = -30 \text{ cm}$$

Object should be placed 30 cm from the optical centre.

Also $m = h'/h = v/u \Rightarrow h' = h(v/u)$

or $h' = 5 \times -15/-30 = 2.5$ cm

Size of image formed is 2.5 cm

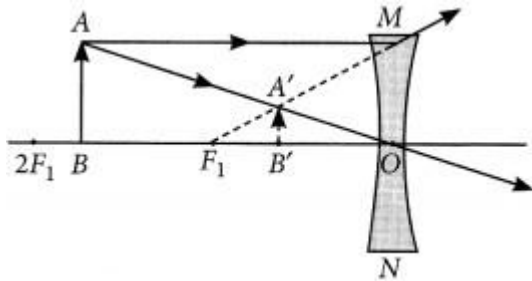


Question 71.

If the image formed by a lens for all positions of the object placed in front of it is always virtual, erect and diminished, state the type of the lens. Draw a ray diagram in support of your answer. If the numerical value of focal length of such a lens is 20 cm, find its power in new cartesian sign conventions. (Foieign 2016)

Answer:

Concave lens always forms virtual, erect and diminished image for all positions of the object.



Focal length of the concave lens

$$f = -20 \text{ cm} = -0.20 \text{ m}$$

$$\text{Power of the lens, } P = 1/f(\text{in m}) = -100/20\text{m} = -5\text{D}$$

Question 72.

State the laws of refraction of light. If the speed of light in vacuum is $3 \times 10^8 \text{ m/s}$, find the absolute refractive index of a medium in which light travels with a speed of $1.4 \times 10^8 \text{ m/s}$. (Foieign 2015)

Answer:

Laws of refraction: Refer to answer 74.

$$\text{The speed of light in vacuum} = 3 \times 10^8 \text{ m/s}$$

$$\text{The speed of light in a medium} = 1.4 \times 10^8 \text{ m/s}$$

\therefore Absolute refractive index

$$= \frac{\text{Speed of light in vacuum}}{\text{Speed of light in a medium}}$$

$$n = \frac{3 \times 10^8 \text{ m/s}}{1.4 \times 10^8 \text{ m/s}} = 2.14$$

Question 73.

State the laws of refraction of light. If the speed of light in vacuum is $3 \times 10^8 \text{ m s}^{-1}$, find the speed of light in a medium of absolute refractive index 1.5. (Delhi 2014, AI 2014)

Answer:

$$\text{The speed of light in vacuum} = 3 \times 10^8 \text{ m/s}$$

$$\text{Absolute refractive index} = 1.5$$

\therefore The speed of light in a medium

$$= \frac{\text{Speed of light in vacuum}}{\text{Absolute refractive index}} = \frac{3 \times 10^8 \text{ m/s}}{1.5}$$

$$= 2 \times 10^8 \text{ m/s}$$

Question 74.

The image of a candle flame placed at a distance of 40 cm from a spherical lens is formed on a screen placed on the other side of the lens at a distance of 40 cm from the lens. Identify the type of lens and write its focal length. What will be the nature of the image formed if the candle flame is shifted 25 cm towards the lens? Draw a ray diagram to justify your answer. (Foieign 2014)

Answer:

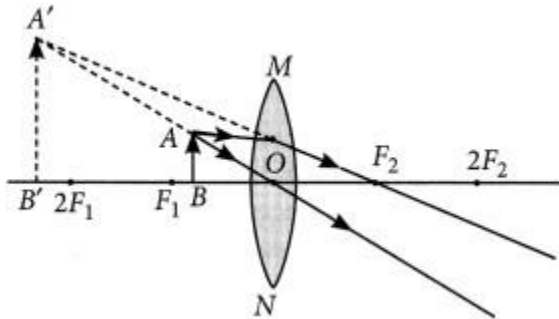
$$\text{Given : } u = -40 \text{ cm, } v = 40 \text{ cm}$$

$$1f = 140 + 140 = 280 \Rightarrow f = 20 \text{ cm}$$

Type of lens : Convex lens

Focal length = 20 cm

Nature of the image will be virtual and erect if the candle flame is shifted 25 cm towards the lens.



Question 75.

An object of height 6 cm is placed perpendicular to the principal axis of a concave lens of focal length 5 cm. Use lens formula to determine the position, size and nature of the image if the distance of the object from the lens is 10 cm. (Delhi 2013)

Answer:

Focal length of given concave lens, $f = -5 \text{ cm}$

Distance, $u = -10 \text{ cm}$, object size, $h = 6 \text{ cm}$

Image distance, $v = ?$

Using lens formula, $1f = 1v - 1u$

$$1/v = 1/f + 1/u = 1/-5 + 1/-10 = -3/10$$

$$v = -10/3 = -3.33 \text{ cm}$$

So, the image is located 3.33 cm from the lens. Magnification (m) of lens is given by

$$m = v/u = -10/3 / -10 = 1/3 = 0.33$$

m is positive implies that image is virtual and erect. Also, magnitude of m is less than one implies that image is diminished.

Since $m = v/u = h'/h \Rightarrow 1/3 = h'/6$ or $h' = 2 \text{ cm}$

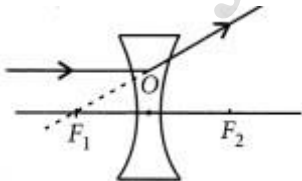
Question 76.

Draw ray diagram to show the path of the refracted ray in each of the following cases. A ray of light incident on a concave lens

(i) is parallel to its principal axis, (ii) is passing through its optical centre and (iii) is directed towards its principal focus. (Delhi 2013 C)

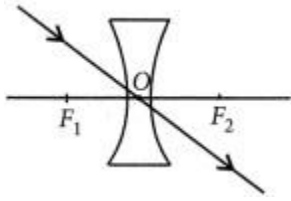
Answer:

(i) A ray of light incident on a concave lens is parallel to its principal axis, the diagram can be drawn as follows:

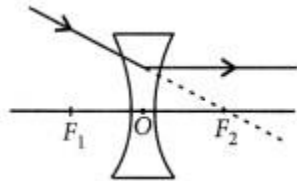


The refracted ray appears to pass through focus on the same side of the lens.

(ii) If a ray of light incident on a concave lens is passing through its optical centre then the refracted ray will go without deviation.



(iii) If a ray of light incident on a concave lens is deflected towards its principal axis then it will go parallel to principal axis.



Question 77.

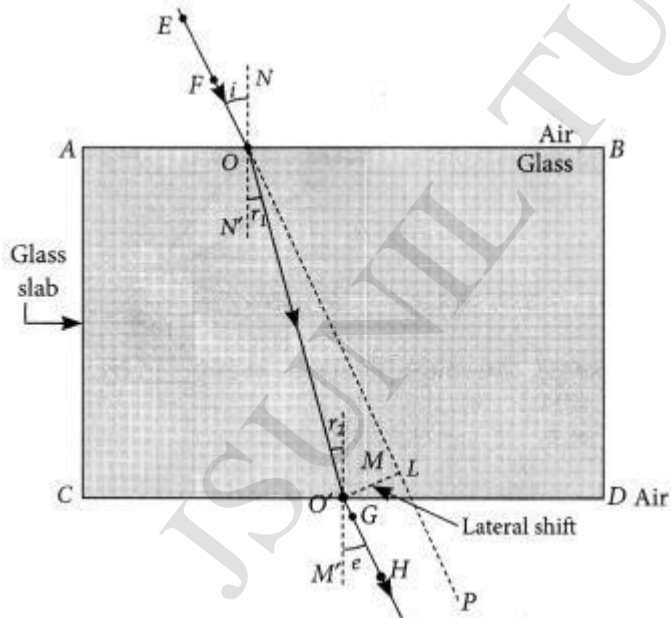
What is the principle of reversibility of light? Show that the incident ray of light is parallel to the emergent ray of light when light falls obliquely on a side of a rectangular glass slab. (AI 2011)

Answer:

Principle of reversibility of light states that the light will follow exactly the same path if the direction is reversed.

Using Snell's law of refraction, $\frac{\sin i}{\sin r_1} = \frac{\sin e}{\sin r_2}$

Since $i_1 = i_2$, so $i = e$



so PQ is parallel to RS.

So, we conclude that incident ray is parallel to the emergent ray.

Question 78.

Draw a ray diagram in each of the following cases to show the formation of image, when the object is placed:

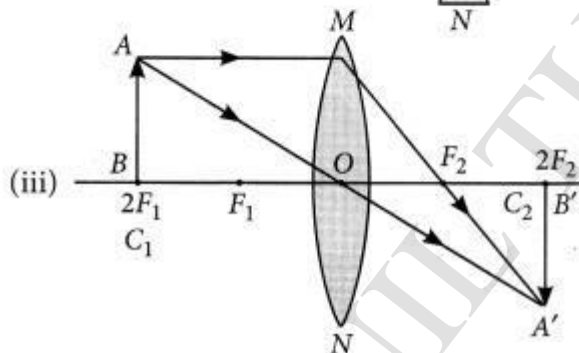
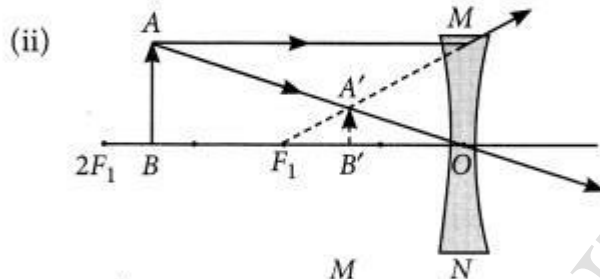
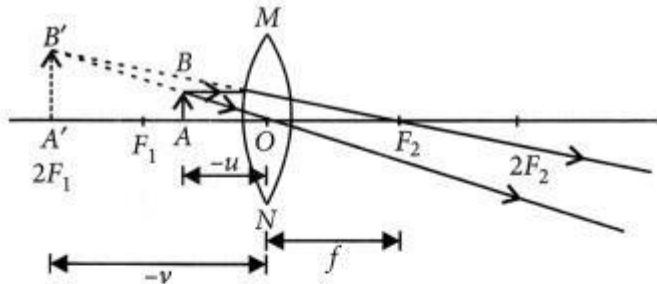
- (i) between optical centre and principal focus of a convex lens.
- (ii) anywhere in front of a concave lens.

(iii) at $2F$ of a convex lens.

State the signs and values of magnifications in the above-mentioned cases (i) and (ii). (2020)

Answer:

(i) When an object is placed between F and optical centre, O of a convex lens, it forms a virtual and erect image. The ray diagram for this situation can be drawn as follows:



In case (i), the magnification, m is given by,

$$m = v/u = -v/-u = \text{positive}$$

i.e., the image formed is virtual and erect.

In case (ii), the magnification,

$$m = v/u = -v/-u = \text{positive}$$

i.e., the image formed is virtual and erect.

Question 80.

Rishi went to a palmist to show his palm. The palmist used a special lens for this purpose.

(i) State the nature of the lens and reason for its use.

(ii) Where should the palmist place/hold the lens so as to have a real and magnified image of an object?

(iii) If the focal length of this lens is 10 cm, the lens is held at a distance of 5 cm from the palm, use lens formula to find the position and size of the image. (2020)

Answer:

(i) The lens used here is a convex lens and it is used as a magnifying glass because at close range, i.e., when the object is placed between optical centre and principal focus it forms an enlarged, virtual and erect image of the object.

(ii) When this lens is placed such that the object is between the centre of curvature and the principal focus, the palmist obtains a real and magnified image.

(iii) Given focal length, $f = 10$ cm and $u = -5$ cm According to lens formula,

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \quad \text{or} \quad \frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$\text{or} \quad \frac{1}{v} = \frac{1}{10} + \frac{1}{-5} = \frac{-5+10}{-50}$$

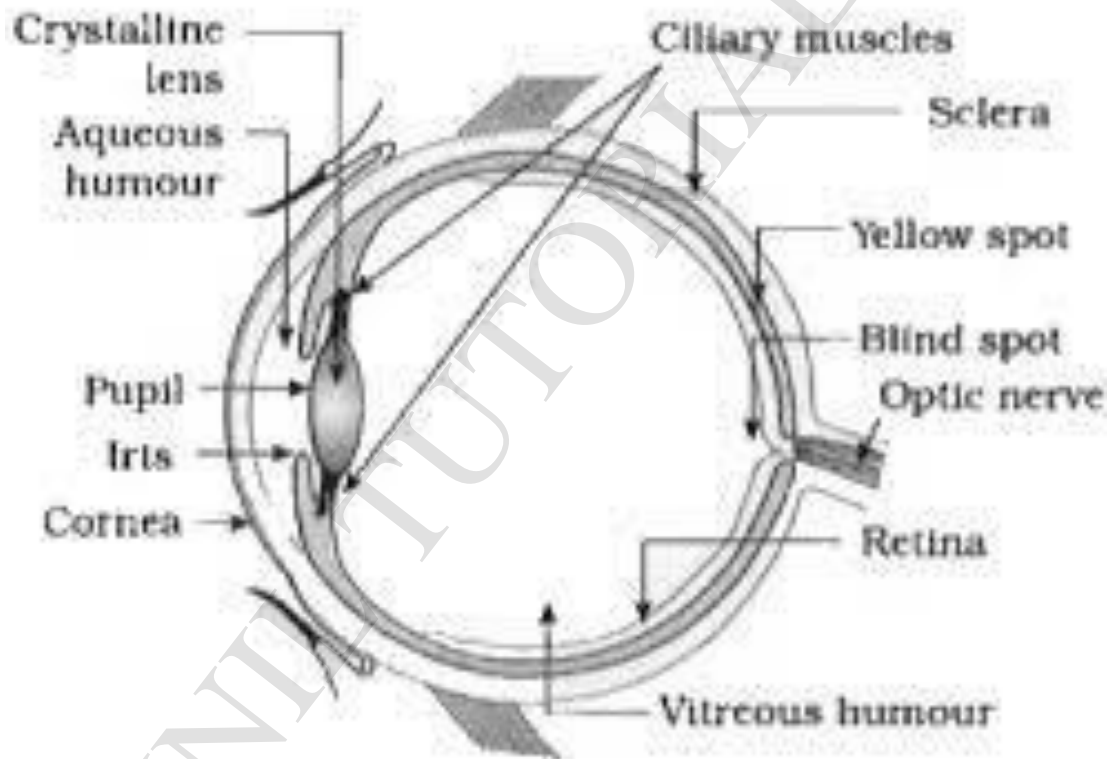
$$\therefore v = \frac{-50}{5} = -10 \text{ cm}$$

Thus, the image will be formed at 10 cm on the same side of the palm and the size of the image will be enlarged.

Chapter- 10
HUMAN EYE AND COLOURFUL WORLD
HUMAN EYE AND COLOURFUL WORLD

Structure of the Human Eye

A human eye is roughly 2.3 cm in diameter and is almost a spherical ball filled with some fluid. It consists of the following parts:



- **Sclera:** It is the outer covering; a protective tough white layer called the sclera (white part of the eye).
- **Cornea:** The front transparent part of the sclera is called the cornea. Light enters the eye through the cornea.
- **Iris:** A dark muscular tissue and ring-like structure behind the cornea is known as the iris. The colour of the iris indicates the colour of the eye. The iris also helps regulate or adjust exposure by adjusting the iris.
- **Pupil:** A small opening in the iris is known as a pupil. Its size is controlled by the help of the iris. It controls the amount of light that enters the eye.

- **Lens:** Behind the pupil, there is a transparent structure called a lens. By the action of ciliary muscles, it changes its shape to focus light on the retina. It becomes thinner to focus on distant objects and becomes thicker to focus on nearby objects.
- **Retina:** It is a light-sensitive layer that consists of numerous nerve cells. It converts images formed by the lens into electrical impulses. These electrical impulses are then transmitted to the brain through optic nerves.
- **Optic nerves:** Optic nerves are of two types. These include cones and rods.
 1. **Cones:** Cones are the nerve cells that are more sensitive to bright light. They help in detailed central and colour vision.
 2. **Rods:** Rods are the optic nerve cells that are more sensitive to dim lights. They help in peripheral vision.

At the junction of the optic nerve and retina, there are no sensory nerve cells. So, no vision is possible at that point and is known as a **blind spot**.

An eye also consists of six muscles. It includes the medial rectus, lateral rectus, superior rectus, inferior rectus, inferior oblique, and superior oblique. The basic function of these muscles is to provide different tensions and torques that further control the movement of the eye.

DEFECTS OF HUMAN EYES

Myopia

Near-sightedness, or myopia, is the defect of vision due to which a person can see nearby objects clearly, but find it difficult to see far-off objects distinctly.

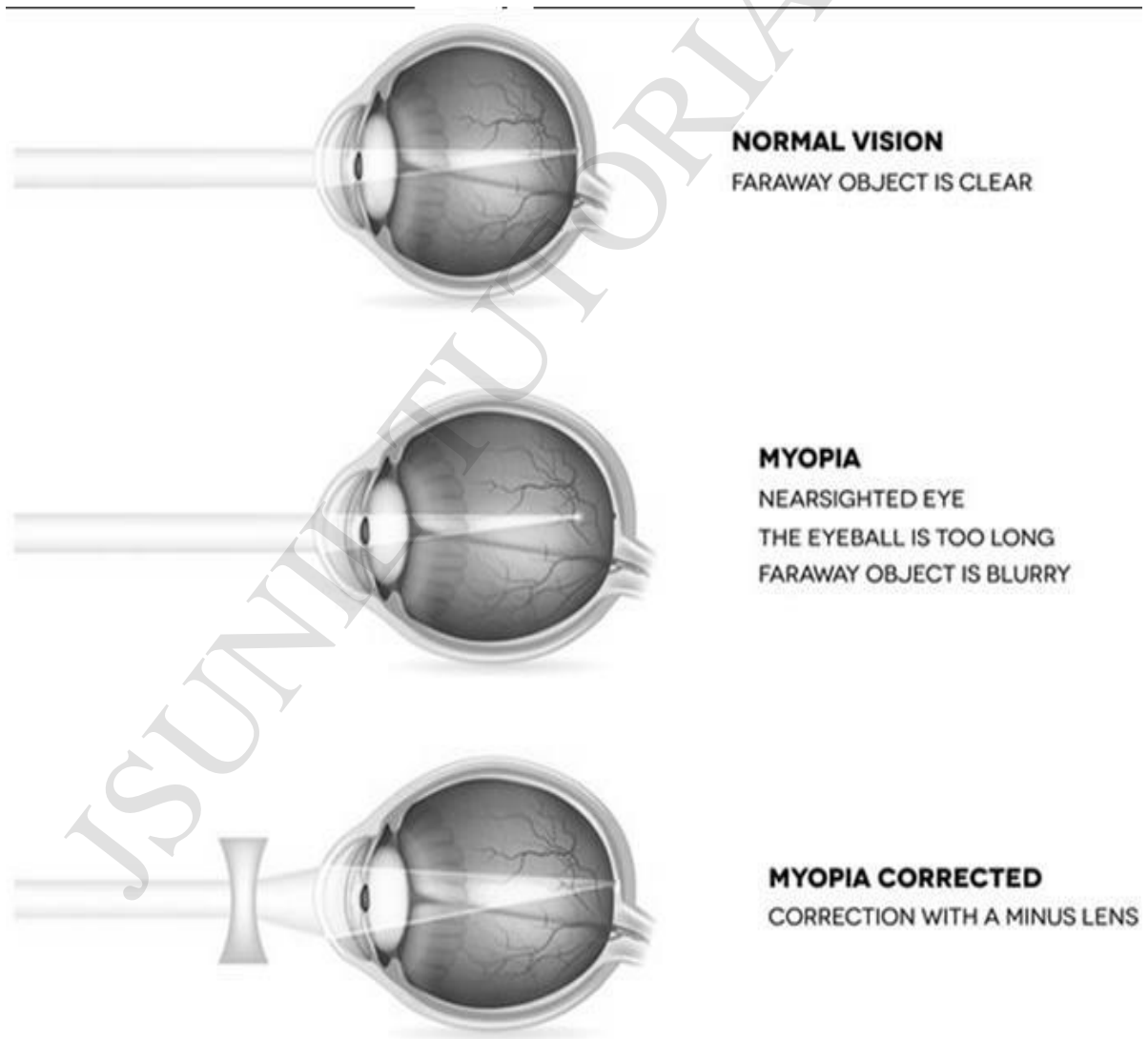
In a myopic person's eye, there is a bulge around the cornea, causing a reduction in the radius of the curvature of the whole eye, and hence, the focal length of the eye is decreased. The eye becomes unable to focus the image of distant objects at the retina as the eyeball is longer (from front to back) than normal. This causes images to be focused in front of the retina instead of on the retina. Thus, the image is formed near the eye lens; that is why this eye defect is called near-sightedness or myopia. As a result of this defect of vision, the distant objects look blurred. The maximum distance at which a myopic eye could see an object is known as its far point; beyond this far point, an image is formed near the eye lens instead of at the retina.

Myopia can be corrected with concave lenses. The lenses focus images farther back in the eye, so they fall on the retina instead of in front of it.

Causes of Myopia

It is caused due to:

1. High converging power of the eye lens (because of its short focal length): Due to the high converging of the eye lens, the image is formed in front of the retina, and a person cannot see distant objects.
2. Eyeball being too long or cornea bulged: If the eyeball is too long, then the retina is at a larger distance from the eye lens. In this case, the image is also formed in front of the retina even though the eye-eye lens corrects converging power.
3. Hereditary or due to uncontrolled diabetes or unattended cataract growths.



(NORMAL VISION & MYOPIA)

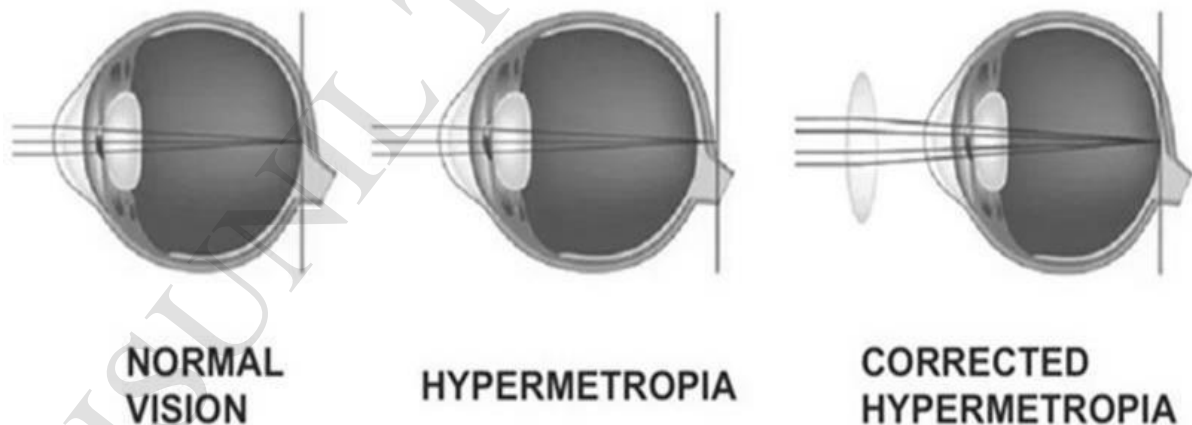
Correction

Myopic eyes do not diverge light rays from far-off objects; hence, a focused image cannot be formed on the retina. Instead, the rays converge much before they reach the retina. *Myopia or short-sightedness can be corrected by wearing spectacles containing a concave lens.* When a concave lens of suitable power is used for the myopic eye, the concave lens first diverges the parallel rays of light from a distant object. Therefore, first, a virtual image is formed at the far point of the myopic eye. Then, since the rays of light appear to be coming from the eye's far point, they are easily focussed by the eye lens, and the image is formed on the retina. Thus, a concave lens is used for a myopic eye to decrease the converging power of the eye lens.

Causes of Hypermetropia

It is caused due to:

1. Low converging or focusing power of crystalline eye lens (because of its large focal length)
2. Eyeball being too short.
3. Hypermetropia can be present in babies at the time of their birth, but as they grow older, the eyeball lengthens to normal, and the defect is cured naturally.



Correction

The near-point of an eye having hypermetropia is more than 25cm. *Therefore, this defect can be corrected by putting a convex lens in front of the eye.* When a convex lens of suitable power is placed in front of the hypermetropic eyes, the convex lens first converges the diverging rays of light coming from a nearby object near the eye, which is the virtual image of the nearby object formed. Since the light rays now appear to be coming from the eye's near point, the eye lens easily focuses and forms the image on the retina.

Thus, a convex lens is used for hypermetropia to increase the converging power of the eye lens.

The hypermetropic eye has positive power. This indicates that the corrective lens required is convex. Such lenses are mainly used during reading or using laptops.

Presbyopia

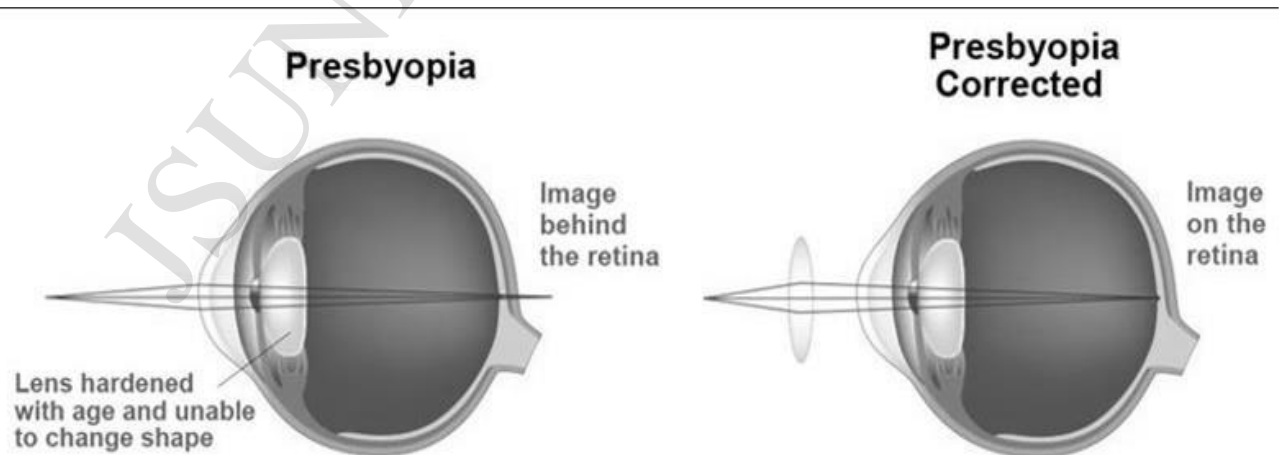
The eyes lose their power of accommodation with ageing. As people grow old, the gradual weakening of the ciliary muscles and diminishing flexibility of the eye lens results in the hardening of the eye lens, making it more difficult for the eye to focus on close objects. This causes the near point to recede away in older people gradually. As a result, these people may find it difficult to see nearby objects distinctly without corrective eyeglasses. This defect of farsightedness caused by the loss of elasticity of the eye lens is called presbyopia. Sometimes, a person may have both farsightedness and short-sightedness. People suffering from presbyopia often require bi-focal lenses. Bi-focal lenses, in general, contain both concave and convex lenses. The upper portion consists of a concave lens to assist distant vision. The lower part is a convex lens to assist near vision.

Causes of Presbyopia

It is caused due to:

1. Gradual weakening of the ciliary muscles.
2. Decreasing flexibility or stiffness of the eye lens.

Both these occur with the eye's natural ageing between 4040 to 6060 years of age, although they may have had normal vision throughout their lives.



Correction

Presbyopia defect is corrected by using bi-focal lenses, which consist of both concave and convex lenses. The upper portion consists of a concave lens. It

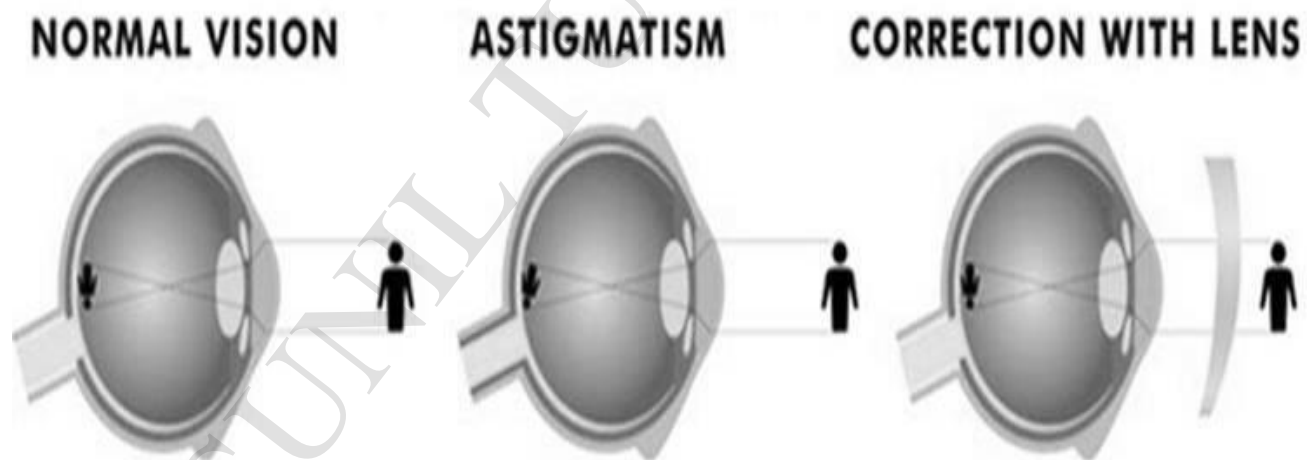
facilitates distant vision. The lower part is a convex lens. It facilitates near vision. Such difference is not visible in progressive lenses, which also function similarly but do not have a line distinguishing the two lenses. Since the transition is smoother, it is more comfortable.

Presbyopia may also be corrected with eyeglasses or contact lenses having a convex lens if both myopia and hypermetropia are not present simultaneously.

Contact lenses used have each lens correcting one defect. People having both defects also use monovision. However, the practical perceptible may not be very good. Modified monovision contact lenses solve the problem of depth perception.

Astigmatism

Astigmatism is a condition caused by a refractive error in which the eye does not focus light evenly on the retina. This results in distorted or blurred vision at any distance. Astigmatism is a common vision problem caused by a fault in the shape of the cornea, resulting in an irregular curve. This can change the way light passes through the cornea and refracts onto the retina. As a result, people with this condition have blurry, fuzzy, or distorted vision.



With developing technologies, it is possible to correct these refractive defects with contact lenses or surgical interventions.

Causes of Astigmatism

1. Irregularly shaped cornea
2. Distorted lens

Types of Astigmatism

1. Corneal Astigmatism: This is due to the irregular shape of the cornea.
2. Lenticular Astigmatism: This is due to the distorted shape of the lens.

Correction

This defect can be corrected by using eyeglasses with cylindrical lenses oriented to compensate for the irregularities in the cornea. Usually, the cornea is spherically shaped, like a baseball. However, in astigmatism, the cornea is elliptically shaped, more like a football. Therefore, the lenses are shaped to counteract the shape of the sections of the cornea that cause the difficulty. Hence, only cylindrical lenses are used to correct astigmatism.

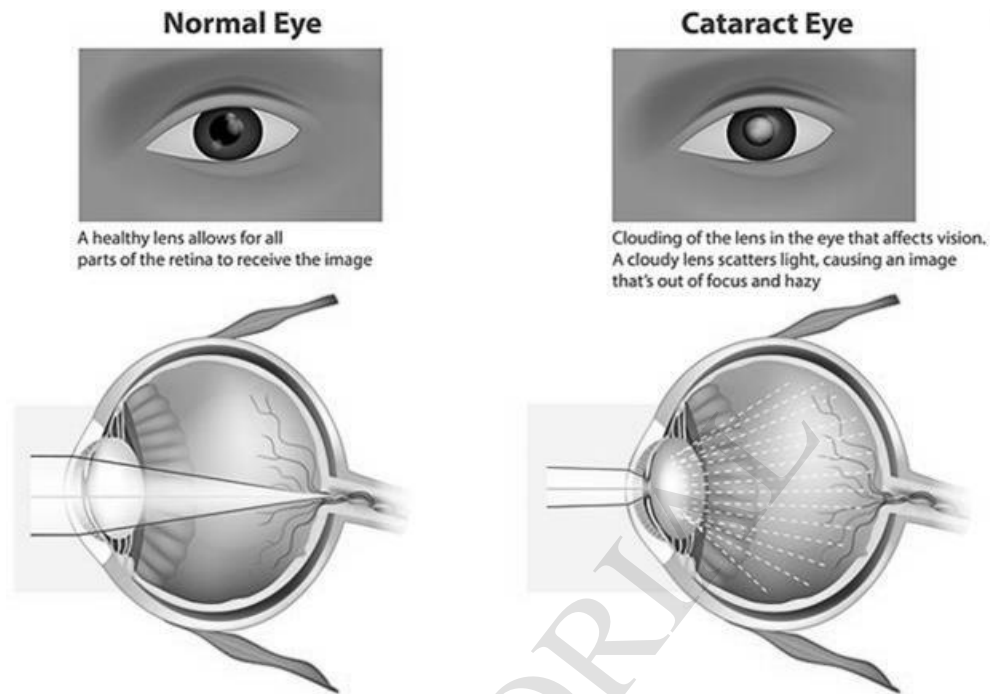
Other Common eye-related Problems

Colour – Blindness

The retina of our eye has a large number of light-sensitive cells having shapes of rods and cones. The rod-shaped cells respond to the light intensity with different brightness and darkness as the cone-shaped cells respond to colour. In dim light, rods are sensitive, but cones are sensitive only in bright. The cones are sensitive to red, green and blue colours of light to different extents.

Due to genetic disorders, some persons do not possess cone-shaped cells that only respond to certain specific colours. Such persons cannot distinguish between particular colours but can be seen well otherwise. Such persons are said to have colour blindness. Driving licenses are generally not issued to persons having colour blindness.

Cataract



Yet another defect of the eye that usually comes old is the *cataract*. The medical condition in which the lens of a person's eyesight becomes progressively cloudy results in blurred vision. It develops when the eye-lens of a person become clouded due to the formation of a membrane over it. It decreases the eye's vision gradually and can lead to a total loss of eye vision. It can be restored after getting surgery. The opaque lens is removed, and an artificial lens is inserted in its place via operation. Any spectacle lenses cannot correct this defect.

Glaucoma

The eyes generate a clear fluid (aqueous humour), filling the space between the cornea and the iris. This causes fluid to filter out through a complex drainage system. This is the balance between the production and drainage of this liquid that determines the eye's intraocular pressure (IOP). Glaucoma is a disease that is caused by increased IOP, usually resulting from a malfunction in the eye's drainage system. High IOP can also cause irreversible damage to the optic nerves and retinal fibres and, if left untreated, can result in a permanent loss of vision.

Age-Related Macular Degeneration (ARMD)

It is a degenerative condition of the macula (the central retina). The reason for its cause is the hardening of the arteries that nourish the retina. This deprives the retinal tissue of the nutrients and oxygen needed to function and causes a deterioration in central vision.

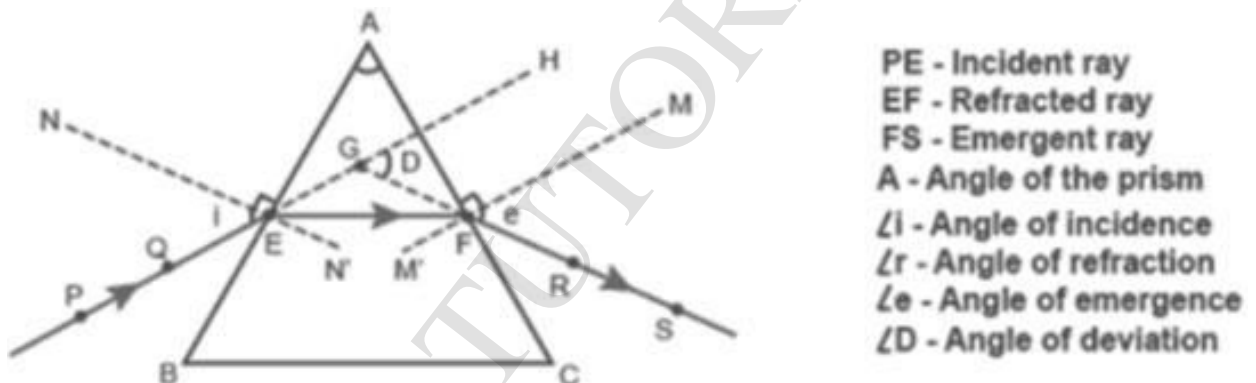
Refraction of light through a prism:

When a ray of light is incident on a rectangular glass slab, after refracting through the slab, it gets displaced laterally. As a result, the emergent ray comes out parallel to the incident ray. Unlike a rectangular slab, the side of a glass prism is inclined at an angle called the angle of the prism.

Prism: A prism is a transparent refracting medium bounded by two plane surfaces, inclined to each other at a certain angle. It has one triangular base and three rectangular lateral surfaces.

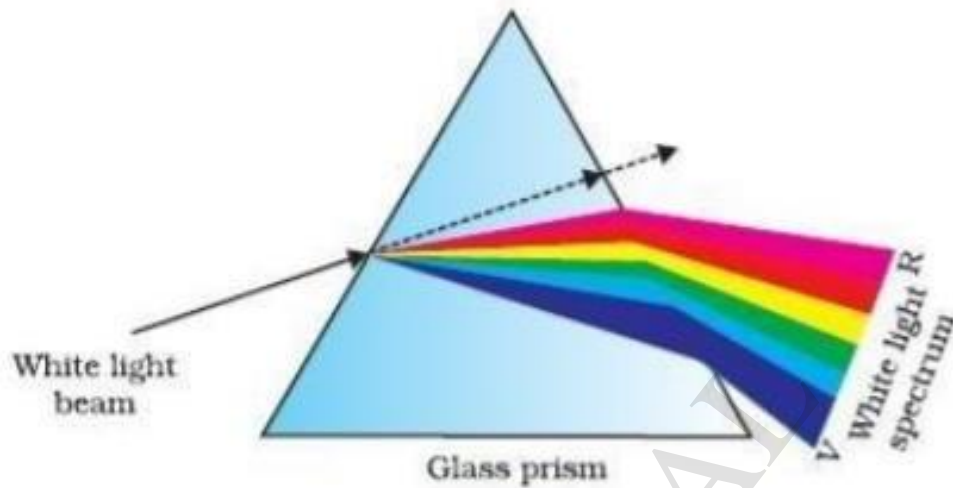
The angle of Prism: The angle between two lateral faces is called the angle of the prism.

The angle of Deviation: The angle between the incident ray and the emergent ray.



Refraction of light through a triangular glass prism

3. Dispersion of white light by a glass prism: The phenomenon of splitting of white light into its seven constituent colours when it passes through a glass prism is called dispersion of white light. The various colours seen are Violet, Indigo, Blue, Green, Yellow, Orange and Red. The sequence of colours remembers as VIBGYOR. The band of seven colours is called the spectrum. The different component colour of light bends at different angle concerning the incident angle. The violet light bends the least while the red bends most.



Dispersion of white light by a prism

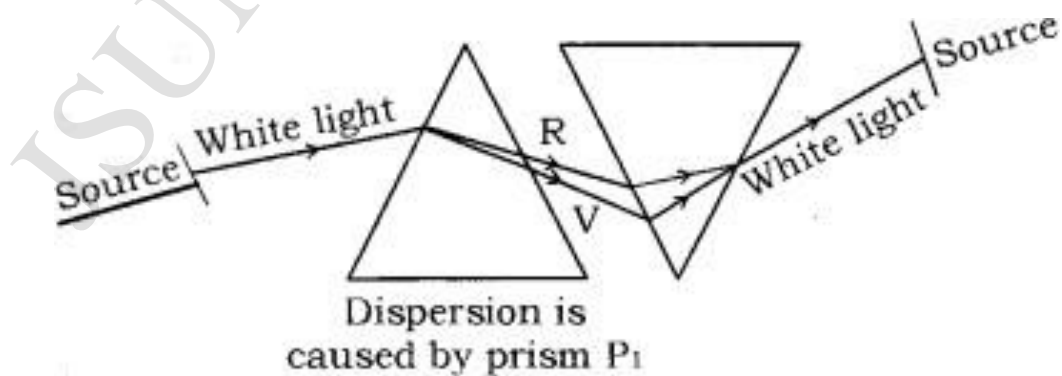
For violet colour, the wavelength is minimum and for red colour wavelength is maximum, i.e. frequency for violet colour is maximum and for red colour frequency is minimum.

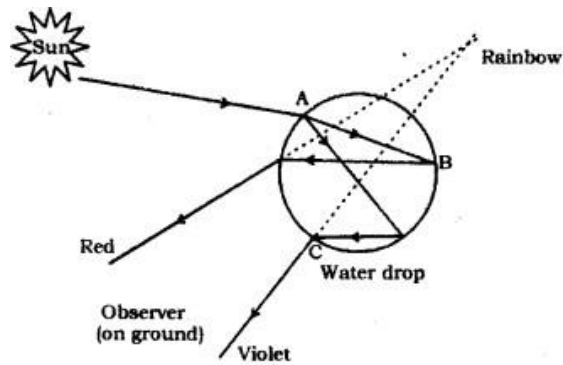
Composition of white light: White light consists of seven colours i.e., violet, indigo, blue, green, yellow, orange and red.

Monochromatic light: Light consisting of single colour or wavelength is called monochromatic light, example; sodium light.

Polychromatic light: Light consisting of more than two colours or wavelengths is called polychromatic light, for example; white light.

Recombination of white light: Newton found that when an inverted prism is placed in the path of dispersed light then after passing through the prism, they recombine to form white light.





Rainbow: It is the spectrum of sunlight in nature. It is formed due to the dispersion of sunlight by the tiny water droplet, present in the atmosphere.

Formation of the rainbow: The water droplets act like a small prism. They refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop. Due to the dispersion of light and internal reflection, different colours reach the observer's eye.

Conditions for the formation of rainbow are:

- (i) The formation of a rainbow involves a series of physical phenomena refraction, dispersion and internal reflection
- (ii) Rainbow is always formed in a direction opposite to that of the sun, i.e. the sun is always behind the observer

The red colour appears on top and violet at the bottom of the rainbow.

A rainbow is always formed in a direction opposite to that of Sun.

At 'A' – Refraction and dispersion take place.

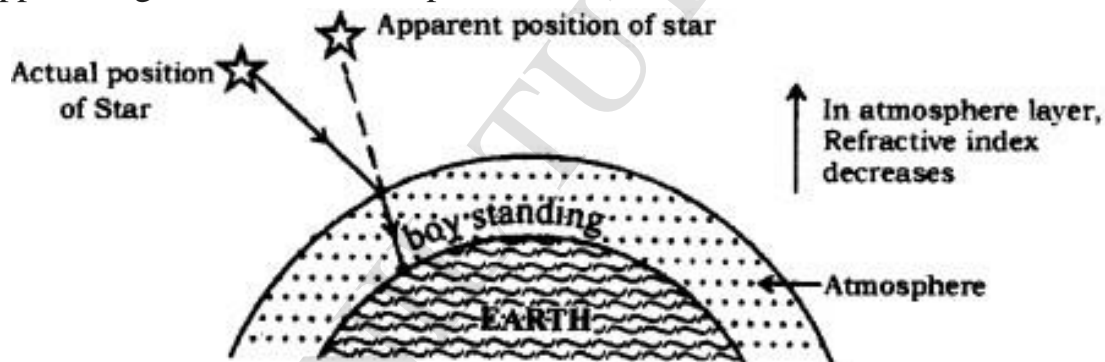
At 'B' – Internal reflection takes place.

At 'C' – Refraction and dispersion take place.

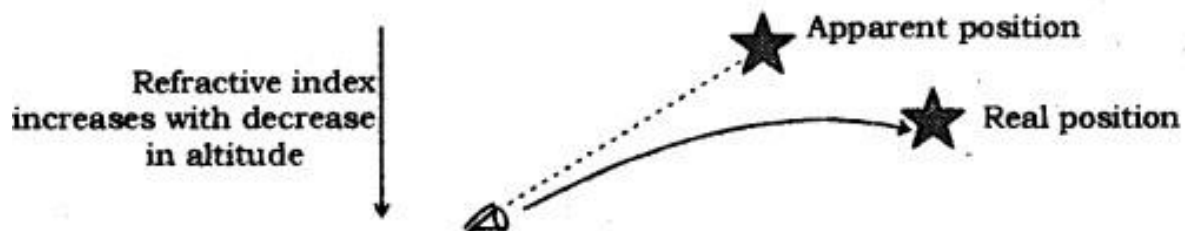
Rainbow formation

4. Atmospheric Refraction: The refraction of light caused by the Earth's atmosphere (having air layers of varying optical densities) is called Atmospheric Refraction.

Appearance of Star Position: It is due to atmospheric refraction of star light. The temperature and density of different layer of atmosphere keeps varying. Hence, we have different medium. Distant star act as point source of light. When the starlight enters the Earth's atmosphere, it undergoes refraction continuously, due to changing refractive index i.e., from Rarer to denser. It bends towards the normal. Due to this, the apparent position of the star is different from actual position. The star appears higher than its actual position.



Twinkling of Star: It is also due to atmospheric refraction. Distant star act like a point source of light. As the beam of starlight keeps deviating from its path, the apparent position of star keeps on changing because physical condition of earth's atmosphere is not stationary. Hence, the amount of light enters our eyes fluctuate sometimes bright and sometimes dim. This is the "Twinkling effect of the star".



5. Scattering of light: According to Rayleigh's Law of Scattering, the amount of scattered light is $1/\lambda^4$ (λ = wavelength). The scattering of light decreases with increase in wavelength.

Examples of the Tyndall effect: Shining a flashlight beam into a glass of milk, the visible beam of headlights in fog is caused by the Tyndall effect. The water droplets scatter the light, making the headlight beams visible.

Colour of the sky: The sunlight that reaches the earth's atmosphere is scattered in all directions by the gases and dust particles present in the atmosphere.

The sky appears blue; this is because the size of the particles in the atmosphere is smaller than the wavelength of visible light, so they scatter the light of a shorter wavelength (blue end of the spectrum). The blue colour is scattered more and hence the sky appears blue.

Some applications of scattering of light in daily life are:

1. The sun's reddish hue at daybreak and sunset.
2. The bright white of the noonday sky.
3. The sky's blue colour forms due to the molecules nitrogen and oxygen.
4. The absence of an atmosphere is what causes the sky to be so dark.
5. Red light is used as a warning signal because, due to its longer wavelength, it is least scattered by particles.
6. The increase in temperature is what gives clouds their white colour.

QUESTIONS FROM PREVIOUS BOARD EXAMS

Question 1.

State one function of the iris in the human eye. (AI 2012)

Answer:

Iris is a dark muscular diaphragm that controls the size of the pupil.

Question 2.

State one function of the crystalline lens in the human eye. (Foreign 2012)

Answer:

The crystalline lens of the human eye focuses the light that enters the eye and forms the image on the retina.

Question 3.

Define the term power of accommodation. Write the modification in the curvature of the eye lens which enables us to see the nearby objects. (Delhi 2019)

Answer:

The ability of the eye lens to adjust its focal length is called the power of accommodation. The ciliary muscles modify the curvature to some extent. The change in the curvature of the eye lens can thus change its focal length. When the ciliary muscles contract, the lens becomes thick and its focal length decreases, thus enabling us to see nearby objects.

Question 4.

Trace the sequence of events that occur when a bright light is focused on your eyes. (Delhi 2019)

Answer:

When a bright light enters the eye then most of the refraction for the light rays entering the eye occurs at the outer surface of the cornea. Then, the crystalline lens merely provides the finer adjustment of the focal length required to focus an object at different distances on the retina. The pupil regulates and controls the amount of light entering the eye. At the retina, the light-sensitive cells get activated upon illumination and generate electric signals. These signals are sent to the brain via the optic nerves. The brain interprets these signals and finally, processes the information so that we perceive objects as they are.

Question 5.

Write about the power of accommodation of the human eye. Explain why the image distance in the eye does not change when we change the distance of an object from the eye. (Delhi 2017)

Answer:

The ability of the eye lens to adjust its focal length is called the power of accommodation. The ciliary muscles modify the curvature to some extent. The change in the curvature of the eye lens can thus change its focal length. Thus, the focal length of the human lens increases or decreases depending on the distance of the object value to this distance of the image does not change. For example, when the ciliary muscles are relaxed, the lens becomes thin and its focal length increases, thus enabling us to see distant objects.

Question 6.

A person suffering from cataracts has

- (a) elongated eyeball
- (b) excessive curvature of the eye lens
- (c) weakened ciliary muscles
- (d) opaque eye lens

Answer:

- (d) A person suffering from cataracts has a cloudy opaque eye lens.

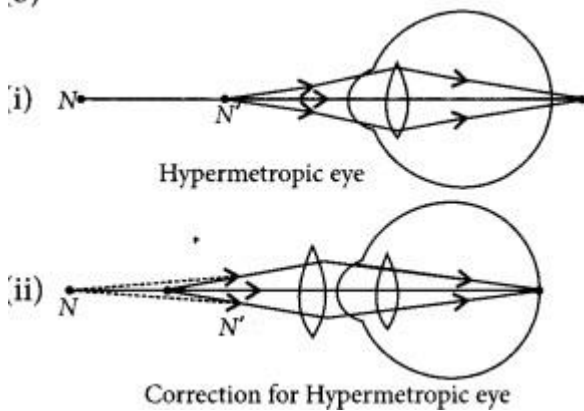
Question 7.

- (a) List two causes of hypermetropia.
- (b) Draw ray diagrams showing (i) a hypermetropic eye and (ii) its correction using a suitable optical device. (2020)

Answer:

- (a) Hypermetropia is caused due to following reasons:

- (i) Shortening of the eyeball
- (ii) Focal length of the crystalline lens is too long.



Question 8.

(a) A person is suffering from both myopia and hypermetropia.

(i) What kind of lenses can correct this defect?

(ii) How are these lenses prepared?

(b) A person needs a lens of power +3 D for correcting his near vision and -3 D for correcting his distant vision. Calculate the focal lengths of the lenses required to correct these defects. (2020)

Answer:

(a) (i) The lens which can correct the vision of such a person suffering from both myopia and hypermetropia is a bifocal lens.

(ii) A common type of bifocal lens contains both concave and convex lenses. It is prepared with the upper portion consisting of a concave lens facilitating distant vision and the lower portion consisting of a convex lens facilitating near vision, (b) The power for correcting his near vision,

$$P_N = +3 \text{ D.}$$

$$\text{As } P = 1/f(\text{m})$$

∴ The focal length of the convex lens needed,

$$f_N = 1/P_N = 0.33 \text{ m} = +33.33 \text{ cm}$$

Power required to correct distant vision, $P_D = -3\text{D}$

∴ The focal length of a concave lens,

$$f_D = 1/P_D = -0.33 \text{ m} = -33.33 \text{ cm.}$$

Question 9.

A person may suffer from both myopia and hypermetropia defects.

(a) What is this condition called?

(b) When does it happen?

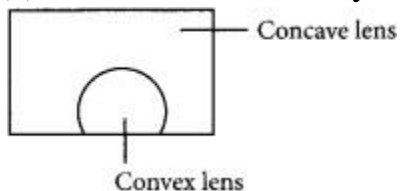
(c) Name the type of lens often required by the persons suffering from this defect. Draw a labelled diagram of such lenses. (2020)

Answer:

(a) This condition is called presbyopia.

(b) It happens due to the gradual weakening of ciliary muscles and diminishing flexibility of the eye lens due to ageing.

(c) It can be corrected by using bifocal lenses.



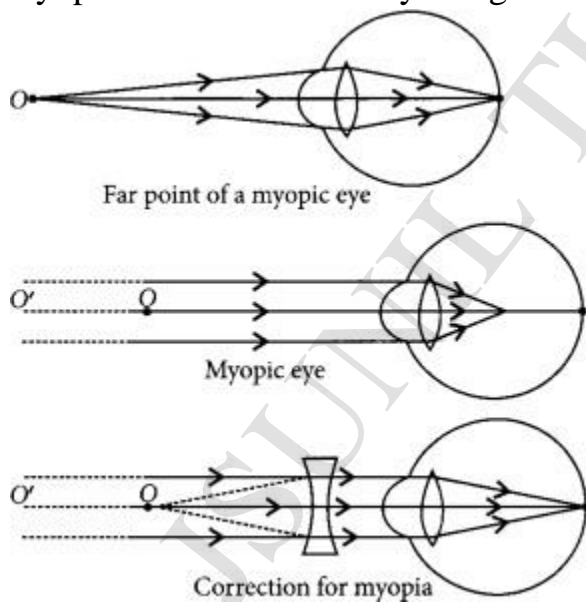
Question 10.

What eye defect is myopia? Describe with a neat diagram how this defect of vision can be corrected by using a suitable lens. (AI 2011)

Answer:

Myopia is also known as near-sightedness. A person with myopia can see nearby objects clearly but cannot see distant objects distinctly.

Myopia can be corrected by using a concave lens of appropriate focal length.



Question 11.

Name the three common defects of vision. What are their causes? Name the type of lens used to correct each of them. (Foreign 2011)

Answer:

Three common defects of vision are

- Myopia
- Hypermetropia
- Presbyopia

Myopia can be caused due to following reasons.

- Elongation of the eyeball.
- Excessive curvature of the eye lens.

Hypermetropia can be caused due to following reasons.

- Shortening of the eyeball.
- Focal length of the eye lens becomes too long.

Presbyopia is caused due to gradual weakening of ciliary muscles and diminishing flexibility of eye lenses due to ageing.

Correction of these defects:

- Myopia can be corrected by using the concave lens of appropriate focal length.
- Hypermetropia can be corrected by using a convex lens of appropriate focal length.
- Presbyopia can be corrected by using the bifocal lens.

Question 12.

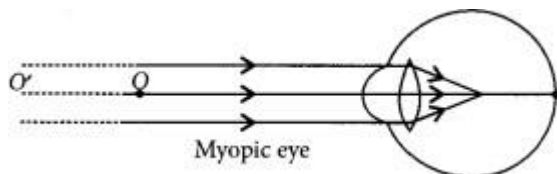
A student is unable to see the words written on the blackboard placed at a distance of approximately 3 m from him. Name the defect of vision the boy is suffering from. State the possible causes of this defect and explain the method of correcting it. (3/5, 2018)

Answer:

The student is suffering from myopia.

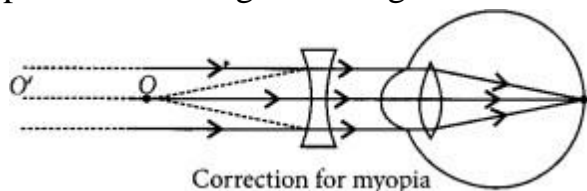
The two possible reasons due to which the defect of vision arises are excessive curvature of the eye lens and elongation of the eyeball.

A student with myopia has a far point nearer than infinity, thus, the image of a distant object is formed in front of the retina.



Correction of myopia: This defect can be corrected by using a concave lens of suitable

power as it brings the image back onto the retina, thus the defect is corrected.



Question 13.

Millions of people in developing countries of the world are suffering from corneal blindness. These persons can be cured by replacing the defective cornea with the cornea of a donated eye. A charitable society in your city has organized a campaign in your neighbourhoods to create awareness about this fact. If you are asked to participate in this mission, how would you contribute to this noble cause?

- State the objective of organizing such campaigns.
- List two arguments that you would give to motivate people to donate their eyes after death.
- List two values that are developed in the persons who actively participate and contribute to such programs. (VBQ, 3/5, Delhi 2016)

Answer:

We can encourage people to participate in the camp and also register ourselves as donor.

- The objective of organising such a campaign is to make people aware and realize their duties towards society.
- By donating our eyes after we die, we can light the life of a blind person.
 - One pair of eyes gives vision to two corneal blind people.
- It shows concern for others.
 - It also shows responsible behaviour towards society.

Question 14.

Write the importance of ciliary muscles in the human eye. Name the defect of vision that arises due to the gradual weakening of the ciliary muscles in old age. What type of lenses are required by persons suffering from this defect to see objects?

Akshay, sitting in the last row in his class, could not see the words written on the blackboard. When the teacher noticed it, he announced if any student sitting in the front row could volunteer to exchange his seat with Akshay. Salman immediately agreed to exchange his seat with Akshay. He could now see the words written on the blackboard. The teacher thought it fit to send the message to Akshay's parents advising them to get his eyesight checked.

In the context of the above event, answer the following questions:

- Which defect of vision is Akshay suffering from? Which type of lens is used to correct this defect?

(b) State the values displayed by the teacher and Salman.

(c) In your opinion, in what way can Akshay express his gratitude towards the teacher and Salman? (VBQ, AI 2015)

Answer:

Ciliary muscles modify the curvature of the eye lens and the head just uses its focal length. It enables us to see objects.

The defect of vision that arises due to the weakening of ciliary muscles in old age is presbyopia, a person suffering from this defect should wear bifocal lenses. These lenses consist of both concave and convex lenses.

(a) Akshay is suffering from myopia or near-sightedness. He should use the concave lens to correct this defect.

(b) Teacher and Salman are concerned and caring.

(c) Akshay can show his gratitude by saying thank you.

Question 15.

Do you know that the corneal-impairment can be cured by replacing the defective cornea with the cornea of the donated eye?

How and why should we organise groups to motivate community members to donate their eyes after death? (2/5, AI 2014)

Answer:

Yes, we know that corneal – impairment can be cured by replacing the objective cornea with the cornea of the donated eye. We can provide the importance of eye donation to the community members. Our eyes can live even after our death. By donating our eyes after die, we can light the life of a blind person. The human eye is one of the most valuable and sensitive sense organs. It enables us to see the wonderful world and colours around us. It is, however, impossible to identify colours while closing the eyes. Thus, of all the sense organs, the human eye is the most significant one as it enables us to see the beautiful colourful world around us. Hence, we should donate our eyes after death.

Question 16.

What is myopia? List two causes for the development of this defect. How can this defect be corrected using a lens? Draw ray diagrams to show the image formation in case (i) defective eye and (ii) corrected eye. (Foreign 2014)

Answer:

Myopia is also known as a near-sightedness defect in which a person can see nearby objects clearly but cannot see distant objects distinctly. This defect may arise due to

(a) excessive curvature of the eye.

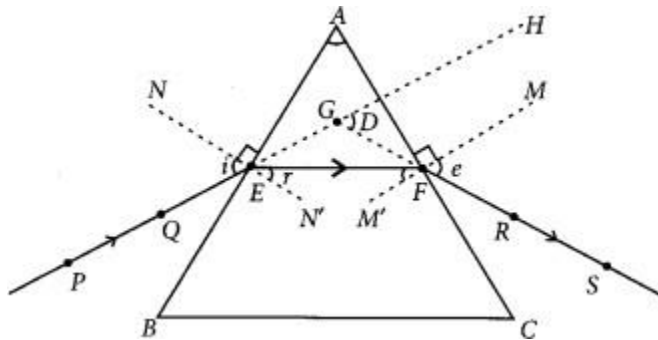
(b) elongation of the eyeball.

This defect can be corrected by using a concave lens of suitable power.

Question 17.

Draw a ray diagram to show the refraction of light through a glass prism. Mark on it (a) the incident ray, (b) the emergent ray and (c) the angle of deviation. (AI 2011)

Answer:



i = angle of incidence

(a) PE = incident ray

(b) FS = emergent ray

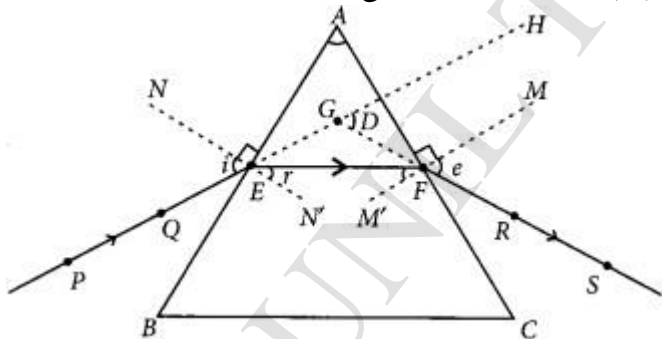
(c) $\angle D$ = angle of deviation

Question 18.

Draw a ray diagram to explain the term angle of deviation. (1/5, Delhi 2017)

Answer:

The emergent ray bends at an angle to the direction of the incident, thus the angle between them is known as the angle of deviation (D).

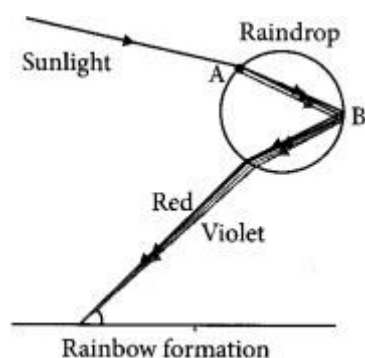


Question 19.

Draw a labelled diagram to explain the formation of a rainbow in the sky. (Foreign 2015)

Answer:

A rainbow is a natural spectrum caused by the dispersion of sunlight by tiny water droplets, present in the atmosphere.



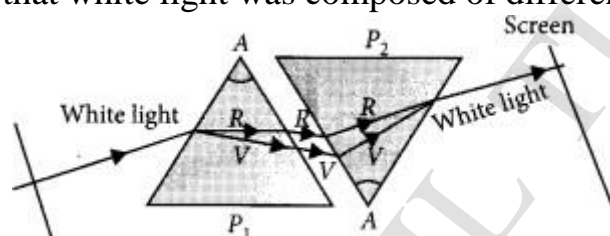
Point A denotes dispersion and point B denotes internal reflection.

Question 20.

How will you use two identical glass prisms so that a narrow beam of white light incident on one prism emerges out of the second prism as white light? Draw and label the ray diagram. (2020)

Answer:

Newton was the first to use a glass prism to obtain the spectrum of white light. He then placed a second identical prism in an inverted position concerning the first prism. This allowed all the colours of the white light to pass through the second prism combining to form a white light emerging from the other side of the second prism. This made him believe that white light was composed of different colours.



Question 21.

Differentiate between a glass slab and a glass prism. What happens when a narrow beam of (i) a monochromatic light and (ii) white light passes through (a) glass slab and (b) glass prism. (2020)

Answer:

Glass slab:

- It is a substance made of glass having three dimensions and has cuboidal structure.
- It does not deviate from the path of light falling on it but produces a lateral displacement of the light ray after refraction. The incident and emergent ray are parallel to each other.

Glass prism:

- A prism is a structure made of glass with two triangle bases and three rectangular lateral surfaces. These surfaces are inclined to each other.
- A prism deviates the path of light rays falling on it. Here the incident ray and emergent ray are not parallel to each other.

(i) When a narrow beam of monochromatic light falls on a

(a) glass slab, it gets refracted at its surface and the emergent ray is laterally displaced from the incident ray.

(b) prism, it gets refracted at the surface and the light gets deviated from its initial path. The angle between the incident ray and emergent ray is known as the angle of deviation.

(ii) When white light passes through a

(a) glass slab, the light does not undergo dispersion as its two refracting surfaces are parallel to each other. The white light is laterally displaced from its initial path.

(b) prism, the white light undergoes dispersion and splits into its constituent colours along with deviation from its initial path.

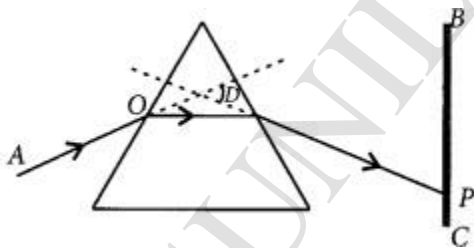
Question 22.

(a) With the help of a labelled ray diagram show the path followed by a narrow beam of monochromatic light when it passes through a glass prism.

(b) What would happen if this beam is replaced by a narrow beam of white light? (2020)

Answer:

(a)



Here, in the figure, $\angle D$ is the angle of deviation of the given monochromatic light by the glass prism.

(b) If AO were a ray of white light, then on screen BC, a spectrum will be observed, consisting of seven colours arranged from bottom to top as follows. Violet, Indigo, Blue, Green, Yellow, Orange, Red (VIBGYOR)

Question 23.

What is a rainbow? Draw a labelled diagram to show the formation of a rainbow. (Delhi 2019)

Answer:

After a rain shower, the sunlight gets dispersed by tiny droplets, present in the atmosphere. The water droplets act like small glass prisms. They refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop. Due to the dispersion of light and internal reflection, different colours reach the observer's eye, which is called a rainbow.

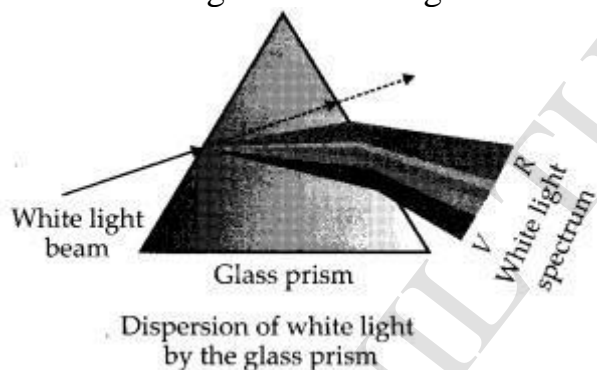
Question 24.

What is 'dispersion of white light'? State its cause. Draw a ray diagram to show the dispersion of white light by a glass prism. (AI 2017)

Answer:

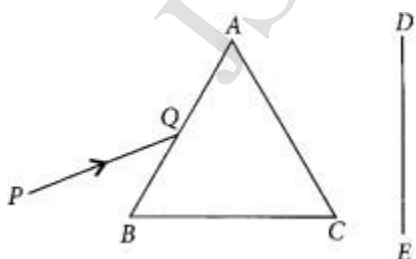
The splitting of white light into its seven constituent colours due to refraction is known as the dispersion of white light.

Cause of dispersion: When a beam of white light enters a prism, it gets refracted and splits into seven constituent colours. The splitting of the light ray occurs due to the different bending angles for each colour. Thus, each colour ray when passing through the prism bends at different angles concerning the incident beam, thus giving rise to a spectrum.



Question 25.

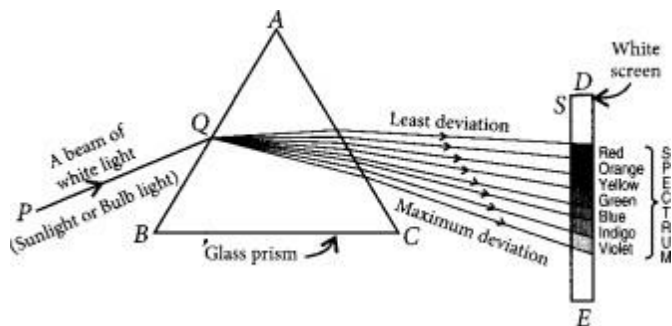
A narrow PQ of white light is passing through a glass prism ABC as shown in the diagram. Trace it on your answer sheet and show the path of the emergent beam as observed on the screen DE.



- (i) Write the name and cause of the phenomenon observed.
- (ii) Where else in nature is this phenomenon observed?

(iii) Based on this observation, state the conclusion which can be drawn about the constituents of white light. (AI 2014)

Answer:



(i) The phenomenon of the splitting up of the white light into its constituent's colours is called dispersion of light. Dispersion of light is caused due to, different constituents and colours of light after different refractive indices to the material of the prism.

(ii) The formation of a rainbow is caused by the dispersion of the white sunlight into its constituent colours.

(iii) Based on the dispersion of white light into its constituent's colours, we can conclude that

(a) The white light consists of seven colours.

(b) The violet light suffers maximum deviations and the red light suffers minimum deviation.

Question 26.

Give reasons:

(i) The extent of deviation of a ray of light on passing through a prism depends on the colour.

(ii) Lights of red colour are used for danger signals. (Foreign 2011)

Answer:

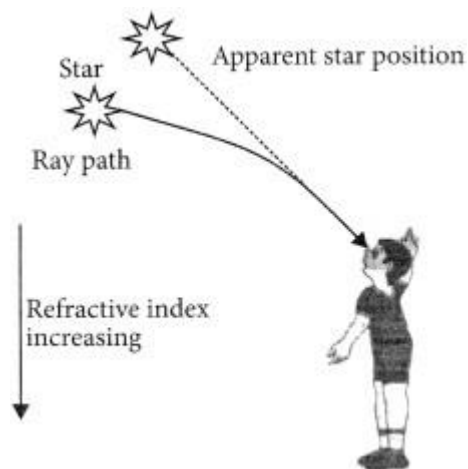
(i) The extent of deviation of a ray of light on passing through a prism depends on the colour because the refractive index of glass for different colours is different. It depends on the wavelength of a particular light.

(ii) Since the wavelength of light is maximum in the spectrum, its penetration power in the air is maximum and so we can see red colour from farther distances. Thus, the danger signal uses red colour.

Question 27.

Why do stars appear to twinkle? Explain. (Foreign 2015)

Answer:



Due to atmospheric refraction, the position of a star visible from the sun is slightly different from its actual position. This apparent position of the star is not stationary but keeps on changing with the change in the physical condition of the earth's atmosphere. Since the stars are very distant, they are approximately point-sized sources of light. As the path of rays of light coming from the star goes on varying slightly, the apparent position of the star fluctuates and the amount of starlight entering the eye flickers the star sometimes appears brighter, and at some other time, fainter, which is the twinkling effect.

Question 28.

Explain why the planets do not twinkle. (Foreign 2015)

Answer:

Planets do not emit light. However, they become visible due to the reflection of light falling on them. The planets are much closer to the earth and thus can be considered as the extended source of light. The fluctuations in the light coming from various points of the planet due to atmospheric refraction get averaged out. As a result, no twinkling of planets is seen.

Question 29.

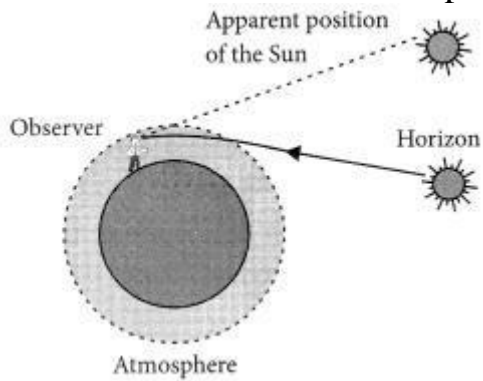
Explain in brief the reason for each of the following:

- (a) Advanced sun-rise
- (b) Delayed sun-set
- (c) Twinkling of Stars (Foreign 2016)

Answer:

(a, b): The Sun is visible to us about 2 minutes before the actual sunrise, and about 2 minutes after the actual sunset because of atmospheric refraction. By actual sunrise, we mean the actual crossing of the horizon by the Sun. The figure shows the actual and apparent positions of the Sun concerning the horizon. The time difference between the actual sunset and the apparent sunset is about 2 minutes. The apparent flattening of the Sun's disc at sunrise and

sunset is also due to the same phenomenon.

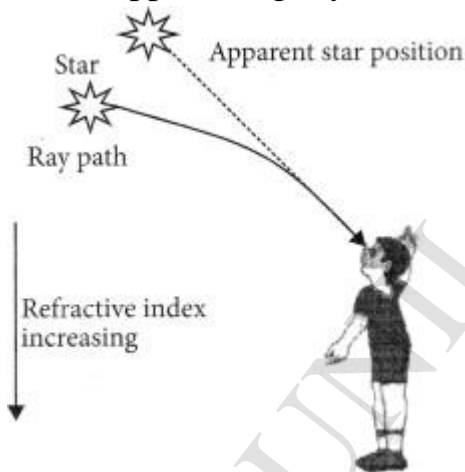


Question 30.

A star appears slightly higher (above) than its actual position in the sky. Illustrate it with the help of a labelled diagram. (AI2012)

Answer:

A star appears slightly above its actual position in the sky. Starlight, on entering the earth's atmosphere undergoes refraction continuously in a medium of gradually changing refractive index, before it reaches the earth. Since the atmosphere bends starlight towards the normal, the star appears slightly above its actual position.



Question 31.

The sky appears dark to passengers flying at very high altitudes mainly because

- (a) Scattering of light is not enough at such heights.
- (b) There is no atmosphere at great heights.
- (c) The size of molecules is smaller than the wavelength of visible light.
- (d) The light gets scattered towards the earth. (2020)

Answer:

- (b) There is no atmosphere at great heights.

Question 32.

Consider the following reasons for the reddish appearance of the sun at sunrise or sunset:

- (A) Light from the sun near the horizon passes through thinner layers of air.
- (B) Light from the sun covers a larger distance of the earth's atmosphere before reaching our eyes.
- (C) Near the horizon, most of the blue light and shorter wavelengths are scattered away by the particles.
- (D) Light from the sun near the horizon passes through thicker layers of air.

The correct reasons are

- (a) A and C only
- (b) B, C and D
- (c) A and B only
- (d) C and D only (2020)

Answer:

(b) Near the horizon, the light rays from the sun have to travel a larger distance through the Earth's atmosphere as compared to when it is away from the horizon. Thus, when this light travels through the atmosphere, most short wavelength lights are scattered away causing the reddish appearance of the sun.

Question 33.

What will be the colour of the sky when it is observed from a place in the absence of any atmosphere? (Delhi 2012)

Answer:

If the earth had no atmosphere, there would not have been any scattering. Then, the sky would look dark.

Question 34.

Give an example of a phenomenon where the Tyndall effect can be observed. (AI 2011)

Answer:

The phenomenon of scattering of light by the colloidal particle gives rise to the Tyndall effect.

This phenomenon is seen when a fine beam of sunlight enters a smoke-filled room through a small hole. This can also be observed when sunlight passes through a canopy of a dense forest.

Question 35.

Why is the colour of the clear sky blue? (Foreign 2011)

Answer:

When sunlight passes the atmosphere, the fine particles in the air scatter blue colour more

strongly than red. This scattered blue light enters our eye and the colour of the clear sky appears blue.

Question 36.

Why is the Tyndall effect shown by colloidal particles? State four instances of observing the Tyndall effect. (2020)

Answer:

The phenomenon of scattering of light by the colloidal particles gives rise to the Tyndall effect. When a beam of light strikes colloidal particles, the path of the beam becomes visible. This is known as the Tyndall effect.

This phenomenon can be observed when

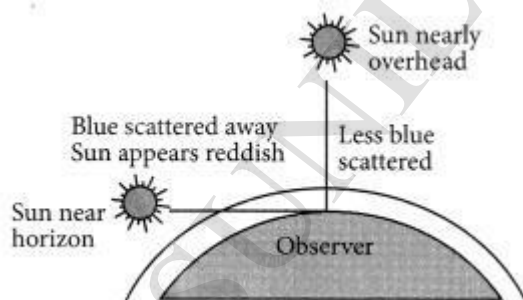
- sunlight passes through a canopy of dense forest when tiny water droplets in the mist scatter light.
- torch light is switched on in a foggy environment, light rays are visible after being scattered by the fog particles in the surrounding air.
- a fine beam of sunlight enters a smoke-filled room through a small hole.
- shining a flashlight beam into a glass of diluted milk produces a Tyndall effect.

Question 37.

Draw a labelled diagram to show (i) the reddish appearance of the sun at sunrise or sunset and (ii) white appearance of the sun at noon when it is overhead. (2020)

Answer:

(i)



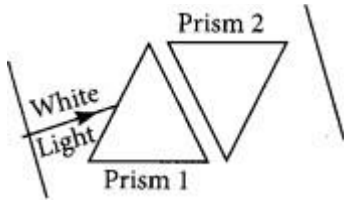
At sunrise and sunset, light from the sun passes through thicker layers of air and a larger distance in the earth's atmosphere. As the red colour has the longest wavelength hence, it is least scattered by the air and dust particles. So, the sun appears reddish.

(ii) At noon, when the sun is overhead, the distance to be travelled is the least. All wavelengths are scattered equally and hence sun appears white.

Question 38.

(a) State the relation between the colour of scattered light and the size of the scattering particle.

(b) The apparent position of an object, when seen through the hot air, fluctuates or wavers. State the basic cause of this observation.



Answer:

(a) The colour of scattered light depends on the size of the scattering particle. Very fine particles scatter short wavelengths such as blue and violet, lights. Large-size particles scatter light of longer wavelengths.

(b) The basic cause of this observation is atmospheric refraction. As hot air is less dense than the colder air surrounding it, it has a slightly lower refractive index. Since the physical condition of the refracting medium, in the air is not stationary, the apparent position of an object, when seen through hot air fluctuates.

CHAPTER 11 ELECTRICITY

- 1. Charge:** It is an inherent property of the body due to which the body feels attractive and repulsive forces. There are two types of electric charges:
 - (i) Positive and (ii) Negative
 - (ii) Like charges are repelling each other.
 - (iii) Unlike charges attract each other.
- 2. Conductors and insulators:** Those substances through which electricity can flow are called conductors. All the metals like silver, copper, aluminium etc. are conductors.
Those substances through which electricity cannot flow are called insulators. Glass, ebonite, rubber, most plastics, paper, dry wood, etc., are insulators.
- 3. Electrostatic potential:** The electrostatic potential at any point is defined as the work done in bringing a unit positive charge from infinity to that point. Potential is denoted by the symbol V and its unit is volt. A potential of one volt at a point means that 1 joule of work is done in bringing 1 unit positive charge from infinity to that point.
- 4. Potential Difference:** The amount of work done in moving unit positive charge from one point to another in an electric field is known as potential difference.
Potential difference = Work done / Quantity of charge transferred
If a W joule of work has to be done to transfer Q coulombs of charge from one point to another point, then the potential difference V between the two points is given by the formula:
Potential difference, $V = W/Q$
The SI unit of potential difference is volt (V).
1 volt: One volt is defined as 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 another. Therefore, 1 volt = 1 joule / 1 coulomb
- 5. Voltmeter:** The potential difference is measured by means of an instrument called voltmeter. The voltmeter is connected in parallel across the points where the potential difference is measured. A voltmeter has high resistance.
- 6. Electric Current:** The electric current is the rate of flow of electric charges (called electrons) in a conductor.
If a charge of Q coulombs flows through a conductor in time t seconds, then the magnitude I of the electric current flowing through it is given by
Current, $I = Q/t$
The SI unit of electric current is ampere and it is denoted by the letter A. Electric current is a scalar quantity.

7. **Ammeter:** Current is measured by an instrument called ammeter. The ammeter is connected in series with the circuit in which the current is to be measured. An ammeter should have very low internal resistance.
8. **Voltaic Cell:** It is one of the earliest devices which are capable of providing a continuous flow of electric current. It is used for converting chemical energy into electrical energy. It was invented by Volta in the year 1800.
9. **Ohm's Law:** At constant temperature, the current flowing through a conductor is directly proportional to the potential difference across its ends. If I is the current flowing through a conductor and V is the potential difference across its ends. Then according to Ohm's law

$$I \propto V$$

This can also be written as:

$$V \propto I$$

$$V = IR$$

Where R is a constant called 'resistance' of the conductor. The value of this constant depends on the nature, length, area of cross-section and temperature of the conductor.

10. **Resistance of a Conductor:** The property of a conductor due to which it opposes the flow of current through it is called resistance. The resistance of a conductor is numerically equal to ratio of potential difference across its ends to the current flowing through it. i.e.

Resistance = Potential difference / Current

$$R = V/I$$

The SI unit of resistance is ohm, which is denoted by symbol Ω .

1 ohm: If $V = 1$ volt, $I = 1$ ampere, then

$$R = 1 \text{ volt} / 1 \text{ ampere} = 1 \text{ ohm}$$

Thus, the resistance of a conductor is said to be 1 ohm if 1 ampere current flows through the conductor when a potential difference of 1 volt is applied across it.

11. **Factors affecting the Resistance of a Conductor:** The resistance of the conductor depends:
- (i) on its length,
 - (ii) on its area of cross-section
 - (iii) on the nature of its material.

12. **Resistivity:** It has been found by the experiments that:

- (i) The resistance of a given conductor is directly proportional to its length.

$$R \propto l \text{(i)}$$

- (ii) The resistance of a given conductor is inversely proportional to its area of cross-section.

$$R \propto 1/A \text{(ii)}$$

By combining the equations (i) and (ii),

$$R = \rho l/A$$

$$R = \rho (l/A)$$

Where ρ is called specific resistance or resistivity of the conductor.

When $l = 1\text{m}$, $A = 1\text{m}^2$, we have $\rho = R$

Thus, the resistivity of a conductor is the resistance of unit length and unit area of cross-section of the conductor. The SI unit of resistivity is ohm metre (Ωm).

13. Combination of Resistance: The resistance can be combined in two ways:

- (i) In series
- (ii) In parallel
- (i) Resistance in series:

Series: 

In series, the total potential difference,

$$V = V_1 + V_2 + V_3 \dots\dots(i)$$

Applying Ohm's law to the entire circuit

$$V = IR \dots\dots(ii)$$

Applying Ohm's law to each resistance separately, we have

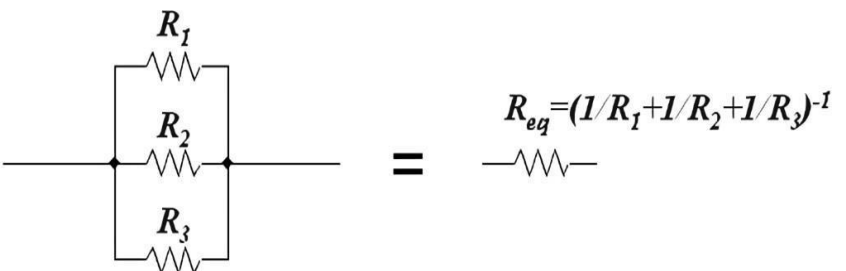
$$V_1 = IR_1; V_2 = IR_2; V_3 = IR_3 \dots\dots(iii)$$

From equations (i), (ii) and (iii), we have

$$IR = IR_1 + IR_2 + IR_3$$

$$R = R_1 + R_2 + R_3$$

- (ii) Resistance in parallel:

Parallel: 

In parallel, the total current:

$$I = I_1 + I_2 + I_3 \dots\dots(i)$$

Applying Ohm's law to the entire circuit

$$I = V/R \dots\dots(ii)$$

Applying Ohm's law to each resistance separately, we have

$$I_1 = V/R_1; I_2 = V/R_2; I_3 = V/R_3 \dots \text{(iii)}$$

From equations (i), (ii) and (iii), we have

$$V/R = V/R_1 + V/R_2 + V/R_3$$

$$1/R = 1/R_1 + 1/R_2 + 1/R_3$$

14. Electric Power: The rate at which work is done by an electric current is known as electric power.

$$\text{Power} = \text{Work done}/\text{Time}$$

$$P = W/t = (V \times Q)/t \dots \text{(i)}$$

The work done by current I when it flows for time t under a potential difference V is given by:

$$W = V \times I \times t \text{ joules} \quad [\text{Because } W = VQ \text{ and } Q = It]$$

Putting the value of W in equation (i), we have

$$P = (V \times I \times t)/t = VI$$

$$P = I^2R \quad [\text{Because } V = IR]$$

$$P = V^2/R \quad [\text{Because } I = V/R]$$

The unit of electric power is watt.

$$\text{Power} = V \times I$$

$$1 \text{ watt} = 1 \text{ volt} \times 1 \text{ ampere}$$

Thus, if a potential difference of 1 volt causes a current of 1 ampere to flow through a wire, the electrical power consumed is one watt.

15. Electrical Energy:

$$\text{Electrical energy} = \text{Power} \times \text{Time}$$

$$E = P \times t$$

The electrical energy consumed by an electrical appliance depends upon

- (i) Power rating of the appliance
- (ii) Time for which it (appliance) is used.

The SI unit of electrical energy is joule.

1 joule is the amount of electrical energy consumed when an appliance of 1 watt is used for 1 second.

16. Commercial Unit of Electrical Energy: Kilowatt hour is the commercial unit of electrical energy. One kilowatt hour is the electrical energy consumed when an electrical appliance having 1kW power rating is used for 1 hour.

$$\text{Energy used} = \text{Power} \times \text{Time}$$

$$1 \text{ kWh} = 1 \text{ kW} \times 1 \text{ h}$$

$$= 1000 \text{ w} \times 60 \times 60 \text{ s}$$

$$= 1000 \text{ Js}^{-1} \times 3600 \text{ s}$$

$$= 3600000 \text{ J} = 3.6 \times 10^6 \text{ J}$$

17. Heating Effect of Current: When an electric current is passed through a high resistance wire, it becomes very hot and produces heat. This effect is called the heating effect of current.

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

$$W = Q \times V \dots\dots(i)$$

But, current, $I = Q/t$

$$Q = I \times t$$

From Ohm's law: $V = I \times R$

Now, putting all these values in equation (i), we have

$$\text{Work done, } W = I^2 \times R \times t$$

This work done is converted into heat energy for maintaining the flow of current I through the conductor for t second.

Heat produced, $H = I^2 \times R \times t$ joules.

18. Applications Of Heating Effect of Current:

- (i) In electrical heating appliances: All electrical heating appliances are based on heating effect of current. For example, appliances, such as electric iron, water heaters and geysers, room heaters, toaster, hot plates are fitted with heating coils made of high resistance wire such as nichrome wire.
- (ii) Electric filament bulb: The use of electric filament bulbs (ordinary electric bulbs) is also based on the heating effect of current. Inside the glass shell of electric bulb there is a filament. This filament is made from a very thin high bulb resistance tungsten wire. When current flows through this filament, it gets heated up. Soon, it becomes white hot and starts emitting light.

QUESTIONS FROM PREVIOUS BOARD EXAMS

Question 1.

A current of 10 A flows through a conductor for two minutes.

- (i) Calculate the amount of charge passed through any area of cross section of the conductor.
 - (ii) If the charge of an electron is 1.6×10^{-19} C, then calculate the total number of electrons flowing.
- (Boards Term I, 2013)

Answer:

Given that: $I = 10$ A, $t = 2$ min = 2×60 s = 120 s

(i) Amount of charge Q passed through any area of cross-section is given by $I = Q/t$

or $Q = I \times t \therefore Q = (10 \times 120)$ A s = 1200 C

(ii) Since, $Q = ne$

where n is the total number of electrons flowing and e is the charge on one electron

$\therefore 1200 = n \times 1.6 \times 10^{-19}$

or $n = \frac{1200}{1.6 \times 10^{-19}} = 7.5 \times 10^{21}$

Question 2.

Define electric current. (1/5, Boards Term I, 2017)

Answer:

Electric current is the amount of charge flowing through a particular area in unit time.

Question 3.

Define one ampere. (1/5, Boards Term I, 2015)

Answer:

One ampere is constituted by the flow of one coulomb of charge per second.

$1 \text{ A} = 1 \text{ C s}^{-1}$

Question 4.

Name a device that you can use to maintain a potential difference between the ends of a conductor. Explain the process by which this device does so. (Boards Term I, 2013)

Answer:

A cell or a battery can be used to maintain a potential difference between the ends of a conductor.

The chemical reaction within a cell generates the potential difference across the terminals of the cell, even when no current is drawn from it. When it is connected to a conductor, it produces electric current and, maintain the potential difference across the ends of the conductor.

Question 5.

Draw the symbols of commonly used components in electric circuit diagrams for

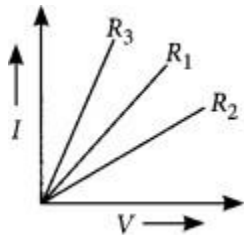
- (i) An electric cell
- (ii) Open plug key
- (iii) Wires crossing without connection
- (iv) Variable resistor
- (v) Battery
- (vi) Electric bulb
- (vii) Resistance (4/5, Boards Term I, 2017)

Answer:

S. No.	Component	Symbol
(i)	An electric cell	
(ii)	Open plug key	
(iii)	Wires crossing without connection	
(iv)	Variable resistor	
(v)	Battery	
(vi)	Electric bulb	
(vii)	Resistance	

Question 6.

A student plots V-I graphs for three samples of nichrome wire with resistances R_1 , R_2 and R_3 . Choose from the following the statements that holds true for this graph. (2020)



- (a) $R_1 = R_2 = R_3$
- (b) $R_1 > R_2 > R_3$
- (c) $R_3 > R_2 > R_1$
- (d) $R_2 > R_1 > R_3$

Answer:

(d) : The inverse of the slope of I-V graph gives the resistance of the material. Here the slope of R_2 is highest. Thus, $R_2 > R_1 > R_3$

Question 7.

State Ohms law. (AI 2019)

Answer:

It states that the potential difference V , across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. Mathematically,

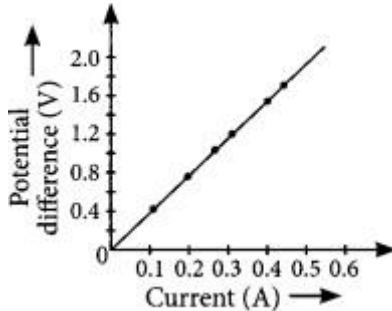
$$V \propto I$$

$$V = RI$$

where R is resistance of the conductor.

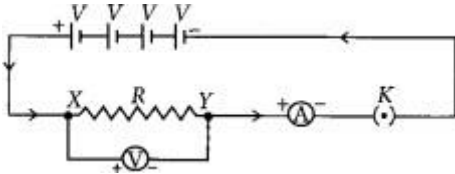
Question 8.

A V-I graph for a nichrome wire is given below. What do you infer from this graph? Draw a labelled circuit diagram to obtain such a graph. (2020)



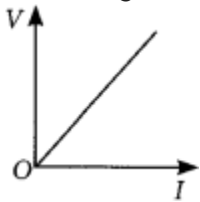
Answer:

As graph is a straight line, so it is clear from the graph that $V \propto I$.



The shape of the graph obtained by plotting potential difference applied across conductor against the current flowing through it will be a straight line.

According to Ohm's law,



$$V = IR \text{ or } R = \frac{V}{I}$$

So, the slope of V - I graph at any point represents the resistance of the given conductor.

Question 9. Name a device that helps to maintain a potential difference between across a conductor.

Ans: A device that helps to maintain a potential difference between conductors is the battery.

Question 10. What determines the rate at which energy is delivered by a current?

Ans: The rate at which energy is delivered by a current is determined by electric power.

Question 11. Alloys are used in electrical heating devices rather than pure metals. Give a reason.

Ans: Alloys are utilised in electricity heating devices rather than pure metals because alloys have a higher resistivity and hence produce more heat. Furthermore, alloy is non-combustible (or oxidises easily at higher temperature).

Question 12. On what factor does the resistance of a conductor depend?

Ans: The factors on which Resistance depends are:-

- (a) Length of the conductor
- (b) Area of cross - section
- (c) Temperature
- (d) Nature of material

Question 13.

Assertion (A) : The metals and alloys are good conductors of electricity.

Reason (R) : Bronze is an alloy of copper and tin and it is not a good conductor of electricity.

- (a) Both (A) and (R) are true and (R) is the correct explanation of the assertion (A).
- (b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion (A).
- (c) (A) is true, but (R) is false.
- (d) (A) is false, but (R) is true. (2020)

Answer:

(c) : Metals and alloys are good conductors of electricity. Bronze is an alloy of copper and tin which are metals and thus is a good conductor of electricity.

Question 14.

A cylindrical conductor of length 'l' and uniform area of cross section 'A' has resistance 'R'. The area of cross section of another conductor of same material and same resistance but of length '2l' is (2020)

- (a) A²
- (b) 3A²
- (c) 2A
- (d) 3A

Answer:

(c) : The resistance of a conductor of length l, and area of cross section, A is

$$R = \rho l/A$$

where ρ is the resistivity of the material.

Now for the conductor of length 2l, area of cross-section A' and resistivity ρ .

$$R' = \rho 2l/A' = \rho 2lA'$$

$$\text{But given, } R = R' \Rightarrow \rho l/A = \rho 2lA' \text{ or } A' = 2A$$

Question 15.

Assertion (A) : Alloys are commonly used in electrical heating devices like electric iron and heater.

Reason (R): Resistivity of an alloy is generally higher than that of its constituent metals but the alloys have low melting points than their constituent metals.

- (a) Both (A) and (R) are true and (R) is the correct explanation of the assertion (A).
- (b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion (A).
- (c) (A) is true, but (R) is false.
- (d) (A) is false, but (R) is true. (2020)

Answer:

- (a)

Question 16.

How is the resistivity of alloys compared with those of pure metals from which they may have

been formed? (Boaid I'eim I, 2017)

Answer:

The resistivity of an alloy is generally higher than that of its constituent metals.

Question 17.

(i) List three factors on which the resistance of a conductor depends.

(ii) Write the SI unit of resistivity. (Boaid I'eim 1, 2015)

Answer:

(i) Resistance of a conductor depends upon the following factors:

(1) Length of the conductor : (Increase the length (l) of the conductor more will be the resistance (R).

R \propto l

(2) Area of cross section of the conductor: (Increase the cross-sectional area of the conductor, less will be the resistance.

R \propto 1/A

(3) Nature of conductor.

(ii) SI unit of resistivity is Ω m.

Question 18.

Calculate the resistance of a metal wire of length 2m and area of cross section $1.55 \times 10^{-6} \text{ m}^2$, if the resistivity of the metal be $2.8 \times 10^{-8} \Omega \text{ m}$. (Boaid I'eim I, 2013)

Answer:

For the given metal wire,

length, l = 2 m

area of cross-section, A = $1.55 \times 10^{-6} \text{ m}^2$

resistivity of the metal, $\rho = 2.8 \times 10^{-8} \Omega \text{ m}$

Since, resistance, R = $\rho l/A$

So R = $(2.8 \times 10^{-8} \times 2 / 1.55 \times 10^{-6}) \Omega$

= $5.61.55 \times 10^{-2} \Omega = 3.6 \times 10^{-2} \Omega$ or R = 0.036 Ω

Question 19.

(a) List the factors on which the resistance of a conductor in the shape of a wire depends.

(b) Why are metals good conductors of electricity whereas glass is a bad conductor of electricity ?

Give reason.

(c) Why are alloys commonly used in electrical heating devices ? Give reason. (2018)

Answer:

(a) (1) Length of the conductor : (Increase the length (l) of the conductor more will be the resistance (R).

R \propto l

(2) Area of cross section of the conductor: (Increase the cross-sectional area of the conductor, less will be the resistance.

R \propto 1/A

(3) Nature of conductor.

- (b) Metal have veíy low íesistivity and hence they aíe good conductoís of electíicity. Wheíeas glass has veíy high íesistivity so glass is a bad conductoí of electíicity.
- (c) Alloys aíe commonly used in electíical heating devices due to the following íeasons
- (i) Alloys have higheí íesistivity than metals
- (ii) Alloys do not get oxidised oí buín íeasily.

Question 20.

Calculate the íesistivity of the mateíial of a wíe of length 1 m, íadius 0.01 cm and íesistance 20 ohms. (Boaíd Í'eím I, 2017)

Answer:

We aíe given, the length of wíe, $l = 1$ m, íadius of wíe, $r = 0.01$ cm = 1×10^{-4} m and íesistance, $R = 20 \Omega$ As we know,

$R = \rho l/A$, wheíe ρ is íesistivity of the mateíial of the wíe.

$$\therefore 20 \Omega = \rho l \pi r^2 = \rho 1 \text{ m} \cdot 3.14 \times (10^{-4})^2 \text{ m}^2$$

$$\therefore \rho = 6.28 \times 10^{-7} \Omega \text{ m}$$

Question 21.

A coppeí wíe has diameteí 0.5 mm and íesistivity $1.6 \times 10^{-8} \Omega \text{ m}$. Calculate the length of this wíe to make it íesistance 100 Ω . How much does the íesistance change if the diameteí is doubled without changing its length? (Boaíd Í'eím I, 2015)

Answer:

Given; íesistivity of coppeí = $1.6 \times 10^{-8} \Omega \text{ m}$, diameteí of wíe, $d = 0.5$ mm and íesistance of wíe, $R = 100 \Omega$

Radius of wíe, $r = d/2 = 0.25$ mm

$$= 0.25 \text{ mm} = 2.5 \times 10^{-4} \text{ m}$$

Aíea of cíoss-section of wíe, $A = \pi r^2$

$$\therefore A = 3.14 \times (2.5 \times 10^{-4})^2$$

$$= 1.9625 \times 10^{-7} \text{ m}^2$$

$$= 1.9 \times 10^{-7} \text{ m}^2$$

As, $R = \rho l/A$

$$\therefore 100 \Omega = 1.6 \times 10^{-8} \Omega \text{ m} \times l / 1.9 \times 10^{-7} \text{ m}^2$$

$$l = 1200 \text{ m}$$

If diameteí is doubled ($d' = 2d$), then the aíea of cíoss-section of wíe will become

$$A' = \pi r'^2 = \pi (d'/2)^2 = \pi (2d/2)^2 = 4A$$

Now $R \propto 1/A$, so the íesistance will decíease by fouí times oí new íesistance will be

$$R' = R/4 = 100/4 = 25 \Omega$$

Question 22.

The íesistance of a wíe of 0.01 cm íadius is 10 Ω . If the íesistivity of the mateíial of the wíe is 50×10^{-8} ohm meteí, find the length of the wíe. (Boaíd Í'eím I, 2014)

Answer:

Heíe, $r = 0.01$ cm = 10^{-4} m, $\rho = 50 \times 10^{-8} \Omega \text{ m}$ and $R = 10 \Omega$ As,

$$R = \rho l/A$$

$$\text{oí } l = RA/\rho = R\rho/(\pi r^2)$$

$$\text{so } l = 10 \times 50 \times 10^{-8} / 3.14 \times (10^{-4})^2$$

$$= 0.628 \text{ m} = 62.8 \text{ cm}$$

Question 23.

A wire has a resistance of 16Ω . It is melted and drawn into a wire of half its original length. Calculate the resistance of the new wire. What is the percentage change in its resistance? (Boaid I'eim I, 2013)

Answer:

When wire is melted, its volume remains same, so,

$$V = V \text{ or } A'l = Al$$

$$\text{Here, } l' = l/2$$

$$\text{Therefore, } A' = 2A$$

$$\text{Resistance, } R = \rho l/A = 16 \Omega$$

$$\text{Now, } R' = \rho l'/A' = \rho(l/2)/2A = 4\rho l/A$$

$$\text{So, } R' = R/4 = 16/4 = 4 \Omega$$

Percentage change in resistance,

$$= \frac{(R - R')}{R} \times 100 = \frac{(16 - 4)}{16} \times 100 = 75\%$$

Question 24.

If the radius of a current carrying conductor is halved, how does current through it change? (2/5 Boaid I'eim I, 2014)

Answer:

If the radius of conductor is halved, the area of cross-section reduced to $(1/4)$ of its previous value.

Since, $R \propto 1/A$, resistance will become four times

From Ohm's law, $V = IR$

For given V , $I \propto 1/R$

So, current will reduce to one-fourth of its previous value.

Question 25.

Define resistance of a conductor. State the factors on which resistance of a conductor depends. Name the device which is often used to change the resistance without changing the voltage source in an electric circuit. Calculate the resistance of 50 cm length of wire of cross sectional area 0.01 mm^2 and of resistivity $5 \times 10^{-8} \Omega \text{ m}$. (Boaid I'eim I, 2014)

Answer:

Resistance is the property of a conductor to resist the flow of charges through it. Factors affecting resistance of a conductor:

Refer to answer 17(i)

Rheostat is the device which is often used to change the resistance without changing the voltage source in an electric circuit.

$$\text{We are given, length of wire, } l = 50 \text{ cm} = 50 \times 10^{-2} \text{ m} \text{ cross-sectional area, } A = 0.01 \text{ mm}^2 \\ = 0.01 \times 10^{-6} \text{ m}^2$$

$$\text{and resistivity, } \rho = 5 \times 10^{-8} \Omega \text{ m.}$$

$$\text{As, resistance, } R = \rho l/A$$

$$\therefore R = \frac{5 \times 10^{-8} \times 50 \times 10^{-2}}{0.01 \times 10^{-6}} \Omega$$

$$= 2.5 \Omega$$

Question 26.

If a person has five resistors each of value 15Ω , then the maximum resistance he can obtain by connecting them is

(a) 1Ω

(b) 5Ω

(c) 10Ω

(d) 25 Ω (2020)

Answer:

(a) The maximum resistance can be obtained from a group of resistors by connecting them in series. Thus,

$$R_s = 15 + 15 + 15 + 15 + 15 = 75 \Omega$$

Question 27.

The maximum resistance which can be made using four resistors each of 2 Ω is

(a) 2 Ω

(b) 4 Ω

(c) 8 Ω

(d) 16 Ω (2020)

Answer:

(c) : A group of resistors can produce maximum resistance when they all are connected in series.

$$\therefore R_s = 2 \Omega + 2 \Omega + 2 \Omega + 2 \Omega = 8 \Omega$$

Question 28.

The maximum resistance which can be made using four resistors each of resistance 12 Ω is

(a) 2 Ω

(b) 1 Ω

(c) 2.5 Ω

(d) 8 Ω (2020)

Answer:

(a) The maximum resistance can be produced from a group of resistors by connecting them in series.

$$\text{Thus, } R_s = 12 \Omega + 12 \Omega + 12 \Omega + 12 \Omega = 48 \Omega$$

Question 29.

Three resistors of 10 Ω , 15 Ω and 5 Ω are connected in parallel. Find their equivalent resistance.

(Boird Term I, 2014)

Answer:

Here, $R_1 = 10 \Omega$, $R_2 = 15 \Omega$, $R_3 = 5 \Omega$.

In parallel combination, equivalent resistance, (R_{eq}) is given by

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\text{So, } \frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{15} + \frac{1}{5}$$

$$\frac{1}{R_{eq}} = \frac{3+2+6}{30} = \frac{11}{30}$$

$$\therefore R_{eq} = \frac{30}{11} \Omega = 2.73 \Omega$$

Question 30.

List the advantages of connecting electrical devices in parallel with an electrical source instead of

connecting them in series. (Boaíd I'eím I, 2013)

Answer:

(a) When a number of electrical devices are connected in parallel, each device gets the same potential difference as provided by the battery and it keeps on working even if other devices fail. This is not so in case the devices are connected in series because when one device fails, the circuit is broken and all devices stop working.

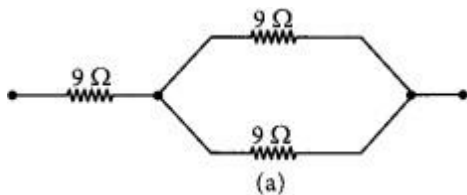
(b) Parallel circuit is helpful when each device has different resistance and requires different current for its operation as in this case the current divides itself through different devices. This is not so in series circuit where same current flows through all the devices, irrespective of their resistances.

Question 31.

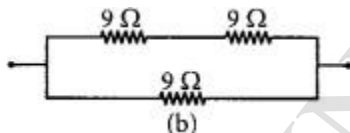
Show how would you join three resistors, each of resistance $9\ \Omega$ so that the equivalent resistance of the combination is (i) $13.5\ \Omega$, (ii) $6\ \Omega$ (2018)

Answer:

(i) The resistance of the series combination is higher than each of the resistances. A parallel combination of two $9\ \Omega$ resistors is equivalent to $4.5\ \Omega$. We can obtain $13.5\ \Omega$ by coupling $4.5\ \Omega$ and $9\ \Omega$ in series. So, to obtain $13.5\ \Omega$, the combination is as shown in figure (a).

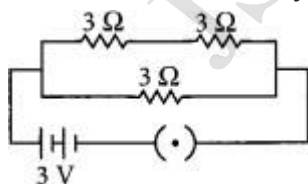


(ii) To obtain an equivalent resistance of $6\ \Omega$, we have to connect two $9\ \Omega$ resistors in series and then connect the third $9\ \Omega$ resistor in parallel to the series combination as shown in the figure (b).



Question 32.

Three resistors of $3\ \Omega$ each are connected to a battery of $3\ \text{V}$ as shown. Calculate the current drawn from the battery. (Boaíd I'eím I, 2017)



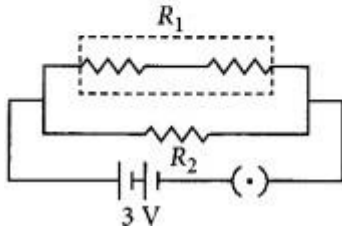
Answer:

As given in circuit diagram, two $3\ \Omega$ resistors are connected in series to form R_1 ; so $R_1 = 3\ \Omega + 3\ \Omega = 6\ \Omega$

And, R_1 and R_2 are in parallel combination, Hence, equivalent resistance of circuit (R_{eq}) given by

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\therefore \frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{3} = \frac{1+2}{6} = \frac{3}{6} = \frac{1}{2}$$



$$R_{eq} = 2 \Omega$$

Using Ohm's law, $V = IR$

We get,

$$3 \text{ V} = I \times 2 \Omega$$

$$\text{or } I = \frac{3 \text{ V}}{2 \Omega} = 1.5 \text{ A}$$

Current drawn from the battery is 1.5 A.

Question 33.

Two identical resistors are first connected in series and then in parallel. Find the ratio of equivalent resistance in two cases. (Board Exam I, 2013)

Answer:

Let resistance of each resistor be R .

For series combination,

$$R_s = R_1 + R_2$$

$$\text{So, } R_s = R + R = 2R$$

For parallel combination,

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \quad \text{or} \quad R_p = \frac{R_1 R_2}{R_1 + R_2}$$

$$\text{So, } R_p = \frac{R \times R}{R + R} = \frac{R}{2}$$

$$\text{Required ratio} = \frac{R_s}{R_p} = \frac{2R}{R/2} = 4:1$$

Question 34.

(a) A 6Ω resistance wire is doubled on itself. Calculate the new resistance of the wire.

(b) Three 2Ω resistors A, B and C are connected in such a way that the total resistance of the combination is 3Ω . Show the arrangement of the three resistors and justify your answer. (2020)

Answer:

(a) Given resistance of wire, $R = 6 \Omega$

Let l be the length of the wire and A be its area of cross-section. Then

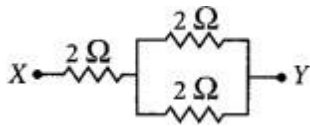
$$R = \rho l A = 6 \Omega$$

Now when the length is doubled, $l' = 2l$ and $A' = A/2$

$$\therefore R' = \rho(2l)A/2 = 4\rho lA = 4 \times 6 \Omega = 24 \Omega$$

(b) Given the total resistance of the combination = 3Ω

In order to get a total resistance of 3Ω , the three resistors have to be connected as shown.



Such that, $\frac{1}{R_p} = \frac{1}{2} + \frac{1}{2} = 1$

$$\Rightarrow R_p = 1 \Omega$$

$$\text{and } R_s = 2 \Omega + 1 \Omega = 3 \Omega$$

Question 35.

Draw a schematic diagram of a circuit consisting of a battery of 3 cells of 2 V each, a combination of three resistors of 10Ω , 20Ω and 30Ω connected in parallel, a plug key and an ammeter, all connected in series. Use this circuit to find the value of the following :

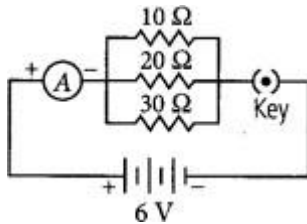
(a) Current through each resistor

(b) Total current in the circuit

(c) Total effective resistance of the circuit. (2020)

Answer:

The circuit diagram is as shown below.



(a) Given, voltage of the battery = $2V + 2V + 2V = 6V$

Current through 10Ω resistance,

$$I_{10} = \frac{V}{R} = \frac{6}{10} = 0.6 \text{ A}$$

Current through 20Ω resistance,

$$I_{20} = \frac{V}{R} = \frac{6}{20} = 0.3 \text{ A}$$

Current through 30Ω resistance,

$$I_{30} = \frac{V}{R} = \frac{6}{30} = 0.2 \text{ A}$$

(b) Total current in the circuit, $I = I_{10} + I_{20} + I_{30}$

$$= 0.6 + 0.3 + 0.2 = 1.1 \text{ A}$$

(c) Total resistance of the circuit,

$$\frac{1}{R_p} = \frac{1}{10} + \frac{1}{20} + \frac{1}{30} = \frac{6}{60}$$

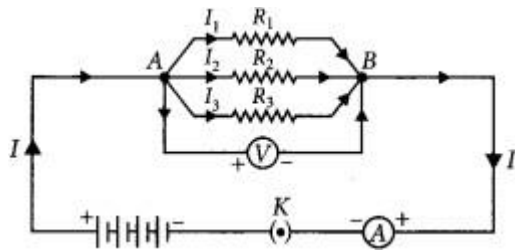
Question 36.

(a) With the help of a suitable circuit diagram prove that the reciprocal of the equivalent resistance of a group of resistances joined in parallel is equal to the sum of the reciprocals of the individual resistances.

(b) In an electric circuit two resistors of 12Ω each are joined in parallel to a $6V$ battery. Find the current drawn from the battery. (Delhi 2019)

Answer:

(a) Resistors in parallel : When resistors are connected in parallel.



- (i) The potential difference across their ends is the same.
 (ii) The sum of current through them is the current drawn from the source of energy of cell.

$$I = I_1 + I_2 + I_3 \text{ or } VR_P = VR_1 + VR_2 + VR_3$$

- (iii) The equivalent resistance is given by,

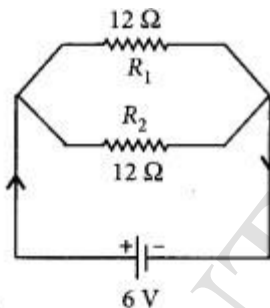
$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Hence equivalent resistance in parallel combination is equal to the sum of reciprocals of the individual resistances.

(b) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

$$\frac{1}{R} = \frac{1}{12} + \frac{1}{12} = \frac{2}{12}$$

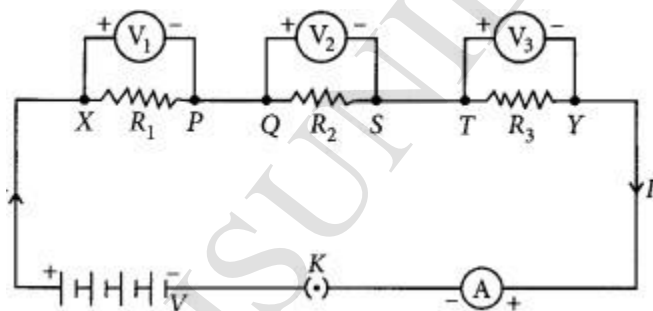
$$\Rightarrow R = 6 \Omega$$



$$\therefore \text{Current, } I = \frac{V}{R} = \frac{6}{6} = 1 \text{ A}$$

Question 37.

For the series combination of three resistors current in each resistor, establish the relation $R = R_1 + R_2 + R_3$ where the symbols have their usual meanings. Calculate the equivalent resistance of the combination of three resistors of 6Ω , 9Ω and 18Ω joined in parallel. (Board Exam I, 2016)



Answer:

Given figure shows the series combination of three resistors R_1 , R_2 and R_3 connected across a voltage source of potential difference V .

Let current I is flowing through the circuit.

V_1 , V_2 and V_3 are the potential differences across resistors R_1 , R_2 and R_3 respectively.

Since, the total potential difference across a combination of resistors in series is equal to the sum of potential difference across the individual resistors.

$$\therefore V = V_1 + V_2 + V_3 \dots (i)$$

In series current through each resistor is same. Applying the Ohms law,
 $V_1 = IR_1$, $V_2 = IR_2$ and $V_3 = IR_3$(ii)

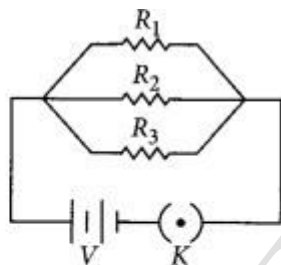
If R_s is the equivalent resistance of the circuit, then
 $V = IR_s$... (iii)

From eqns. (i), (ii) and (iii),
 we can write $IR_s = IR_1 + IR_2 + IR_3$
 or $R_s = R_1 + R_2 + R_3$

We can conclude that when several resistors are joined in series, the resistance of the combination R_s equals the sum of their individual resistances, R_1 , R_2 and R_3

Given : $R_1 = 6 \Omega$, $R_2 = 9 \Omega$,
 $R_3 = 18 \Omega$ are connected in parallel.

Equivalent resistance, R_{eq} , is given by



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\therefore \frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{9} + \frac{1}{18} = \frac{3+2+1}{18} = \frac{6}{18} = \frac{1}{3}$$

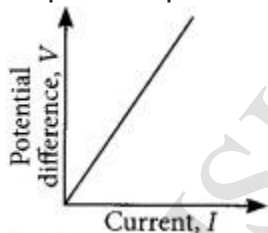
or $R_{eq} = 3 \Omega$

Question 38

Represent Ohm's law graphically.

Answer:

Graphical representation of Ohm's law

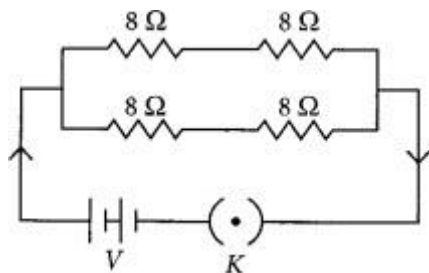


Question 39.

You have four resistors of 8Ω each. Show how you would connect these resistors to have effective resistance of 8Ω ? (4/5, Board Exam I, 2015)

Answer:

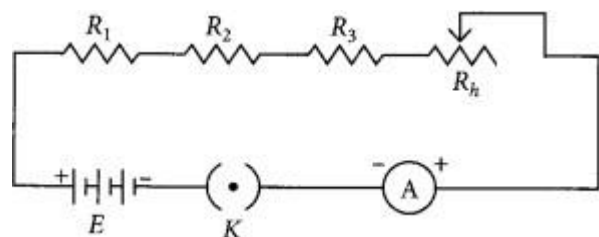
If you have four 8Ω resistors and the effective resistance is also 8Ω then the two 8Ω resistors are connected in series. Now you have a pair of two 16Ω resistors ($8 \Omega + 8 \Omega$). If you connect these resistors in parallel, you will have net resistance 8Ω .



Question 40.

Draw a labelled circuit diagram showing three resistors R_1 , R_2 and R_3 connected in series with a battery (E), a rheostat (R_h), a plug key (K) and an ammeter (A) using standard circuit symbols. Use this circuit to show that the same current flows through every part of the circuit. List two precautions you would observe while performing the experiment. (Board Exam I, 2014)

Answer:



Change the positions of ammeter and note the reading of ammeter each time. You will find that all the reading obtained are same.

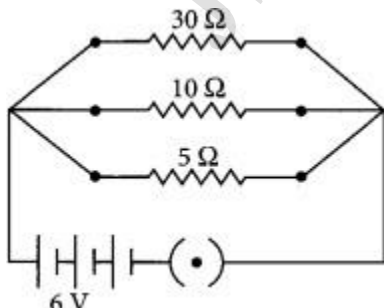
So, the value of the current in the ammeter is the same, independent of its position in the electric circuit. It means that in this circuit (series combination) the current is the same in every part of the circuit.

Precautions:

- (i) All the connections are neat and tight.
- (ii) Ammeter is connected with the proper polarity, i.e., positive terminal of the ammeter should go to positive terminal and negative terminal of ammeter to the negative terminal of the battery or cell used.

Question 41.

Two wires A and B are of equal length and have equal resistances. If the resistivity of A is more than that of B, which wire is thicker and why? For the electric circuit given below calculate:



- (i) current in each resistor

- (ii) total current drawn from the battery, and
 (iii) equivalent resistance of the circuit. (Boaíd I'eím I, 2014)

Answer:

Let l_A , a_A and R_A be the length, area of cross-section and resistance of wire A and l_B , a_B and R_B of wire B.

Here, $l_A = l_B$ and $R_A = R_B$

If ρ_A and ρ_B are the resistivities of wire A and B respectively then

$R_A = \rho_A \frac{l_{AA}}{a_{AA}}$ and $R_B = \rho_B \frac{l_{BB}}{a_{BB}}$, As $R_A = R_B$

$\therefore \rho_A \frac{l_{AA}}{a_{AA}} = \rho_B \frac{l_{BB}}{a_{BB}}$

or $\rho_A \rho_B = a_{AA} a_{BB}$

Since $\rho_A > \rho_B$ therefore $a_A > a_B$ Hence, wire A is thicker than wire B.

For parallel combination,

$V_1 = V_2 = V_3 = 6V$

(i) Using Ohm's law

$I_1 = V_1/R_1 = 6/30 = 0.2 A$

$I_2 = V_2/R_2 = 6/10 = 0.6 A$

$I_3 = V_3/R_3 = 6/5 = 1.2 A$

(ii) Total current drawn from battery,

$I = I_1 + I_2 + I_3 = 0.2 + 0.6 + 1.2 = 2 A$

(iii) Equivalent resistance of the circuit, R_{eq} can be obtained by Ohm's law

$V = I R_{eq}$

So, $6 V = 2 A \times R_{eq}$ or, $R_{eq} = 6/2 = 3 \Omega$

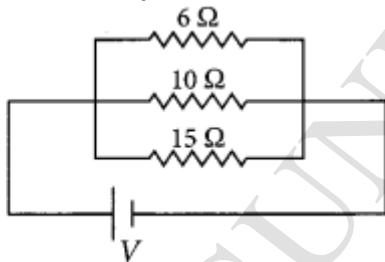
Alternatively, $1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3$

$1/30 + 1/10 + 1/5 = 1/3 + 1/30 = 10/30 + 1/30 = 11/30 = 1/3$

or $R_{eq} = 3 \Omega$

Question 42.

Find the equivalent resistance of the following circuit.



Answer: For the given circuit,

$R_1 = 6 \Omega$, $R_2 = 10 \Omega$, $R_3 = 15 \Omega$.

As $1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3$

$1/R_{eq} = 1/6 + 1/10 + 1/15$

$= 5/30 + 3/30 + 2/30 = 10/30 = 1/3$

$R_{eq} = 3 \Omega$

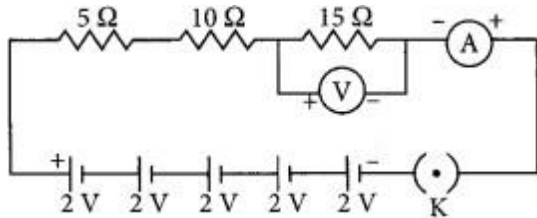
Question 43.

Draw a circuit diagram for a circuit consisting of a battery of five cells of 2 volts each, a 5Ω resistor, a 10Ω resistor and a 15Ω resistor, an ammeter and a plug key, all connected in series.

Also connect a voltmeter to record the potential difference across the 15Ω resistor and calculate

- (i) the electric current passing through the above circuit and
(ii) potential difference across $5\ \Omega$ resistor when the key is closed. (Boaid I'eim 1, 2013)

Answer:



Potential of the battery, $V = (2 \times 5) \text{ V} = 10 \text{ V}$

Equivalent resistance,

$$R_{eq} = R_1 + R_2 + R_3$$

$$= (5 + 10 + 15)\Omega = 30\ \Omega$$

(i) Current through circuit, $I = \frac{V}{R} = \frac{10}{30} \text{ A} = \frac{1}{3} \text{ A}$

(ii) Potential across $5\ \Omega$ resistor, $V_1 = IR_1$

$$= \frac{1}{3} \times 5 = \frac{5}{3} \text{ V} = 1.67 \text{ V}$$

Question 44.

The resistance of a resistor is reduced to half of its initial value. In doing so, if other parameters of the circuit remain unchanged, the heating effects in the resistor will become

- (a) two times
(b) half
(c) one-fourth
(d) four times (2020)

Answer:

(a) : We know, $H = I^2 R t = \frac{V^2}{R} t$

Now when, $R' = \frac{R}{2}$, $V' = V$ and $t' = t$

$$H' = \frac{V^2 t'}{R'} = \frac{V^2 t}{R/2} = 2 \frac{V^2 t}{R} = 2H$$

Question 45.

(a) Write the mathematical expression for Joules law of heating.

(b) Compute the heat generated while transferring 96000 coulomb of charge in two hours through a potential difference of 40 V. (2020)

Answer:

(a) The Joule's law of heating implies that heat produced in a resistor is

(i) directly proportional to the square of current for a given resistance,

(ii) directly proportional to resistance for a given current, and

(iii) directly proportional to the time for which the current flows through the resistor.

$$\text{i.e., } H = I^2 R t$$

(b) Given, charge $q = 96000 \text{ C}$, time $t = 2 \text{ h} = 7200 \text{ s}$ and potential difference $V = 40 \text{ V}$

$$\text{We know, } H = I^2 R t = \frac{Q}{t} \times \frac{V}{Q} \times t \times t = VQ$$

$$= 40 \times 96000 = 3.84 \times 10^6 \text{ J} = 3.84 \text{ MJ}$$

Question 46.

Question 47.

Explain the use of an electric fuse. What type of material is used for fuse wire and why? (Boaid

Íeím I, 2016)

Answer:

Electric fuse protects circuits and appliances by stopping the flow of any unduly high electric current. It consists of a piece of wire made of a metal or an alloy of appropriate melting point, for example aluminium, copper, iron, lead etc. If a current larger than the specified value flows through the circuit, the temperature of the fuse wire increases. This melts the fuse wire and breaks the circuit.

Question 48.

(a) Why is tungsten used for making bulb filaments of incandescent lamps?

(b) Name any two electric devices based on heating effect of electric current. (2/5, Boaid Íeím I, 2015)

Answer:

(a) (i) Tungsten is a strong metal and has high melting point (3380°C).

(ii) It emits light at high temperatures (about 2500°C).

(b) Electric laundry iron and electric heater are based on heating effect of electric current.

Question 49.

A fuse wire melts at 5 A. If it is desired that the fuse wire of same material melt at 10 A, then whether the new fuse wire should be of smaller or larger radius than the earlier one? Give reasons for your answer. (3/5, Boaid Íeím I, 2014)

Answer:

Let the resistance of the wire be R, heat produced in the fuse at 5 A in 1s is

$$H = (5)^2 R \quad (H = I^2 R t)$$

50. fuse melts at $(5)^2 R$ joules of heat.

Let, the resistance of new wire is R'

So, heat produced in 1 second = $(10)^2 R'$

To prevent it from melting

$$(5)^2 R = (10)^2 R' \quad \text{or } R' = R/4$$

As R is 1A

\therefore cross-sectional area of new fuse wire is four times the first fuse.

Now, $A = \pi r^2$, so new radius is twice the previous one. So, at 10 A, the new fuse wire of same material and length has larger radius than the earlier one.

Question 50.

What is heating effect of current? List two electrical appliances which work on this effect. (2/5, Boaid Íeím I, 2013)

Answer:

If only resistors are connected to the battery, the source energy continually gets dissipated entirely in the form of heat. This is known as heating effect of current, 'the amount of heat produced in time t is given by Joule's law of heating.

$$H = I^2 R t$$

Where, I is current flowing through resistor R.

The electric laundry iron, electric toaster, electric oven, electric kettle and electric heater are some common devices based on heating effect of current.

Question 51.

Two bulbs of 100 W and 40 W are connected in series. The current through the 100 W bulb is 1 A. The current through the 40 W bulb will be

- (a) 0.4 A
- (b) 0.6 A
- (c) 0.8 A
- (d) 1 A (2020)

Answer:

(d) : Given power of first bulb, $P_1 = 100 \text{ W}$ and second bulb $P_2 = 40 \text{ W}$

Current through 100 W bulb, $I_1 = 1 \text{ A}$

Current through 40 W bulb, $I_2 = ?$

Since both the bulbs are connected in series, the electric current passing through both the bulbs are same i.e., $I_2 = 1 \text{ A}$.

Question 52.

Write the relation between resistance (R) of filament of a bulb, its power (P) and a constant voltage V applied across it. (Boaid I'eim I, 2017)

Answer:

$$P = V^2/R$$

Question 53.

Power of a lamp is 60 W. Find the energy in joules consumed by it in 1s. (Boaid I'eim I, 2016)

Answer:

Here, power of lamp, $P = 60 \text{ W}$ time,

$$t = 1 \text{ s}$$

$$\text{So, energy consumed} = \text{Power} \times \text{time} = (60 \times 1) \text{ J} = 60 \text{ J}$$

Question 54.

Two lamps, one rated 100 W; 220 V, and the other 60 W; 220 V, are connected in parallel to electric mains supply. Find the current drawn by two bulbs from the line, if the supply voltage is 220 V. (2/3, 2018, Boaid I'eim I, 2014)

Answer:

Since both the bulbs are connected in parallel and to a 220 V supply, the voltage across each bulb is 220 V. Then

Current drawn by 100 W bulb,

$$I_1 = \text{power rating} / \text{voltage applied} = 100 \text{ W} / 220 \text{ V} = 0.454 \text{ A}$$

Current drawn by 60 W bulb,

$$I_2 = 60 \text{ W} / 220 \text{ V} = 0.273 \text{ A}$$

Total current drawn from the supply line,

$$I = I_1 + I_2 = 0.454 \text{ A} + 0.273 \text{ A} = 0.727 \text{ A} = 0.73 \text{ A}$$

Question 55.

How much current will an electric iron draw from a 220 V source if the resistance of its element when hot is 55 ohms? Calculate the wattage of the electric iron when it operates on 220 volts.

(Boaid I'eim I, 2016)

Answer:

$$\text{Here, } V = 220 \text{ V, } R = 55 \Omega$$

By Ohm's law $V = IR$

$$\therefore 220 = 7 \times 55 \text{ oí } I = 4A$$

Wattage of electric iron = Power

$$= V^2/R = (220)^2/55 = 880 \text{ W}$$

Question 56.

An electric iron has a rating of 750 W; 200 V. Calculate:

- (i) the current required.
- (ii) the resistance of its heating element.
- (iii) energy consumed by the iron in 2 hours. [Boaid 1^oéim 1, 2015]

Answer:

Here, $P = 750 \text{ W}$, $V = 200 \text{ V}$

(i) As $P = VI$

$$I = P/V = (750/200) \text{ A} = 3.75 \text{ A}$$

(ii) By Ohm's law $V = IR$ oí $R = V/I$

$$\therefore R = 200/3.75 \Omega = 53.3 \Omega$$

(iii) Energy consumed by the iron in 2 hours

$$= P \times t = 750 \text{ W} \times 2 \text{ h} = 1.5 \text{ kWh}$$

$$\text{oí } E = (750 \times 2 \times 3600) \text{ J} = 5.4 \times 10^6 \text{ J}$$

Question 57.

An electric bulb is connected to a 220 V generator. The current is 2.5 A. Calculate the power of the bulb. (1/3, Boaid 1^oéim I, 2015)

Answer:

Here, $V = 220 \text{ V}$, $I = 2.5 \text{ A}$

$$\text{Power of the bulb } P = VI = 220 \times 2.5 \text{ W} = 550 \text{ W}$$

Question 58.

- (a) Define power and state its SI unit.
- (b) A torch bulb is rated 5 V and 500 mA. Calculate its
 - (i) power
 - (ii) resistance
 - (iii) energy consumed when it is lighted for 2 1/2 hours.

Answer:

(a) Power is defined as the rate at which electric energy is dissipated or consumed in an electric circuit.

$$P = VI = I^2R = V^2/R$$

The SI unit of electric power is watt (W). It is the power consumed by a device that carries 1 A of current when operated at a potential difference of 1 V.

$$1 \text{ W} = 1 \text{ volt} \times 1 \text{ ampere} = 1 \text{ V A}$$

(b) Given, $V = 5 \text{ V}$ and $I = 500 \text{ mA} = 0.5 \text{ A}$

(i) Power, $P = V \times I = 5 \times 0.5 = 2.5 \text{ W}$

(ii) As, $P = V^2/R \Rightarrow R = V^2/P = 25/2.5 = 10 \Omega$

(iii) Given, time $t = 2.5 \text{ hrs} = 9000 \text{ s}$

$$\therefore \text{The energy consumed, } E = P \times t$$

$$= 2.5 \times 9000 = 2.25 \times 10^4 \text{ J}$$

$$= 6.25\text{-Watt hour}$$

Question 59.

Two identical resistors, each of resistance 15Ω , are connected in (i) series, and (ii) parallel, in turn to a battery of 6 V . Calculate the ratio of the power consumed in the combination of resistors in each case. (2020)

Answer:

Given, $R_1 = R_2 = 15 \Omega$, $V = 6 \text{ V}$

(i) When connected in series,

$$R_s = R_1 + R_2 = 15 \Omega + 15 \Omega = 30 \Omega$$

$$\text{Power, } P_s = V^2/R_s = 36/30 \text{ W}$$

(ii) When connected in parallel,

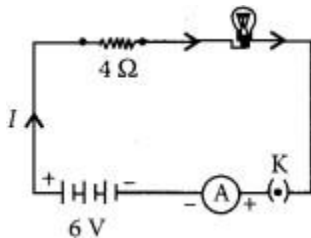
$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow R_p = \frac{15}{2} \Omega$$

$$\therefore \text{Power, } P_p = \frac{V^2}{R_p} = \frac{36}{15} \times 2 \text{ W}$$

$$\therefore \text{The ratio, } \frac{P_s}{P_p} = \frac{36}{30} \times \frac{15}{36 \times 2} = \frac{1}{4}$$

Question 60.

An electric lamp of resistance 20Ω and a conductor of resistance 4Ω are connected to a 6 V battery as shown in the circuit. Calculate.



(a) the total resistance of the circuit

(b) the current through the circuit,

(c) the potential difference across the (i) electric lamp and (ii) conductor, and

(d) power of the lamp. (Delhi 2019)

Answer:

Resistance of the lamp = 20Ω

External resistance = 4Ω

(a) As both the lamp and external resistance are connected in series, therefore the total resistance,

$$R = 20 + 4 = 24 \Omega$$

(b) Current, $I = VR = 6/24 = 0.25 \text{ A}$

(c) (i) Potential difference across the electric lamp

Total voltage / Total resistance \times resistance of lamp

$$= 6/24 \times 20 = 5 \text{ V}$$

(ii) Potential difference across conductor

Total voltage / Total resistance \times resistance of conductor

$$= 6/24 \times 4 = 1 \text{ V}$$

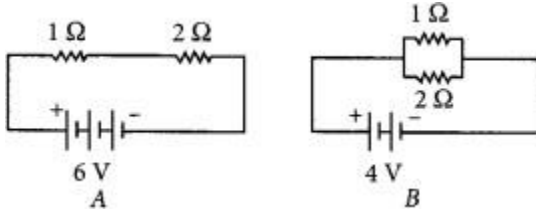
(d) Power of the lamp

$$= (\text{current})^2 \times \text{resistance of lamp}$$

$$= (0.25)^2 \times 20 = 1.25 \text{ W}$$

Question 61.

Compare the power used in 2Ω resistor in each of the following circuits. (AI 2019)



Answer:

In circuit A,

Total resistance, $R = 1 + 2 = 3 \Omega$

Voltage across $2 \Omega = V_{\text{Total}} \frac{R_{\text{Total}}}{R} \times 2 \Omega = 6 \times \frac{2}{3} = 4 \text{ V}$

\therefore Power used in 2Ω resistor,

$$P = V^2 R = (4)^2 \times 2 = 8 \text{ W}$$

In circuit B, Voltage across both the resistor is same i.e. 4 V and both are connected in parallel combination.

\therefore Power used in 2Ω resistor = $V^2 R = (4)^2 \times 2 = 8 \text{ W}$

\therefore Power used in 2Ω resistor in each case is same i.e. 8 W.

Question 62.

A bulb is rated 40 W; 220 V. Find the current drawn by it, when it is connected to a 220 V supply. Also find its resistance. If the given bulb is replaced by a bulb of rating 25 W; 220 V, will there be any change in the value of current and resistance? Justify your answer and determine the change. (AI 2019)

Answer:

In first case, $P = 40 \text{ W}$, $V = 220 \text{ V}$

Current drawn $I = \frac{P}{V} = \frac{40}{220} = 0.18 \text{ A}$

Also, resistance of bulb,

$$R = \frac{V^2}{P} = \frac{(220)^2}{40} = 1210 \Omega$$

In second case, $P = 25 \text{ W}$, $V = 220 \text{ V}$

Current drawn, $I = \frac{P}{V} = \frac{25}{220} = 0.11 \text{ A}$

Also, resistance of the bulb,

$$R = \frac{V^2}{P} = \frac{(220)^2}{25} = 1936 \Omega$$

Hence, by replacing 40 W bulb to 25 W bulb, having same source of voltage the amount of current flows decreases while resistance increases.

Question 63.

(a) How two resistors, with resistances $R_1 \Omega$ and $R_2 \Omega$ respectively are to be connected to a battery of emf V volts so that the electrical power consumed is minimum?

(b) In a house 3 bulbs of 100 watt each lighted for 5 hours daily, 2 fans of 50 watt each used for 10 hours daily and an electric heater of 1.00 kW is used for half an hour daily. Calculate the total energy consumed in a month of 31 days and its cost at the rate of Rs 3.60 per kWh. (Board Exam I, 2017)

Answer:

(a) Power consumed is minimum when current through the circuit is minimum, so the two resistors are connected in series.

(b) Power of each bulb $P_1 = 100$ watt

Total power of 3 bulbs, $P_1 = 3 \times 100 = 300$ watt

Energy consumed by bulbs in 1 day

$$E_1 = P_1 \times t = 300 \text{ watt} \times 5 \text{ hours.}$$

$$= 1500 \text{ Wh} = 1.5 \text{ kWh}$$

Power of each fan = 50 watt

Total power of 2 fans = 2×50 watt

$$P_2 = 100 \text{ watt}$$

Energy consumed by fans in 1 day

$$E_2 = P_2 \times t = 100 \text{ watt} \times 10 \text{ hours}$$

$$= 1000 \text{ watt hour} = 1 \text{ kWh}$$

Energy consumed by heater,

$$E_3 = 1 \text{ kW} \times 1/2 \text{ h} = 0.5 \text{ kWh}$$

Total energy consumed in one day

$$E = E_1 + E_2 + E_3 = (1.5 + 1 + 0.5) \text{ kWh} = 3 \text{ kWh}$$

Total energy consumed in a month of 31 days

$$= E \times 31 = (3 \times 31) \text{ kWh} = 93 \text{ kWh}$$

$$\text{Cost of energy consumed} = \text{Rs } (93 \times 3.60) = \text{Rs } 334.80$$

Question 64.

(a) An electric bulb is connected to a 220 V generator. If the current drawn by the bulb is 0.50 A, find its power.

(b) An electric refrigerator rated 400 W operates 8 hours a day. Calculate the energy per day in kWh.

(c) State the difference between kilowatt and kilowatt hour. (3/5, Board Term I, 2013)

Answer:

(a) Here, $V = 220 \text{ V}$, $I = 0.50 \text{ A}$

$$\text{Power of the bulb, } P = VI = (220 \times 0.5) \text{ W} = 110 \text{ W}$$

(b) Energy consumed by electric refrigerator in a day = Power \times time

$$= 400 \text{ W} \times 8 \text{ h} = 3200 \text{ Wh} = 3.2 \text{ kWh}$$

(c) Kilowatt is unit of power and kilowatt hour is a unit of energy.

Question 65.

(i) State one difference between kilowatt and kilowatt hour. Express 1 kWh in joules.

(ii) A bulb is rated 5V; 500 mA. Calculate the rated power and resistance of the bulb when it glows. (Board Term I, 2013)

Answer:

(i) Refer to answer 64(c).

$$1 \text{ kWh} = 1000 \text{ W} \times 1 \text{ h}$$

$$= 1000 \text{ W} \times 3600 \text{ s} = 3600000 \text{ J} = 3.6 \times 10^6 \text{ J}$$

(ii) Here, $V = 5 \text{ V}$, $I = 500 \text{ mA} = 0.5 \text{ A}$

Power rating of bulb is

$$P = VI = (5 \times 0.5)W = 2.5W$$

$$\text{Resistance of the bulb is } R = V/I = (5/0.5) \Omega = 10 \Omega$$

Chapter- 12

MAGNETIC EFFECTS OF CURRENT

Magnet: Magnetic field and magnetic field lines, Magnetic field due to a current carrying conductor, Right hand thumb rule, Magnetic field due to current through a circular loop.

Magnetic field due to current in a solenoid.

Magnet is an object that attracts objects made of iron, cobalt and nickel. Magnet comes to rest in North – South direction, when suspended freely.

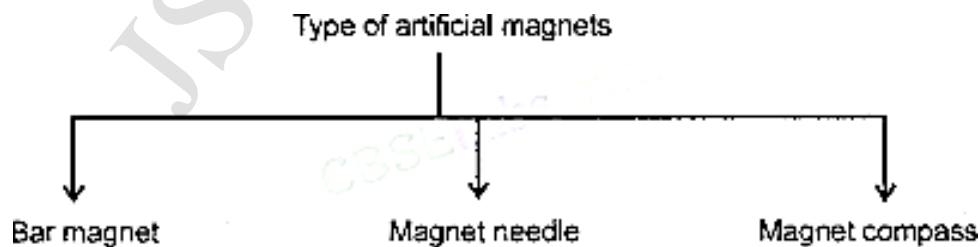
Use of Magnets: Magnets are used

- in refrigerators.
- in radio and stereo speakers.
- in audio and video cassette players.
- in children's toys and;
- on hard discs and floppies of computers.

Properties of Magnet

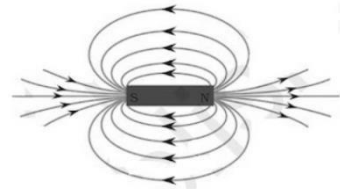
- A free suspended magnet always points towards the north and south direction.
- The pole of a magnet which points toward north direction is called north pole or north-seeking.
- The pole of a magnet which points toward south direction is called south pole or south seeking.
- Like poles of magnets repel each other while unlike poles of magnets attract each other.

Magnetic field: The area around a magnet where a magnetic force is experienced is called the magnetic field. It is a quantity that has both direction and magnitude, (i.e., Vector quantity).



Magnetic field and field lines: The influence of force surrounding a magnet is called magnetic field. In the magnetic field, the force exerted by a magnet can be detected using a compass or any other magnet.

The magnetic field is represented by magnetic field lines.
The imaginary lines of magnetic field around a magnet are called field line or field line of magnet. When iron fillings are allowed to settle around a bar magnet, they get arranged in a pattern which mimicks the magnetic field lines. Field line of a magnet can also be



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detected using a compass. Magnetic field is a vector quantity, i.e. it has both direction and magnitude.

Direction of field line: Outside the magnet, the direction of magnetic field line is taken from North Pole to South Pole. Inside the magnet, the direction of magnetic field line is taken from South Pole to North pole.

Strength of magnetic field: The closeness of field lines shows the relative strength of magnetic field, i.e. closer lines show stronger magnetic field and vice – versa. Crowded field lines near the poles of magnet show more strength.

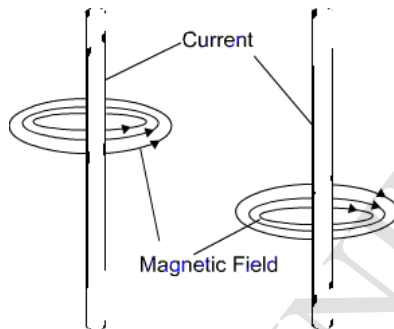
Properties of magnetic field lines

- (i) They do not intersect each other.
- (ii) It is taken by convention that magnetic field lines emerge from North pole and merge at the South pole. Inside the magnet, their direction is from South pole to North pole. Therefore, magnetic field lines are closed curves.

Magnetic field lines due to current a current carrying straight conductor

A current carrying straight conductor has magnetic field in the form of concentric circles, around it. Magnetic field of current carrying straight conductor can be shown by magnetic field lines.

The direction of magnetic field through a current carrying conductor depends upon the direction of flow electric current.

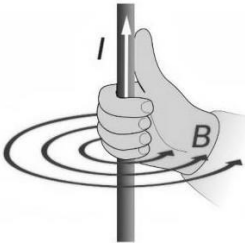


Let a current carrying conductor be suspended vertically and the electric current is flowing from south to north. In this case, the direction of magnetic field will be anticlockwise. If the current is flowing from north to south, the direction of magnetic field will be clockwise.

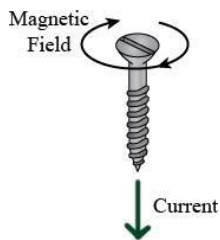
The direction of magnetic field, in relation to direction of electric current through a straight conductor can be depicted by using the Right-Hand Thumb Rule. It is also known as Maxwell's Corkscrew Rule.

Right-Hand Thumb Rule: If a current carrying conductor is held by right hand, keeping the thumb straight and if the direction of electric current is in the direction of thumb, then the

direction of wrapping of other fingers will show the direction of magnetic field.



Maxwell's Corkscrew rule: As per Maxwell's Corkscrew Rule, if the direction of forward movement of screw shows the direction of the current, then the direction of rotation of screw shows the direction of magnetic field.

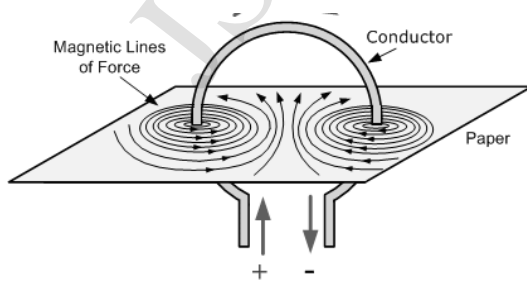


Properties of magnetic field

- The magnitude of magnetic field increases with increase in electric current and decreases with decrease in electric current.
- The magnitude of magnetic field produced by electric current decreases with increase in distance and vice – versa. The size of concentric circles of magnetic field lines increases with distance from the conductor, which shows that magnetic field decreases with distance.
- Magnetic field lines are always parallel to each other.
- No two field lines cross each other.

Magnetic field lines due to a current through a circular loop

In case of a circular current carrying conductor, the magnetic field is produced in the same manner as it is in case of a straight current carrying conductor.



In case of a circular current carrying conductor, the magnetic field lines would be in the form of

iron concentric circles around every part of the periphery of the conductor. Since, magnetic field lines tend to remain closer when near to the conductor, so the magnetic field would be stronger near the periphery of the loop. On the other hand, the magnetic field lines would be distant from each other when we move towards the centre of the current carrying loop. Finally, at the centre, the arcs of big circles would appear as a straight line.

The direction of the magnetic field can be identified using Right Hand Thumb's Rule. Let us assume that the current is moving in anti-clockwise direction in the loop. In that case, the magnetic field would be in clockwise direction, at the top of the loop. Moreover, it would be in an anti-clockwise direction at the bottom of the loop.

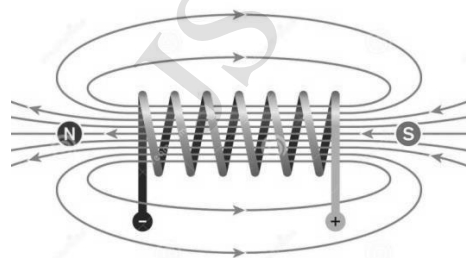
Clock Face Rule: A current carrying loop works like a disc magnet. The polarity of this magnet can be easily understood with the help of Clock Face Rule. If the current is flowing in anti – clockwise direction, then the face of the loop shows north pole. On the other hand, if the current is flowing in clockwise direction, then the face of the loop shows south pole.

Magnetic field and number of turns of coil: Magnitude of magnetic field gets summed up with increase in the number of turns of coil. If there are n turns of coil, magnitude of magnetic field will be n times of magnetic field in case of a single turn of coil.

The strength of the magnetic field at the centre of the loop(coil) depends on :

- (i) **The radius of the coil:** The strength of the magnetic field is inversely proportional to the radius of the coil. If the radius increases, the magnetic strength at the centre decreases
- (ii) **The number of turns in the coil :** As the number of turns in the coil increase, the magnetic strength at the centre increases, because the current in each circular turn is having the same direction, thus, the field due to each turn adds up.
- (iii) **The strength of the current flowing in the coil:** As the strength of the current increases, the strength of three magnetic fields also increases.

Magnetic field due to a current in a Solenoid: Solenoid is the coil with many circular turns of insulated copper wire wrapped closely in the shape of a cylinder. A current carrying solenoid produces similar pattern of magnetic field as a bar magnet. One end of solenoid behaves as the north pole and another end behaves as the south pole.



Magnetic field lines are parallel inside the solenoid, similar to a bar magnet, which shows that magnetic field is same at all points inside the solenoid.

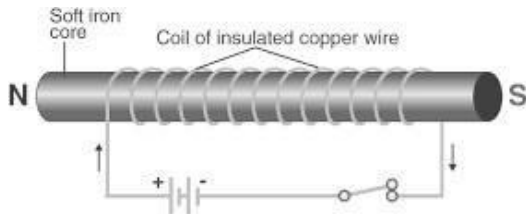
Magnetic field produced by a solenoid is similar to a bar magnet.

The strength of magnetic field is proportional to the number of turns and magnitude of current. By producing a strong magnetic field inside the solenoid, magnetic materials can be magnetized. Magnet formed by producing magnetic field inside a solenoid is called electromagnet.

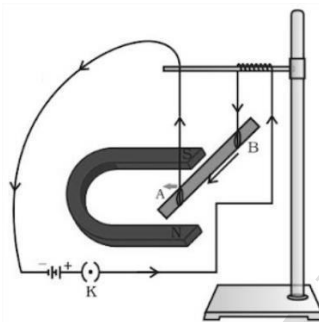
Electromagnet, Fleming's Left-Hand Rule, Electric motor, Electromagnetic induction, Fleming's right hand rule, Electric generator and domestic electric circuits.

Electromagnet: An electromagnet consists of a long coil of insulated copper wire wrapped on a soft iron.

Magnet formed by producing magnetic field inside a solenoid is called electromagnet.



Force on a current carrying conductor in a magnetic field: A current carrying conductor exerts a force when a magnet is placed in its vicinity. Similarly, a magnet also exerts equal and opposite force on the current carrying conductor. This was suggested by Marie Ampere, a French Physicist and considered as founder of science of electromagnetism.

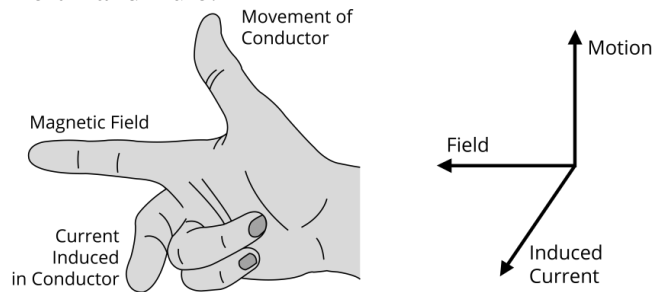


The direction of force over the conductor gets reversed with the change in direction of flow of electric current. It is observed that the magnitude of force is highest when the direction of current is at right angles to the magnetic field.

Fleming's Left-Hand Rule: If the direction of electric current is perpendicular to the magnetic field, the direction of force is also perpendicular to both of them. The Fleming's Left Hand Rule states that if the left hand is stretched in a way that the index finger, the middle finger and the thumb are in mutually perpendicular directions, then the index finger and middle finger of a stretched left hand show the direction of magnetic field and direction of electric current respectively and the thumb shows the direction of motion or force acting on the conductor. The directions of electric current, magnetic field and force are similar to three mutually perpendicular axes, i.e. x, y, and z-axes.

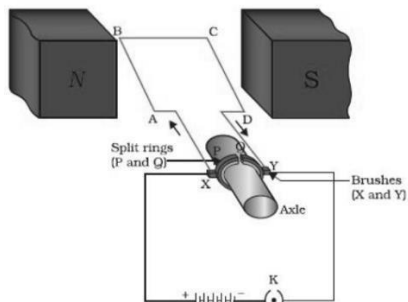
Many devices, such as electric motor, electric generator, loudspeaker, etc. work on Fleming's

Left Hand Rule.



Electric motor: A device that converts electrical energy to mechanical energy. It is of two types : AC and DC Motor. Electrical energy is converted into mechanical energy by using an electric motor. Electric motor works on the basis of rule suggested by Marie Ampere and Fleming's Left Hand Rule.

Principle of Electric Motor: When a rectangular coil is placed in a magnetic field and a current is passed through it, force acts on the coil, which rotates it continuously. With the rotation of the coil, the shaft attached to it also rotates.



Construction: It consists of the following parts ---

Armature: It is a rectangular coil (ABCD) which is suspended between the two poles of a magnetic field.

The electric supply to the coil is connected with a commutator.

- **Commutator or Split – ring:** Commutator is a device which reverses the direction of flow of electric current through a circuit. It is two halves of the same metallic ring.
- **Magnet:** Magnetic field is supplied by a permanent magnet NS.
- **Sliding contacts or Brushes Q** which are fixed.
- **Battery:** These are consisting of few cells.

Working: When an electric current is supplied to the coil of the electric motor, it gets deflected because of magnetic field. As it reaches the halfway, the split ring which acts as commutator reverses the direction of flow of electric current. Reversal of direction of the current, reverses the direction of forces acting on the coil. The change in direction of force pushes the coil, and it

moves another half turn. Thus, the coil completes one rotation around the axle. Continuation of this process keeps the motor in rotation.

In commercial motor, electromagnet instead of permanent magnet and armature is used.

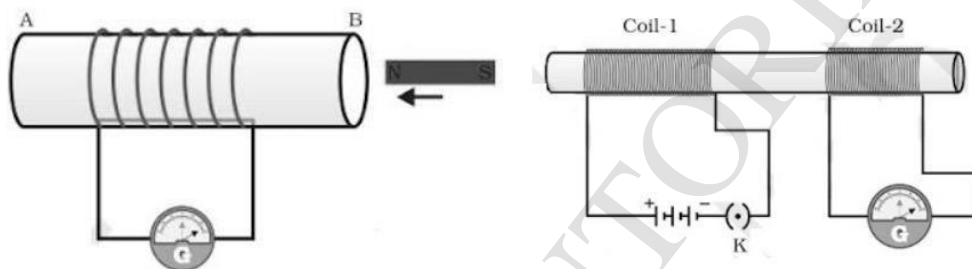
Armature is a soft iron core with large number of conducting wire turns over it. Large number of turns of conducting wire enhances the magnetic field produced by armature.

Uses of motors:

- Used in electric fans.
- Used for pumping water.
- Used in various toys.

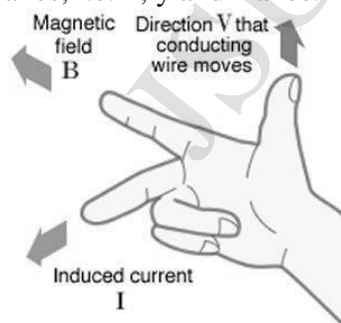
Electromagnetic Induction: Michael Faraday, an English Physicist is supposed to have studied the generation of electric current using a magnetic field and a conductor.

Electricity production as a result of magnetism (induced current) is called Electromagnetic Induction.



When a conductor is set to move inside a magnetic field or a magnetic field is set to be changing around a conductor, electric current is induced in the conductor. This is just opposite to the exertion of force by a current carrying conductor inside a magnetic field. In other words, when a conductor is brought in relative motion vis – a – vis a magnetic field, a potential difference is induced in it. This is known as electromagnetic induction.

Fleming's Right-Hand Rule: Electromagnetic induction can be explained with the help of Fleming's Right Hand Rule. If the right hand is structured in a way that the index (fore) finger, middle finger and thumb are in mutually perpendicular directions, then the thumb shows direction of induced current in the conductor, in conductor The directions of movement of conductor, magnetic field and induced current can be compared to three mutually perpendicular axes, i.e. x, y and z axes.



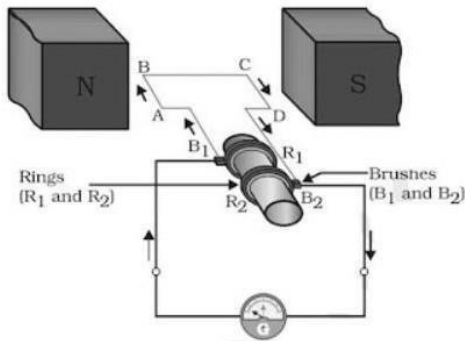
The mutually perpendicular directions also point to an important fact that when the magnetic field and movement of conductor are perpendicular, the magnitude of induced current would be

maximum.

Electromagnetic induction is used in the conversion of kinetic energy into electrical energy.

Electric Generator: A device that converts mechanical energy into electrical energy is called an electric generator.

Electric generators are of two types: AC generator and a DC generator. Principle of electric generator: Electric motor works on the basis of electromagnetic induction.



Construction and Working: The structure of an electric generator is similar to that of an electric motor. In case of an electric generator, a rectangular armature is placed within the magnetic field of a permanent magnet. The armature is attached to wire and is positioned in a way that it can move around an axle. When the armature moves within the magnetic field, an electric current is induced. The direction of induced current changes, when the armature crosses the halfway mark of its rotation.

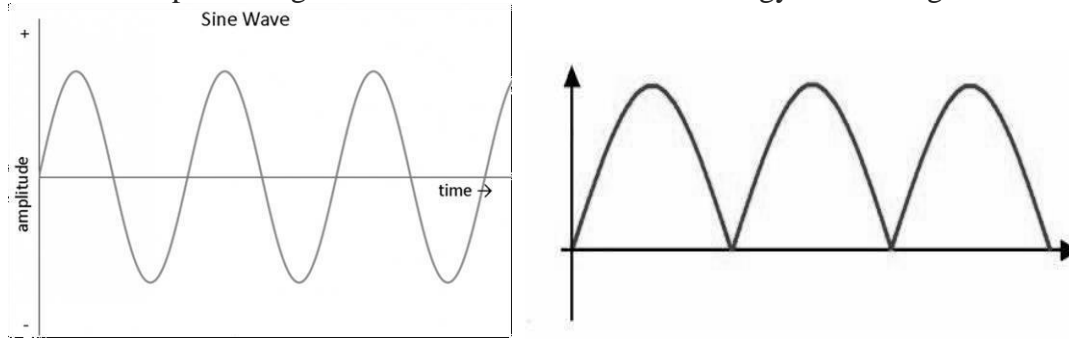
Thus, the direction of current changes once in every rotation. Due to this, the electric generator usually produces alternate current, i.e. A.C. To convert an A.C generator into a D.C generator, a split ring commutator is used. This helps in producing direct current.

Electrical generator is used to convert mechanical energy into electrical energy.

A.C and D.C Current

A.C – Alternate Current: Current in which direction is changed periodically is called Alternate Current. In India, most of the power stations generate alternate current. The direction of current changes after every $1/100$ second in India, i.e., the frequency of A.C in India is 50 Hz. A.C is

transmitted up to a long distance without much loss of energy is advantage of A.C over D.C.



D.C – Direct Current: Current that flows in one direction only is called Direct current. Electrochemical cells produce direct current. Advantages of A.C over D.C

- Cost of generator of A.C is much less than that of D.C.
- A.C can be easily converted to D.C.
- A.C can be controlled by the use of choke which involves less loss of power whereas, D.C can be controlled using resistances which involves high energy loss.
- AC can be transmitted over long distances without much loss of energy.
- AC machines are stout and durable and do not need much maintenance.

Disadvantages of AC

- AC cannot be used for the electrolysis process or showing electromagnetism as it reverses its polarity.
- AC is more dangerous than DC.

Domestic Electric Circuits: We receive electric supply through mains supported through the poles or cables. In our houses, we receive AC electric power of 220 V with a frequency of 50 Hz. The 3 wires are as follows

- Live wire – (Red insulated, Positive)
- Neutral wire – (Black insulated, Negative)
- Earth wire – (Green insulated) for safety measure to ensure that any leakage of current to a metallic body does not give any serious shock to a user.

Short Circuit: Short-circuiting is caused by the touching of live wires and neutral wire and sudden a large current flow.

It happens due to

- damage of insulation in power lines.
- a fault in an electrical appliance.

Overloading of an Electric Circuit: The overheating of electrical wire in any circuit due to the flow of a large current through it is called overloading of the electrical circuit.

A sudden large number of current flows through the wire, which causes overheating of wire and may cause fire also.

Electric Fuse: It is a protective device used for protecting the circuit from short-circuiting and overloading. It is a piece of thin wire of material having a low melting point and high resistance.

- Fuse is always connected to live wire.
- Fuse is always connected in series to the electric circuit.
- Fuse is always connected to the beginning of an electric circuit.
- Fuse works on the heating effect

QUESTIONS FROM PREVIOUS BOARD EXAMS

Question 1.

What is meant by magnetic field?

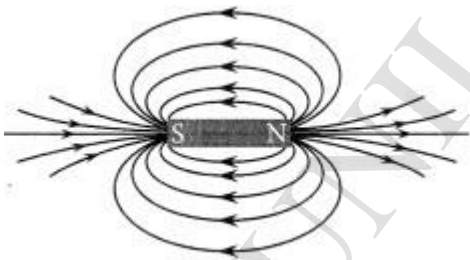
Answer:

Magnetic field : It is defined as the space surrounding the magnet in which magnetic force can be experienced.

Question 2.

Draw magnetic field lines around a bar magnet. Name the device which is used to draw magnetic field lines. (Board Term I, 2015)

Answer:



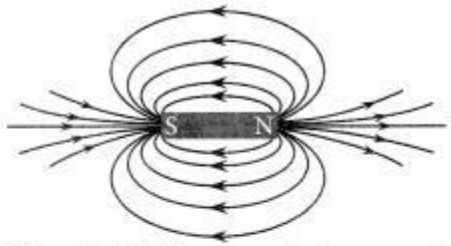
Compass needle is used to draw magnetic field lines.

Question 3.

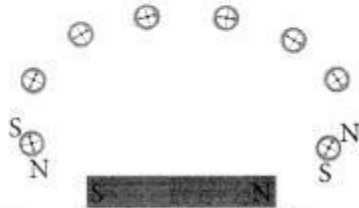
Design an activity to demonstrate that a bar magnet has a magnetic field around it. (Board Term I, 2017)

Answer:

One can easily demonstrate the presence of field lines around a bar magnet using compass needles. Place the magnet on a white sheet and mark its boundaries on sheet. Place the compass near the north pole of magnet and mark the position of needle. Now move the compass such that its south pole occupies the position previously occupied by its north pole. Repeat this step several times and you will have pattern as shown in the figure.



Magnetic field lines around a bar magnet



Drawing a magnetic field line with the help of a compass needle

Repeat the above procedure and draw as many lines as you can. These lines represent the magnetic field around the magnet. These are known as magnetic field lines.

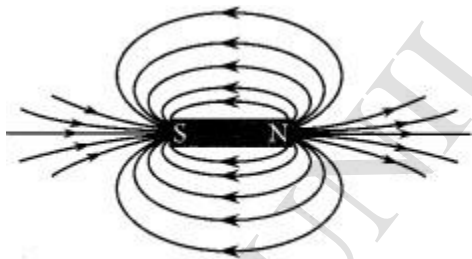
Question 4.

What are magnetic field lines? Justify the following statements:

- (a) Two magnetic field lines never intersect each other.
- (b) Magnetic field are closed curves. (Boards Term I, 2016)

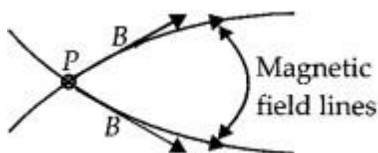
Answer:

Imagine continuous closed curves used to represent the magnetic field in a region is known as magnetic field lines. It is directed from north pole to south pole outside the magnet and south pole to north pole inside the magnet.



Magnetic field lines around a bar magnet

- (a) The direction of magnetic field (B) at any point is obtained by drawing a tangent to the magnetic field line at that point. In case, two magnetic field lines intersect each other at the point P as shown in figure, magnetic field at P will have two directions, shown by two arrows, one drawn to each magnetic field line at P , which is not possible.



(b) It is taken by convention that the field lines emerge from north pole and merge at the south pole. Inside the magnet, the direction of field lines is from its south pole to its north pole. Thus, the magnetic field lines are closed curves.

Question 5.

(a) What is meant by a magnetic field? Mention two parameters that are necessary to describe it completely.

(b) If field lines of a magnetic field are crossed at a point, what does it indicate? (Boaid I'eim I, 2013)

Answer:

(a) It is defined as the space surrounding the magnet in which magnetic force can be experienced.

Necessary parameters are:

- Magnitude of magnetic field.
- Direction of field lines

(b) If field lines of a magnetic field are crossed at a point, it indicates that there are two directions of magnetic field at a point which is not possible.

Question 6.

A compass needle is placed near a current carrying straight conductor. State your observation for the following cases and give reasons for the same in each case.

(a) Magnitude of electric current is increased.

(b) The compass needle is displaced away from the conductor. (AI 2019)

Answer:

(a) As the amount of magnetic field strength is directly proportional to the amount of current, so the deflection of compass needle increases.

(b) Since magnetic field strength at a point is inversely proportional to the distance from the wire. Hence deflection of compass decreases when it is displaced away from the conductor.

Question 7.

State how the magnetic field produced by a straight current carrying conductor at a point depends on

(a) current through the conductor

(b) distance of point from conductor. (Boaid I'eim I, 2014)

Answer:

Strength of magnetic field produced by a straight current-carrying wire at a given point is

(a) directly proportional to the current passing through it.

(b) inversely proportional to the distance of that point from the wire.

$$i.e., B \propto \frac{I}{r} \left\{ \begin{array}{l} B \rightarrow \text{magnetic field} \\ I \rightarrow \text{current} \\ r \rightarrow \text{distance between wire and} \\ \text{point of observation} \end{array} \right.$$

Question 8.

Give reason for the following

- (i) There is either a convergence or a divergence of magnetic field lines near the ends of a current carrying straight solenoid.
- (ii) The current carrying solenoid when suspended freely rests along a particular direction. (2/3, 2020)

Answer:

(i) There is either a convergence or a divergence of magnetic field lines near the ends of a current carrying straight solenoid because it behaves similar to that of a bar magnet and has a magnetic field line pattern similar to that of a bar magnet. Thus the ends of the straight solenoid behaves like poles of the magnet, where the converging end is the south pole and the diverging end is the north pole.

(ii) The current carrying solenoid behaves similar to that of a bar magnet and when freely suspended aligns itself in the north-south direction.

Question 9.

Find the direction of magnetic field due to a current carrying circular coil held:

- (i) vertically in North – South plane and an observer looking it from east sees the current to flow in anticlockwise direction,
- (ii) vertically in East – West plane and an observer looking it from south sees the current to flow in anticlockwise direction,
- (iii) horizontally and an observer looking at it from below sees current to flow in clockwise direction. (Boards Term I, 2017)

Answer:

According to right hand rule, the direction of magnetic field is

- (i) west to east
- (ii) north to south
- (iii) into the paper.

Question 10.

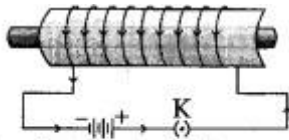
- (a) State three factors on which the strength of magnetic field produced by a current carrying solenoid depends.
- (b) Draw circuit diagram of a solenoid to prepare an electromagnet. (Boards Term I, 2016)

Answer:

(a) Strength of magnetic field produced by a current carrying solenoid depends upon the following factors:

- number of turns in the coil
- amount of current flowing through it
- radius of coil
- Material of core of the solenoid.

(b) A strong magnetic field produced inside a solenoid can be used to magnetise a piece of magnetic material, like soft iron, when placed inside the coil. The magnet so formed is called an electromagnet.



An electromagnet-A current-carrying solenoid coil which is used to magnetise steel rod inside it.

Question 11.

(a) State Right Hand Thumb rule to find the direction of the magnetic field around a current carrying straight conductor.

(b) How will the magnetic field be affected on:

(i) increasing the current through the conductor

(ii) reversing the direction of flow of current in the conductor? (Board Exam I, 2015)

Answer:

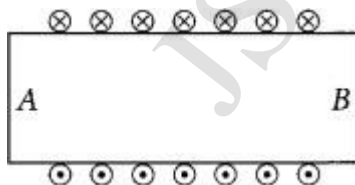
(a) It states that you are holding a current carrying straight conductor in your right hand such that the thumb points towards the direction of current. Then your fingers will wrap around the conductor in the direction of the field lines of the magnetic field.

(b) (i) If the current is increased, the magnetic field strength also increases.

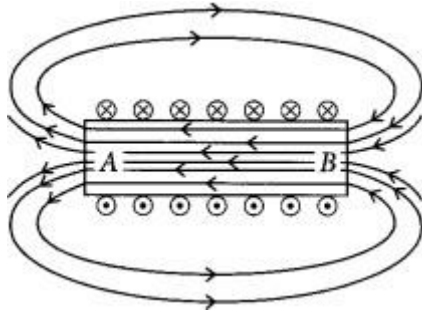
(ii) If the direction of current is reversed, the direction of magnetic field also get reversed.

Question 12.

Diagram shows the lengthwise section of a current carrying solenoid. \otimes indicates current entering into the page, \odot indicates current emerging out of the page. Decide which end of the solenoid A or B, will behave as north pole. Give reason for your answer. Also draw field lines inside the solenoid.



Answer:



Using right hand thumb rule we can draw the magnetic field lines around the conductor as shown. From figure, end A of solenoid act as north pole and end B will act as south pole. Inside the solenoid field lines are in the form of parallel straight lines.

Question 13.

Write one application of right-hand thumb rule. (1/3, Board Term I, 2013)

Answer:

It is used to find the direction of magnetic field around a current carrying conductor.

Question 14.

Why don't two magnetic lines of force intersect each other?

Ans. No, two magnetic field lines can ever intersect each other. If they do, then it would mean that at the point of intersection there are two directions of magnetic field, which is not possible.

Question 15.

What is solenoid? Draw the pattern of magnetic field lines of

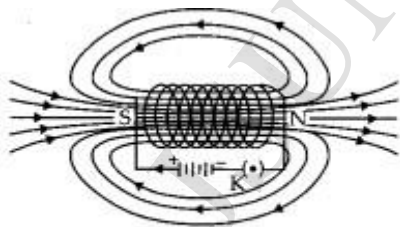
(i) a current carrying solenoid and

(ii) a bar magnet.

List two distinguishing features between the two fields. (Delhi 2019)

Answer:

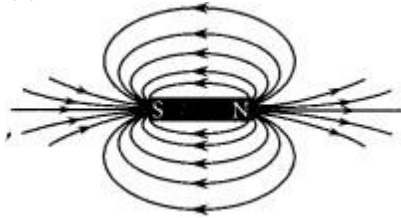
(i) Solenoid: A coil of many circular turns of insulated copper wire wrapped in the shape of cylinder is called solenoid.



Field lines of the magnetic field through and around a current-carrying solenoid

The pattern of magnetic field lines inside the solenoid indicates that the magnetic field is the same at all points inside the solenoid. That is, the field is uniform inside the solenoid.

(ii) Magnetic field lines around a bar magnet.



Following are the distinguishing features between the two fields.

- (a) A bar magnet is a permanent magnet whereas solenoid is an electromagnet, therefore field produced by solenoid is temporary and stay till current flows through it.
- (b) Magnetic field produced by solenoid is stronger than magnetic field of a bar magnet.

Question 16.

What are magnetic field lines? List three characteristics of these lines. Describe in brief an activity to study the magnetic field lines due to a current carrying circular coil. (Board Term I, 2017, 2016)

Answer:

Magnetic field lines : These are the imaginary close curves which are used to represent the magnetic field around the magnet.

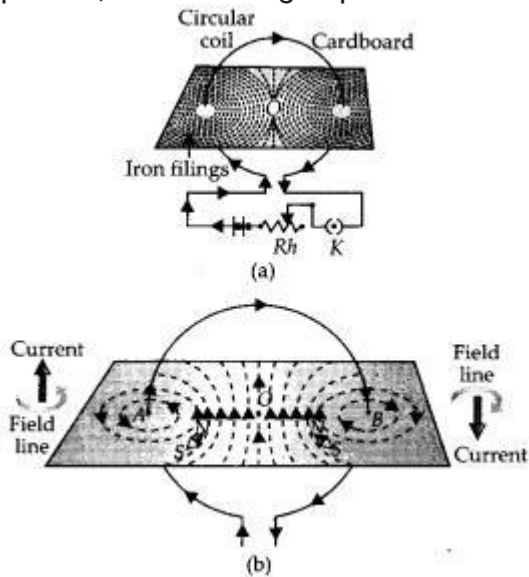
The properties of the magnetic field lines are listed below:

- Magnetic field lines start at the north pole and end at the south pole.
- Magnetic field lines do not intersect each other, because there can't be two directions of the magnetic field at any one point.
- The degree of closeness of the field lines depends upon the strength of the magnetic field. Stronger the field, closer are the field lines.

In order to find the magnetic field due to a coil, it is held in a vertical plane and is made to pass through a smooth cardboard in such a way that the centre (O) of the coil lies at the cardboard. A current is passed through the coil and iron filings are sprinkled on the cardboard. These iron filings arrange themselves in a pattern similar to one shown in the figure. This pattern represents the magnetic field lines due to the coil.

In order to find the direction of magnetic field lines, we plot the magnetic field with the help of a compass needle. The pattern of magnetic field lines so obtained is shown in figure (b). From this

patteín, the following important conclusion have been drawn.



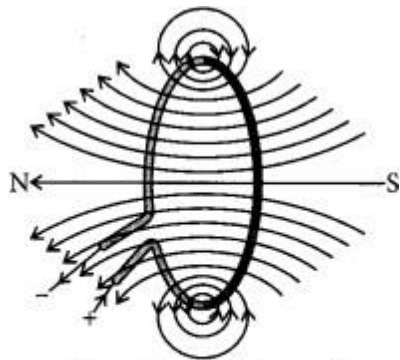
- The magnetic field lines near the coil are nearly circular and concentric. This is due to the reason that the segments of the coil in contact with the board at the points A and B are almost like straight conductors. The direction of the field lines can also be found by applying right-hand thumb rule.
- The field lines are in the same direction in the space enclosed by the coil.
- Near the centre of the coil, the field lines are nearly straight and parallel. As such the magnetic field at the centre of the coil can be taken to be uniform.
- The direction of the magnetic field at the centre is perpendicular to the plane of the coil.
- As we move towards the centre of the coil, the strength of magnetic field increases. Magnetic field is maximum at its centre. This is due to the reason that the two magnetic field (one due to the semicircular segment of the coil through A and the other due to the semicircular segment through B) assist each other.

The magnitude of the magnetic field at the centre of the coil is directly proportional to the current flowing through it and total number of turns and inversely proportional to the radius of the coil. This is due to the reason that the current in all the circular turns of the coil is in the same direction. As such, the resultant magnetic field due to the coil is equal to the sum of the field due to all these turns.

Question 17.

Draw the magnetic field lines through and around a single loop of wire carrying electric current. (2/5, Board Term I, 2016)

Answer:



Magnetic field lines of the field produced by a current-carrying circular loop.

Question 18.

State the use of magnetic field produced inside a solenoid. (Boárd I'eím I, 2015)

Answer:

Solenoid is used to form strong but temporary magnet called electromagnets. These electromagnets are used in wide variety of instruments and used to lift heavy iron, objects.

Question 19.

State the effect of a magnetic field on the path of a moving charged particle. (Boárd I'eím I, 2014)

Answer:

A charged particle moving in a magnetic field may experience a force in the direction perpendicular to direction of magnetic field and direction of motion of particle. This force deflects the charged particle from its path.

Question 20.

State the direction of magnetic field in the following case.



Answer:

Using Fleming's left hand rule, the direction of magnetic field is out of the plane of paper.

Question 21.

Write one application of Fleming's left hand rule. (1/3, Boárd I'eím I, 2013)

Answer:

Fleming's left hand rule is used to find the direction of force on a current carrying conductor placed in a magnetic field acting perpendicular to the direction of current.

Question 22.

A current carrying conductor is placed in a magnetic field. Now answer the following.

- (i) List the factors on which the magnitude of force experienced by conductor depends.
- (ii) When is the magnitude of this force maximum?

- (iii) State the rule which helps, in finding the direction of motion of conductor.
- (iv) If initially this force was acting from right to left, how will the direction of force change if:
- (a) direction of magnetic field is reversed?
- (b) direction of current is reversed? (Boaid I'eim I, 2017)

Answer:

(i) When a current carrying wire is placed in a magnetic field, it experiences a magnetic force that depends on

- (a) current flowing in the conductor
- (b) strength of magnetic field
- (c) length of the conductor
- (d) angle between the element of length and the magnetic field.

(ii) Force experienced by a current carrying conductor placed in a magnetic field is largest when the direction of current is perpendicular to the direction of magnetic field.

(iii) The rule used in finding the direction of motion of the conductor placed in a magnetic field is Fleming's left hand rule.

Fleming's left hand rule is as follows:

Stretch out the thumb, the forefinger, and the second (middle) finger of the left hand so that these are at right angles to each other. If the forefinger gives the direction of the magnetic field (N to S), the second (middle) finger the direction of current then the thumb gives the direction of the force acting on the conductor.

(iv) (a) Direction of force will be reversed when direction of magnetic field is reversed, i.e., now force on conductor will act from left to right.

(b) Direction of force will be reversed, if the direction of current is reversed, i.e., the force on the conductor will act from left to right.

Question 23.

State whether an alpha particle will experience any force in a magnetic field if (alpha particles are positively charged particles)

- (i) it is placed in the field at rest.
- (ii) it moves in the magnetic field parallel to field lines.
- (iii) it moves in the magnetic field perpendicular to field lines.

Justify your answer in each case. (Boaid I'eim I, 2016)

Answer:

(i) No, alpha particle will not experience any force if it is at rest, because only moving charge particle can experience force when placed in a magnetic field.

(ii) No, alpha particle will not experience any force if it moves in the magnetic field parallel to field lines because charge particle experiences force only when it moves at an angle other than 0° with magnetic field.

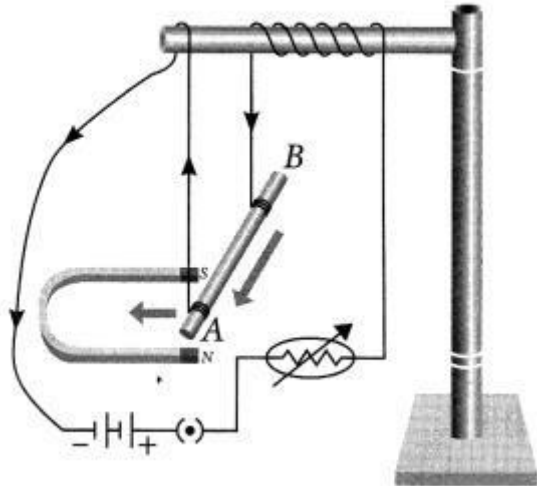
(iii) Alpha particle will experience a force in the direction perpendicular to the direction of magnetic field and direction of motion of alpha particle.

Question 24.

Describe an activity with labelled diagram to show that a force acts on current carrying conductor placed in a magnetic field and its direction of current through conductor. Name the rule which determines the direction of this force. (Boards Term I, 2016)

Answer:

A small aluminium rod suspended horizontally from a stand using two connecting wires. Place a strong horseshoe magnet in such a way that the rod lies between the two poles with the magnetic field directed upwards. For this, put the north pole of the magnet vertically below and south pole vertically above the aluminium rod.



Connect the aluminium rod in series with a battery, a key and a rheostat. Pass a current through the aluminium rod from one end to other (B to A). The rod is displaced towards left. When the direction of current flowing through the rod is reversed, the displacement of rod will be towards right. Direction of force on a current carrying conductor is determined by Fleming's left hand rule.

Question 25.

- (a) Write the principle of working of an electric motor.
(b) Explain the function of the following parts of an electric motor.
(i) Armature (ii) Brushes (iii) Split ring (2018)

Answer:

- (a) Principle : Current carrying conductor when placed at right angle to a magnetic field, experiences a force due to which we get motion. The direction of the force is given by Fleming's left hand rule.
(b) (i) Armature is a conductive part of motor which generates torque in the motor.
(ii) The two stationary brushes in a simple electric motor draw current from the battery and supply it to the armature of motor.
(iii) The role of split ring is to change the direction of current flowing through the coil after each half-rotation of coil.

Question 26.

The change in magnetic field lines in a coil is the cause of induced electric current. Name the underlying phenomenon. (2020)

Answer:

The phenomenon in which electric current is generated by varying magnetic fields around a coil is called electromagnetic induction.

Question 27.

Define the term induced electric current. (2020) Answer:

The current induced in a conductor when the magnetic field around it changes is known as induced electric current.

Question 28.

Fleming's Right-hand rule gives

- (a) magnitude of the induced current.
- (b) magnitude of the magnetic field.
- (c) direction of the induced current.
- (d) both, direction and magnitude of the induced current. (2020)

Answer:

(c) Fleming's Right-hand rule gives the direction of induced current.

Question 29.

What is the function of a galvanometer in a circuit? (Delhi 2019)

Answer:

Galvanometer is an instrument that can detect the presence of electric current in a circuit.

Question 30.

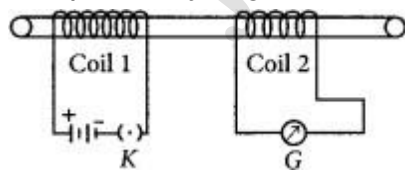
Write any one method to induce current in a coil. (Board Term I, 2016)

Answer:

By keeping the magnet in a fixed position and moving the coil towards and away from the magnet, we can induce current in the coil.

Question 31.

Two coils of insulated copper wire are wound over a non-conducting cylinder as shown. Coil 1 has comparatively large number of turns. State your observations, when



- (i) Key K is closed
- (ii) Key K is opened

Give reason for each of your observations. (2020)

Answer:

(i) When key is closed, after setting up the circuit as shown, one can observe a deflection on the galvanometer connected to the second coil. This is because, a potential difference and thus a current is induced in coil 2 as there is change in the current and the magnetic field associated with it in coil 1. When the magnetic field changes in coil 1, the magnetic field lines around coil 2 also changes. This induces a current in coil 2.

(ii) When key K is opened, after closing it for sometime it can be observed that the galvanometer shows a deflection, but this time in the opposite direction. This is because, when the current stops flowing in coil 1, the magnetic field associated with it changes in the opposite direction as in the first case, thus inducing a current in the opposite direction.

Question 32.

Two circular coils P and Q are kept close to each other, of which coil P carries a current. What will you observe in the galvanometer connected across the coil Q

(a) if current in the coil P is changed?

(b) if both the coils are moved in the same direction with the same speed?

Give reason to justify your answer in each

Answer:

(a) When the amount of current in the coil P is changed, an induced current will induce in the coil Q due to change in magnetic field lines i.e., magnetic flux.

(b) If both the coils are moved in the same direction with the same speed, then there is no net change in magnetic flux. Hence there will be no deflection in the galvanometer.

Question 33.

In Faraday's experiment if instead of moving the magnet towards the coil we move the coil towards the magnet. Will there be any induced current? Justify your answer. Compare the two cases. (Board Term I, 2017)

Answer:

Yes, there will be an induced current in both the cases as there is a change in the number of magnetic field lines associated with the coil or we can say that there is a motion of a magnet with respect to the coil.

Same of current will be induced and the direction of flow of current will also be the same in the two cases.

Question 34.

Write one application of Fleming's right hand rule. (1/3, Board Term I, 2013)

Answer:

Fleming's right hand rule is used to find the direction of induced current.

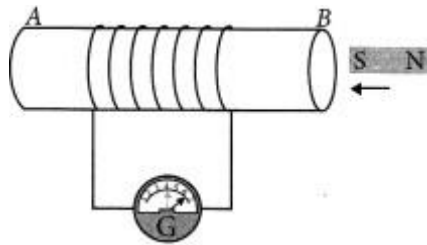
Question 35.

(a) A coil of insulated copper wire is connected to a galvanometer. With the help of a labelled diagram state what would be seen if a bar magnet with its south pole towards one face of this coil is

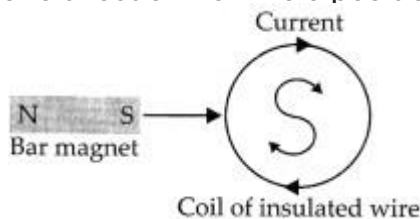
- (i) moved quickly towards it,
- (ii) moved quickly away from it,
- (iii) placed near its one face?
- (b) Name the phenomena involved in the above cases.
- (c) State Fleming's right hand rule. (Boards Term I, 2017)

Answer:

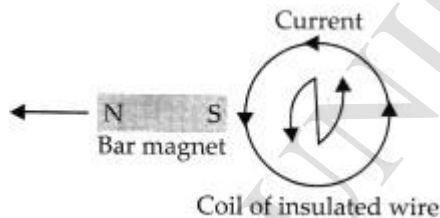
(a) If a coil of insulated wire is connected to a galvanometer and a bar magnet with south pole is moved towards one face of the coil then, given situation is shown in the figure.



(i) Moved quickly towards the coil : A current is induced in clockwise direction in the coil with respect to the side facing the north pole of the magnet and needle of galvanometer will deflect in one direction from zero position.



(ii) Moved quickly away from coil : A current is induced in anti-clockwise direction in the coil with respect to the side facing the north pole of the magnet and the needle of the galvanometer will deflect in opposite direction from (i).



(iii) Placed near its one face : No deflection of the needle of galvanometer is observed.

(b) The phenomena involved is called electromagnetic induction.

(c) Fleming's right hand rule: Stretch the right hand such that the first finger, the central finger and the thumb are mutually perpendicular to each other.

If the first finger points along the direction of the field (magnetic field) and the thumb points along the direction of motion of the conductor, then the direction of induced current is given by the direction of the central finger.

Question 36.

Write the frequency of alternating current (AC) in India. How many times per second it changes its

direction? (Boaíd I'eím I, 2015)

Answer:

The frequency of A.C. in India is 50 Hz and it changes direction twice in each cycle. Therefore, it changes direction $2 \times 50 = 100$ times in one second.

Question 37.

How is the type of current that we receive in domestic circuit different from the one that runs a clock? (Boaíd I'eím I, 2014)

Answer:

The current that we receive from domestic circuit is alternating current (A.C.) and the current that is used to run a clock is direct current (D.C.). Direct current always flows in one direction whereas the alternating current reverses its direction periodically.

Question 38.

Define alternating current and direct current.

Explain why alternating current is preferred over direct current for transmission over long distances. (Boaíd I'eím I, 2014)

Answer:

Alternating current (A.C.) : An electric current whose magnitude changes with time and direction reverses periodically is called alternating current.

Direct current (D.C.) : An electric current whose magnitude is either constant or variable but the direction of flow in a conductor remains the same is called direct current.

A.C. can be transmitted to distant places without much loss of electric power than D.C. What is why A.C. is preferred over D.C. for transmission of current over a long distance.

Question 39.

(i) Alternating current has a frequency of 50 Hz. What is meant by this statement? How many times does it change its direction in one second? Give reason for your answer.

(ii) Mention the frequency of D.C. that is given by a cell. (Boaíd I'eím I, 2013)

Answer:

(i) The frequency of household supply of A.C. in India is 50 Hz. This means, A.C. completes 50 cycles in one second. Thus, A.C. changes direction $2 \times 50 = 100$ times in one second.

(ii) Frequency of D.C. is zero as its direction does not change with time.

Question 40.

At the time of short circuit, the electric current in the circuit.

(a) varies continuously (b) does not change

(c) reduces substantially

(d) increases heavily. (2020)

Answer:

(d) At the time of short circuit, the live and neutral wires come in direct contact, thus increasing the current in the circuit abruptly.

Question 41.

Mention and explain the function of an earth wire. Why it is necessary to earth metallic appliances? (Boaid I'eim I, 2013)

Answer:

Many electric appliances of daily use like electric press, heater, toaster, refrigerator, table fan etc. have a metallic body. If the insulation of any of these appliances melts and makes contact with the metallic casing, the person touching it is likely to receive a severe electric shock. This is due to the reason that the metallic casing will be at the same potential as the applied one. Obviously, the electric current will flow through the body of the person who touches the appliance. To avoid such serious accidents, the metal casing of the electric appliance is earthed. Since the earth does not offer any resistance, the current flows to the earth through the earth wire instead of flowing through the body of the person.

Question 42.

Give reason for the following :

The burnt out fuse should be replaced by another fuse of identical rating. (1/3, 2020)

Answer:

A burnt out fuse should be replaced with identical rating because it helps in protecting the circuit from overloading and short circuiting. If a fuse of higher rating is used then it may not melt and cut off the supply during overloading. Similarly a fuse of lower rating may melt frequently even for a normal flow of current. This results in decreasing the efficiency of the circuit.

Question 43.

Give reasons for the following:

(a) It is dangerous to touch the live wire of the main supply rather than neutral wire.

(b) In household circuit, parallel combination of resistances is used.

(c) Using fuse in a household electric circuit is important. (Boaid I'eim I, 2017)

Answer:

(a) Live wire is at 220V and neutral wire is at zero volt since the electric current flows from higher potential to lower potential, we can get an electric shock by touching live wire but that is not the case with neutral wire.

(b) In parallel combination, each resistor gets same potential from the source. We can use separate on/off switches with each appliance. Also in case if any one resistor fails then the circuit will not break. So, it is safe and convenient to connect household circuit in parallel combination of resistors

(c) Fuse is an important safety device. It is used in series with any electrical appliance and protects it from short-circuiting and overloading.

Question 44.

(a) Fuse acts like a watchman in an electric circuit. Justify this statement.

(b) Mention the usual current rating of the fuse wire in the line to (i) lights and fans (ii) appliance of 2 kW of more power. (Boaid I'eim I, 2014)

Answer:

(a) When an unduly high electric current flows through the circuit, the fuse wire melts due to joule

heating effect and breaks the circuit. Hence, it keeps an eye on the amount of current flowing and also stops the current if it exceeds the maximum value. So, fuse acts like a watchman in an electric circuit.

- (b) (i) A fuse of rating 5A is usually used for lights and fans.
 (ii) A fuse of rating 15 A is usually used for appliance of 2 kW or more power.

Question 45.

Write two ways to induce current in a coil?

- Ans. (i) By moving a bar magnet towards or away from the coil.
 (ii) By placing a coil near another coil connected across a battery.

Question 46.

- (a) Name two safety measures commonly used in an electric circuit and appliances.
 (b) What precaution should be taken to avoid the overloading of domestic electric circuits? (Board Exam I, 2017)

Answer:

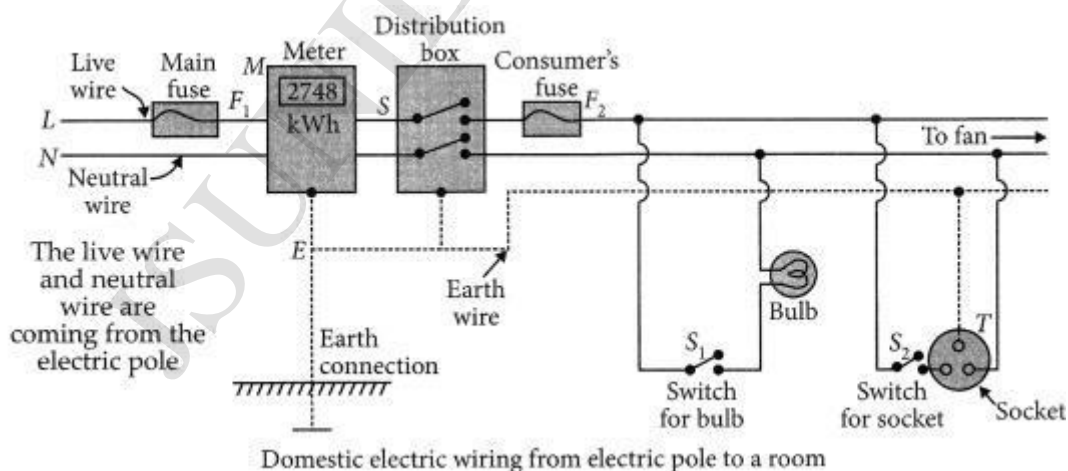
- (a) Fuse and the connection of earthing wire are the two safety measures commonly used in electric circuit and appliances.
 (b) Provide fuses/MCBs of proper rating.

Question 47.

- (a) Draw a schematic diagram of a common domestic circuit showing provision of
 (i) Earthing wire, (ii) Main fuse
 (iii) Electricity meter and
 (iv) Distribution box.
 (b) Distinguish between short circuiting and overloading. (Board Exam I, 2015)

Answer:

(a)



- (b) Overloading : The condition in which a high current flows through the circuit and at the same time too many appliances are switched on then the total current drawn through the circuit may exceed its rated value.

Short circuiting: The condition when the live wire comes in direct contact with the neutral wire, due to which a high current flows in the circuit.

JSUNIL TUTORIAL

CHAPTER- 13 OUR ENVIRONMENT

Content- Eco-system, Environmental problems, Ozone depletion, wastes production and their solutions, Biodegradable and non-biodegradable substances.

ECOSYSTEM

An ecosystem is a system consisting of biotic and abiotic components that function together as a unit.

- Biotic components- all the living things
- Abiotic components - non-living things like water, light, wind, soil etc.

Ecosystem maintains a balance in the nature.

- Natural ecosystem – forest, pond, lake
- Man-made (artificial ecosystem)- crop fields, garden

Producer: autotrophic, perform photosynthesis e.g. green plants, blue green algae

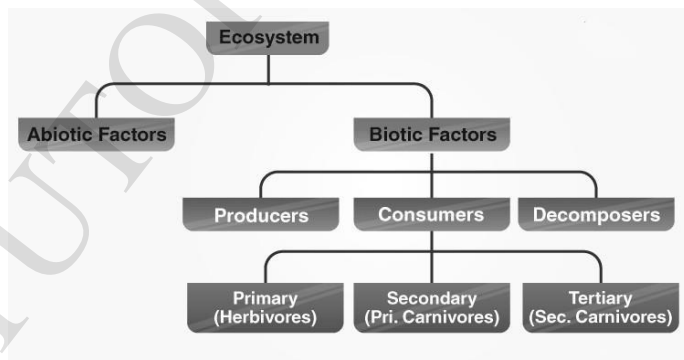
Consumer: consume the food produced either directly from producer or indirectly by feeding on other consumers
types of consumers:-

- i- Herbivores – deer
- ii- Carnivores – lion
- iii- Omnivores – cat
- iv- Parasites – bacteria

Decomposers: feed on dead and decomposed products. E.g. fungi, bacteria

Importance of Decomposers –

- Break down dead remains and waste products of organisms.
- Break down the complex organic substance into simple inorganic substances.
- Release minerals into the soil. Thus helps in maintaining the fertility of soil.
- Clean the environment
- Help in recycling the materials in the biosphere.



FOOD CHAIN

The sequence of living organisms in an ecosystem in which one organism consumes another organism to transfer food energy, is called a food chain.

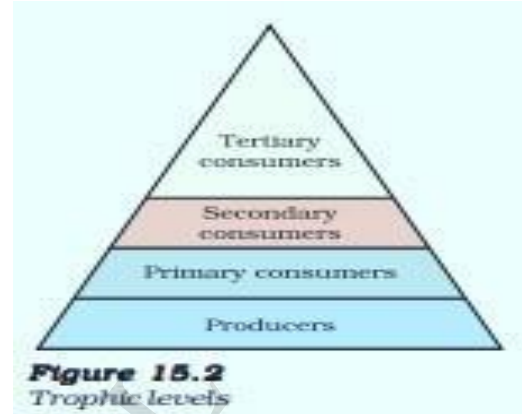
For example

- i- Grass ---- Goat...Tiger
- ii- Grass---- insects.....frog.....snake.....eagle
- iii- Planktons.....insects.....fish.....crane

TROPHIC LEVELS:

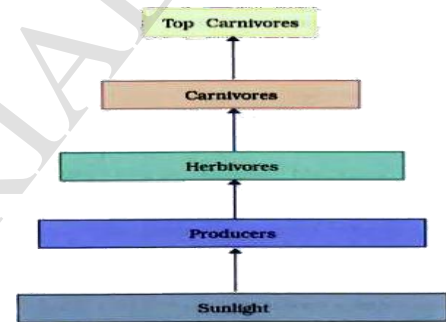
The various steps in the food chain at which the transfer of food (or energy) takes place is called trophic levels.

The different trophic levels are – Producers (T1), Primary consumers (herbivores-T2), Secondary consumers (primary carnivores -T2), Tertiary consumers (Secondary carnivores -T3), Decomposers



Significance of Food Chains

- The food chain transfer energy from one trophic level to another.
- Autotrophs-----
heterotrophs.....decomposers
- Only 10 % of energy is transferred from one trophic level to another. Rest of energy is lost as heat, into doing work, in digestion, growth, reproduction. It is called 10 % law.
- Help in study of food relationships and interactions among the various organisms in an ecosystem.



FOOD WEB

It is inter-connected food chains in an ecosystem.

It forms a network of relationship between various species.

In a food web, one organism may occupy a position in more than one food chain.

More stable food chain / food web means more stable ecosystem.

FOOD PYRAMID-

It is graphic representation of food chain.

It may be formed as, depicted as a pyramid having a broad base formed by producers and tapering to a point formed by end consumers.

BIOMAGNIFICATION

Accumulation of toxic pollutants at successive higher trophic level is called as bio magnification.

OZONE LAYER

- Ozone (O₃) is a molecule formed by three atoms of oxygen.
- Ozone shields the surface of the earth from ultraviolet (UV) radiation from the Sun.
- UV radiation is highly damaging to organisms. It may cause even skin cancer in human beings.

- Ozone at the higher levels of the atmosphere is a product of UV radiation acting on oxygen (O₂) molecule.
- The higher energy UV radiations split apart some molecular oxygen (O₂) into free oxygen (O) atoms. These atoms then combine with the molecular oxygen to form ozone as shown—
- The ozone layer depletion takes place at higher rate. The major cause is chlorofluorocarbons (CFCs) which are used as refrigerants and in fire extinguishers.

BIODEGRADABLE AND NON BIODEGRADABLE WASTES

- i- **Biodegradable Wastes:** These can be broken down by the biological processes. E.g. Food waste, plant parts, animal wastes, agricultural residue, paper etc. Decomposers can decompose these without harming ecosystem. Food waste, trees leaves, urine and fecal matter, sewage agricultural residue, paper, wood, cloth, cow-dung etc.
- ii- **Non-biodegradable waste-** these can't be broken down by biological processes. E.g. - Chemical pesticides, DDT, mercury, lead, plastics, polythene bags etc. These wastes are major pollutants of the environment.

MAINTAINING THE GARBAGE WE PRODUCE

- Change in attitudes toward using only biodegradable items.
- Proper disposal of wastes
- Follow Sewage treatment norms
- 3 'R' principle- reduce , recycle, reuse

IMPORTANT QUESTIONS

Very Short Answer Type Question

Q1-The flow of energy in the food chain is unidirectional. Why?

Ans: Energy flows from sun to plants (autotroph), plants to animals (consumer).

Q 2- In a food chain, 10,000 joules of energy is available to the producer. How much energy will be available to the secondary consumer to transfer it to the tertiary consumer?

Ans: 10 J

Q 3- Producers always occupy the first trophic level in any food chain. Why?

Ans: Only producers have the ability to trap solar energy and manufacture organic food through the process of photosynthesis.

Q 4 - Name any two abiotic components of an environment.

Answer:

- (a) Climatic factors (light, temperature, rainfall)
- (b) Edaphic factor (Soil)

Q 5- Give any two ways in which biodegradable substance would affect the environment.

Ans: They keep the environment clean as they are easily decomposed.

They can easily go through the geochemical cycle with the help of decomposers.

Short Answer Type Question

Q6-What will happen if we kill all the organisms in one trophic level?

Ans: i- The organisms in specific trophic level will not be able to get the food

ii-It will cause a disturbance in food chain and therefore ecological imbalance will take place.

Q7- Why is a lake considered to be a natural ecosystem?

Ans: In Lake living organisms grow, reproduce and interact with other biotic and abiotic components. In lake different components carry out all activities in nature by themselves without any human interference; therefore it is referred to as a natural ecosystem.

Q 8 - How can we help in reducing the problem of waste disposal? List two ways.

Ans: i-Separation of biodegradable and non-biodegradable wastes

ii-Preparation of compost / vermicomposting from biodegradable waste

iii-Recycling of waste

Q 9- Which gas shield the surface of earth from harmful radiation of the sun. why these radiations are supposed to be harmful for us?

Answer- Ozone gas

Harmful radiation of the sun like UV radiation may causes skin cancer, cataract, fall in immunity in infants, decline in photosynthesis rate etc

Q 10- In a certain study conducted on the occurrence of DDT along food chains in an ecosystem, the concentration of DDT in grass was found to be 0-5 ppm. In sheep, it was 2 ppm and in man it was 10 ppm. Name the phenomenon and define?

Ans: Bio-magnification

Bio-magnification is the increase in the level of a toxic substance with each successive rise in the trophic level of a food chain.

Long Answer Type Questions

Q11- Why bacteria and fungi are called decomposers? List any two advantages of decomposers to the environment.

Answer: Decomposers degrade breakdown the complex organic substances into simple inorganic substances that go into the soil and are used up once more by the plants.

Advantages:

- i- Clean environment by decomposing dead bodies of plants/ animals
- ii- Replenish nutrients (Inorganic substance) into soil
- iii- Helps in Nutrient recycling

Q12- Answer the followings-

- i- **What is ozone? How is it formed in the atmosphere?**
- ii- **How ozone layer is useful**
- iii- **Name the substances responsible for the depletion of ozone layer.**

Ans:

- i- Ozone is triatomic form of oxygen, O₃. Ozone is formed in the upper atmosphere by the action of ultraviolet (UV) radiations over oxygen (O₂)
- ii- It protects us from harmful UV radiation of sun.
- iii- The important ozone depleting substances chlorofluorocarbons (CFC), methane, N₂O, chlorine.

Q13- (a) Write two harmful effects of using plastic bags on the environment. Suggest alternatives to the usage of plastic bags.

(b) List any two practices that can be followed to dispose of the waste produced in our homes.

Ans: (a) Harmful effects of using plastic bags :

(i) These are non-biodegradable substances. They cannot be decomposed and therefore remains as pollutants in nature for many years.

(ii) The plastic bags choke drains and causes waterlogging.

(iii) The plastic release harmful chemicals in soil, water slowly over to years.

Jute bags and cloth bags are the alternatives to the polyethene bags.

(b) Practices to dispose off the waste produced in our homes:

(i) Separation of biodegradable and non- biodegradable wastes.

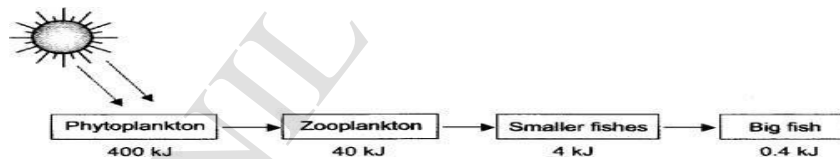
(ii) The biodegradable waste can be converted to manure.

(iii) Non-biodegradable waste should be disposed off at suitable places from where municipal authorities can pick them up and dispose properly and scientifically.

(iv) Reuse the waste

Q14- Draw a line diagram to show flow of solar energy in ecosystem

Ans:



Q 15- In the following food chain, 100 J of energy is available to the lion. How much energy was available to the producer?

Ans : simple food chain

Plants ———> Deer ———> Lion.

As per 10 % law only 10 % of energy is transferred to next trophic level-

Energy available to deer = 100J x 10 = 1000 J

Energy available to plants = 1000 x 10 = 10,000 J.