1 CHAPTER

Chemical Reactions and Equations

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (A) is correct

Explanation: To balance the reaction:

$$Pb(NO_3)_2 \xrightarrow{heat} PbO + NO_2 + O_2$$

Lead (Pb): It is balanced, as there is 1 lead atom in $Pb(NO_3)_2$ and 1 in PbO

Nitrogen (N): Each molecule of $Pb(NO_3)_2$ contains 2 nitrogen atoms from its 2 nitrate groups. To balance this on the product side, we need 2 nitrogen atoms, which means we require 2 molecules of NO_2.

Oxygen (O): Each molecule of $Pb(NO_3)_2$ has 6 oxygen atoms. On the product side, PbO has 1 oxygen, 2 molecules of NO_2 contribute 4 oxygen atoms, and O_2 contributes 2 oxygen atoms. To balance the oxygen atoms, we need to multiply the entire reaction by 2.

This gives the balanced equation:

$2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

So, $p = 2$, $q = 2$, and $r = 4$.

2. Option (B) is correct

Explanation: In cooking, heat is absorbed by the food to bring about chemical changes, making cooking an endothermic process.

In contrast, the burning of a candle, the reaction of sodium with air, and the decomposition of vegetable matter are exothermic reactions, as they release heat during the process.

3. Option (B) is correct

Explanation: When sodium hydroxide is heated with Zinc granules, Sodium Zincate and hydrogen gas is evolved.

$2NaOH(aq) + Zn(s) \rightarrow Na_2ZnO_2(aq) + H_2(g)\uparrow$

When burning splinter is brought near the mouth of the test tube, it burns with a pop sound. If Zinc granules react with strong acids (HCl or H_2SO_4) then again Hydrogen gas will be evolved.

$Zn_{(s)} + (dil)\ 2HCl \rightarrow ZnCl_2 + H_2\uparrow$

$Zn_{(s)} + (dil)\ H_2SO_4 \rightarrow ZnSO_4 + H_2\uparrow$

4. Option (C) is correct

Explanation: Photochemical decomposition is a breakdown that uses light as its energy source. Among the options given, the reaction involving silver bromide ($2AgBr \rightarrow 2Ag + Br_2$) is a photochemical decomposition reaction.

5. Option (D) is correct

Explanation: A redox reaction is where oxidation and reduction occur simultaneously in a reaction. Here MnO_2 is reduced to $MnCl_2$ and HCl is oxidized to H_2O and Cl_2.

6. Option (D) is correct

Explanation: $CaSO_4$+ Al (case 1) and $FeSO_4$ + Cu (case 3) do not displace Ca and Fe from their sulphates due to their lower reactivity. In $CuSO_4$ + Ca and $ZnSO_4$ + Mg reactions, Ca and Mg are more reactive and displace Cu and Zn from the sulphates, resulting in the formation of $CaSO_4$ and $MgSO_4$.

7. Option (C) is correct

Explanation: In this reaction SO_2 act as an oxidizing agent that's why SO_2 is undergoing reduction to form sulphur. During the reaction, sulphur in H_2S is oxidised to sulphur with an oxidation state of O.

8. Option (A) is correct

Explanation: Calcium carbonate on heating decomposes to form calcium oxide (quick lime) and carbon dioxide. The equation for this thermal decomposition reaction can be written as: $CaCO_3 \rightarrow CaO + CO_2$. Therefore, *X* in the above reaction is calcium oxide (quick lime).

9. Option (A) is correct.

Explanation: The balanced chemical equation is: $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$. Therefore, the values of *a, b, c,* and *d* are: $a = 1$, $b = 6$, $c = 2$ $d = 3$.

10. Option (B) is correct.

Explanation: (A) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$: This is a double displacement or metathesis reaction, where two compounds exchange bonds or ions to form different compounds.

(B) $CaO + H_2O \rightarrow Ca(OH)_2$: This is a combination or synthesis reaction, where two or more reactants combine to form a single product.

(C) $KNO_3 + H_2SO_4 \rightarrow KHSO_4 + HNO_3$: This is also a double displacement or metathesis reaction, similar to option (A).

(D) $ZnCl_2 + H_2S \rightarrow ZnS + 2HCI$: This is a displacement or substitution reaction, where one element displaces another element from a compound.

Therefore, the correct answer is option (B), because it is the only one that is a combination reaction, while the others are double displacement or displacement reactions.

11. Option (B) is correct.

Explanation: The reaction involves zinc (Zn) reacting with acetic acid (CH_3COOH) to form zinc acetate $(CH_3COO)_2Zn$ and hydrogen gas (H_2). This is a single replacement or displacement reaction. In this reaction, zinc displaces hydrogen from acetic acid, forming zinc acetate and hydrogen gas.

12. Option (C) is correct

Explanation: Zinc Nitrate → Zinc Oxide + Dioxygen + Nitrogen Dioxide

The balanced equation is:

$2Zn(NO_3)_2 \rightarrow 2ZnO + 4NO_2 + O_2$

13. Option (D) is correct

Explanation: $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ is a redox reaction, but not a combination reaction. Redox reactions are oxidation and reduction reactions. It is a chemical reaction in which the oxidation states of the reactants are changed. Combination reaction is a type of reaction in which two reactants combines to form a product. The above reaction is not a combination reaction but it is a redox reaction as oxidation and reduction is taking place simultaneously In this reaction, carbon monoxide (CO) acts as a reducing agent and Fe_2O_3 as an oxidising agent.

14. Option (A) is correct

Explanation: I. $CuO + H_2$: This reaction involves the reduction of copper oxide by hydrogen, forming copper and water. It is not a combination reaction.

II. ZnO + C: This reaction involves the reduction of zinc oxide by carbon, forming zinc and carbon monoxide. It is not a combination reaction.

III. $Na + O_2$: This reaction involves the combination of sodium and oxygen to form sodium oxide. It is a combination reaction.

IV. $CH_4 + O_2$: This reaction involves the combustion of methane with oxygen to form carbon dioxide and water. It is not a combination reaction.

15. Option (D) is correct

Explanation: Double-replacement reactions involve the formation of an insoluble ionic compound. Barium sulphate, in the reaction provided, is the insoluble salt formed, indicating a double displacement reaction.

16. Option (C) is correct

Explanation: The balanced chemical equation is:

$NaCl + NH_3 + H_2O + CO_2 \rightarrow NaHCO_3 + NH_4Cl$

i.e. Sodium chloride + Ammonia + Water + Carbon dioxide → Sodium hydrogen carbonate + Ammonium chloride

17. Option (B) is correct

Explanation: Here H_2 is getting oxidised since its oxidation number is increasing and CuO is getting reduced since its oxidation number is decreasing. The one who gets oxidised act as reducing agent and the one who get reduced act as an oxidising agent. So here H_2 is a reducing agent and CuO is an oxidising agent.

18. Option (B) is correct

Explanation: Lead (II) Iodide (PbI_2) is insoluble in water, so it forms a solid precipitate. Potassium nitrate (KNO_3) remains in the aqueous solution.

19. Option (B) is correct

Explanation:

X = Mg; Y = MgO;

In this reaction, magnesium and oxygen combine to create magnesium oxide.

$2Mg + O_2 \rightarrow 2MgO$

20. Option (D) is correct

Explanation: When red coloured copper metal is heated in presence of oxygen it forms copper (II) oxide which is a black solid.

$2Cu + O_2 \rightarrow 2CuO$

21. Option (A) is correct

Explanation: When lead nitrate ($Pb(NO_3)_2$) is heated, it undergoes thermal decomposition to form lead oxide (PbO), nitrogen dioxide (NO_2), and oxygen (O_2).

The reaction is:

$$2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$$

22. Option (C) is correct

Explanation: The balanced equations is:

$MnO_2 + 4HCI \rightarrow MnCl_2 + 2H_2O + Cl_2$

Therefore, the values of x, y and z are 4, 2 and 1

23. Option (C) is correct

Explanation: An endothermic process absorbs heat from its surroundings.

(A) Formation of slaked lime – ($Ca(OH)_2$):

$$CaO + H_2O \rightarrow Ca(OH)_2 + \text{heat}$$

This is an exothermic reaction, as it releases heat.

(B) Decomposition of vegetable matter into compost: This process involves the breakdown of organic matter by microbes, releasing energy in the form of heat. It is exothermic.

(C) Dissolution of ammonium chloride in water: When ammonium chloride (NH_4Cl) dissolves in water, it absorbs heat from the surroundings, making the solution colder. This is an endothermic process.

(D) Digestion of food in our body: Digestion involves the breakdown of food molecules, which releases energy (e.g., in the form of ATP). This is an exothermic process.

24. Option (B) is correct

Explanation: Salt and hydrogen gas are produced when metals and acids react. As a result, when zinc combines with sulphuric acid, zinc sulphate is formed along with the release of hydrogen gas.

$Zn_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_{2(g)}$

25. Option (B) is correct

Explanation: The balanced chemical equation shown above is: $3Fe_{(s)} + 4H_2O_{(l)} \rightarrow Fe_3O_{4(s)} + 4H_{2(g)}$. The ratio $x : y = 3 : 4$.

26. Option (C) is correct

Explanation: The reaction in the given set up involves zinc granules reacting with dilute sulphuric acid:

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$$

This reaction produces hydrogen gas (H_2), which is denoted as gas 'X'.

When a burning matchstick is brought near the gas, it burns with a pop sound, which confirms the presence of hydrogen.

27. Option (C) is correct.

Explanation: In a single displacement reaction of the form PQ + R → PR+Q, the following is typically true: The ion R in the product PR will be anion as in the reactant R. The stability of PR as compared to PQ will be high.

28. Option (D) is correct

Explanation: The two chemical reactions that are of the SAME type are:

(P) $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

(S) $2KOH + H_2SO_4 \rightarrow K_2SO_4 + H_2O$

Both of these reactions are double displacement reactions, where the ions in the reactants exchange places to form new compounds. In reaction P, the silver ions (Ag^+) From $AgNO_3$ exchange with the sodium ions (Na^+) from NaCl to form AgCl and $NaNO_3$. In reaction S, the potassium ions (K^+) from 2KOH exchange with the hydrogen ions (H^+) from H_2SO_4 to form K_2SO_4 and H_2O.

29. Option (C) is correct

Explanation: Simple displacement (or single displacement) reaction occurs when one element replaces another in a compound.

$$A + BC \rightarrow AC + B$$

Here, A is usually a more reactive metal or non-metal that displaces B from the compound BC.

When a metal reacts with an acid, for example:

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Zinc displaces hydrogen from hydrochloric acid to form zinc chloride and hydrogen gas.

30. Option (D) is correct

Explanations: The necessary condition for all chemical reactions is that there should be physical contact between the reactants.

31. Option (A) is correct

Explanation: The coefficients of PbO and NO_2 in the given balanced chemical equation of represent the ratio of the number of moles produced the two substances. Therefore, the correct answer is the ratio of the number of moles produced of the two substances.

32. Option (D) is correct

Explanation: The balanced chemical equation shown above is:

$$3Fe + 4H_2O \longrightarrow Fe_3O_4 + 4H_2$$

In this equation, three atoms of iron combine with water to form one molecule of iron oxide.

33. Option (C) is correct

Explanation: Decomposition reaction is a type of chemical reaction in which a compound breaks down into two or more simpler substances. In the case of rotting of fruits and vegetables, the complex organic compounds are broken down into simpler substances such as water, carbon dioxide, and other organic compounds by the action of enzymes and bacteria.

34. Option (B) is correct

Explanation: The combustion of methane can be represented by the following chemical equation:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{heat energy}$$

This equation shows that one molecule of methane reacts with two molecules of oxygen gas to produce one molecule of carbon dioxide, two molecules of water, and heat energy. The heat energy released during this reaction can be used as a source of fuel for various purposes.

35. Option (B) is correct

Explanation:

- It is a type of reaction in which one element is replaced by another in a compound.
- The general description of displacement reaction can be given as:

  $AB + C \rightarrow AC + B$
- The given reaction is an example of a displacement reaction is:

$$4NH_{3(g)} + 5O_{2(g)} \rightarrow 4NO_{(g)} + 6H_2O_{(g)}$$
(Ammonia) (Oxygen) (Nitric oxide) (Water)

- This is a displacement reaction, as the ions get exchanged within other compounds.

36. Option (A) is correct

Explanation:

- Oxidation in terms of Oxygen (O) can be defined as the addition of Oxygen. So that Iron (Fe) is oxidized due to the addition of Oxygen forming Iron(II, III) oxide (Fe_3O_4).
- An oxidizing agent is the species that oxidize the other substance and reduces itself. Water (H_2O) oxidizes Fe and itself reduces to form Hydrogen gas.

37. Option (A) is correct

Explanation: Photosynthesis is a photochemical combination reaction. It is a subtype of combination reaction in which light energy is a catalyst, where light energy is directly absorbed from sunlight.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (C) is correct

Explanation: When dilute HCl is added to a metal (substance 'X'), a colourless gas (hydrogen) is produced, which burns with a pop sound when a burning matchstick is brought near, confirming the presence of flammable hydrogen gas. However, the reason is incorrect because, in this reaction, hydrogen does not displace the metal. Instead, the metal reacts with the acid, displacing hydrogen from HCl and releasing hydrogen gas. Therefore, the assertion is true, but the reason is false.

2. Option (A) is correct

Explanation: When zinc reacts with nitric acid, it does not release hydrogen gas, unlike many other reactions where metals react with acids (like zinc with hydrochloric acid). The general reaction when zinc reacts with nitric acid is:

$$Zn + 2HNO_3 \rightarrow Zn(NO_3)_2 + H_2O + NO_2$$

In this reaction, Zinc reacts with nitric acid. Instead of hydrogen gas (H_2) being released, nitrogen dioxide (NO_2) is released as a product, which is a brown gas, and water (H_2O) is formed.

Reason: Hydrogen gas is not evolved because nitric acid is a strong oxidizing agent. It oxidizes any hydrogen gas produced to form water (H_2O).

Hence, both Assertion (A) and Reason (R) are correct, and Reason (R) correctly explains Assertion (A).

3. Option (A) is correct

Explanation: When quicklime reacts with water, it undergoes an exothermic reaction, releasing a large amount of heat. Therefore, both the assertion and the reason are correct, and the reason correctly explains why the reaction is exothermic.

4. Option (D) is correct

Explanation: Assertion is false because $BaSO_4$ is insoluble in water and forms white precipitate. The reason in true because all aqueous solution do not form precipitate with aqueous solution but in some case it is possible.

5. Option (D) is correct

Explanation: The assertion is incorrect because burning of natural gas is an exothermic process, not endothermic. The reason is correct as it accurately describes the chemical reaction involving methane and oxygen.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i) At 1 minute

(ii) (a) The rate of the reaction increases when the reaction is repeated with magnesium powder in place of magnesium ribbon under the same conditions. 25 cm^2 of hydrogen gas is formed at 2 minutes.

OR

(b) Adding more amount of acid to the flask - 'Yes'

Heating the acid in the flask - 'Yes'

Using a higher concentration of acid - 'Yes'

(iii) $Mg_{(s)} + 2HCl(aq) \rightarrow MgCl_{2(aq)} + H_2(g)$

2. (i) Silver sulphide, a black coloured compound gets formed on the surface of silver by the action of corrosion.

(ii) Gold and Platinum are the metals which do not corrode easily.

(iii) (a) Corrosion is said to be an oxidation reaction because it involves the loss of electrons by a metal. In the process of corrosion, metal atoms are oxidized by oxygen in the presence of moisture or other corrosive substances. This results in the formation of metal oxides or other compounds, leading to the deterioration of the metal. The transfer of electrons from the metal to the oxygen is characteristic of oxidation reactions, which is why corrosion is described as an oxidation process. Iron articles are shiny when new, but get coated with reddish brown colour

when left for some time.

OR

(b) The marble statues often slowly get corroded when kept in air for a long time. This is because the marble does react with the acidic compounds which are present in the air, like carbonic acid, sulphuric acid and nitric acid etc.

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. (i) Exothermic / Displacement reaction / Redox reaction.
Heat is evolved or a more reactive element displaces a less reactive element or aluminium reduces iron (III) oxide to iron

(ii) Double displacement / Precipitation reaction.
As there is an exchange of ions between reactants and products / (Yellow) precipitate (of Lead iodide) is formed.

2. When calcium oxide (CaO) reacts with water, it undergoes a chemical reaction known as combination reaction. In this reaction, two substances combine to form a single product. The balanced chemical equation can represent this reaction:
$CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)}$ + Heat
In this reaction, water is added to calcium oxide (Quick lime), resulting in the formation of calcium hydroxide (Slaked lime).

3. A precipitation reaction involves the formation of an insoluble product (precipitate) when two aqueous ionic compounds react and exchange ions. The statement "No precipitation reaction can occur without exchange of ions" is justified because the formation of a precipitate depends on the combination of specific ions that form an insoluble compound. Without ion exchange, there would be no interaction between ions that could result in the formation of an insoluble product.

Example: Reaction:

$Na_2SO_{4(aq)} + BaCl_{(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$
The formation of precipitate, such as $BaSO_4$ is possible only because of the exchange of ions between the reactants. This justifies the statement that 'No precipitation reaction can occur without the exchange of ions between the two reactants.'

4.

Displacement Reaction	Double Displacement Reaction
A displacement reaction occurs when a more reactive element removes a less reactive element from the solution.	A double displacement reaction occurs when the ions of both reactants exchange places to generate new molecules.
Example: $CuSO_{4(aq)} + Fe_{(s)} \rightarrow FeSO_{4(aq)} + Cu_{(s)}$	Example: $AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(aq)}$

5. When magnesium ribbon (Mg) is burnt in air, it reacts with oxygen (O_2) to form magnesium oxide (MgO). The chemical equation for this reaction is:

$2Mg_{(s)} + O_{2(g)} \rightarrow 2\ MgO_{(s)}$

The ash produced in this reaction is magnesium oxide (MgO), which is a white solid.

This reaction is an example of a synthesis or combination reaction. In a synthesis reaction, two or more substances combine to form a single product. In this case, magnesium (Mg) and oxygen (O_2) combine to form magnesium oxide (MgO).

6. The product formed is copper oxide which is black in colour.

The chemical equation for the reaction is:

$2Cu + O_2 \xrightarrow{Heat} 2CuO$

7. $BaCl_2(aq) + Na_2SO_4\ (aq) \rightarrow BaSO_4\ (s) + 2NaCl\ (aq)$
Ba^{2+}, SO_4^{2-}

8. Yes, the given reaction is a redox reaction.

In this reaction, HCl is oxidised to Cl_2 and MnO_2 is reduced to $MnCl_2$.

9. When aqueous solutions of potassium iodide and lead nitrate are mixed together, yellow precipitate of lead iodide is formed.

The reaction is Double displacement reaction or Precipitation reaction.

$Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$

10. HNO_3—Nitric acid

$Ca(OH)_2$—Calcium hydroxide

$Ca(NO_3)_2$—Calcium nitrate

H_2O—Water

11. (i) $CaO + H_2O \rightarrow Ca(OH)_2$

(ii) It is the example of combination reaction and exothermic reaction because CaO combining with H_2O and forming $Ca(OH)_2$, during the reaction heat is releasing that's why it is exothermic reaction.

12. (i) $2K_{(s)} + 2H_2O_{(l)} \rightarrow 2KOH_{(aq)} + H_{2(g)}$

(ii) The type of chemical reaction that is prevented by storing potassium metal under kerosene is a single displacement reaction.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. (i) Change in colour: The solution will become green in colour.

$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4 + Cu(s)$

Blue Green

(ii) Change in temperature: The temperature will increase.

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$ + Heat

(iii) **Formation of precipitate:** Yellow precipitate of PbI_2 is formed.

$Pb(NO_3)_2\ (aq) + 2\ KI(aq) \rightarrow PbI_2(s) + 2\ KNO_3(aq)$

Yellow precipitate

2. Bubbles of hydrogen gas are formed which stick to the surface of calcium and make it lighter than water.

$Ca_{(s)} + 2H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)} + H_{2(g)}$

When the aqueous solution of the product formed, i.e. Calcium hydroxide ($Ca(OH)_2$) reacts with Carbon dioxide gas, the solution formed turns milky.

$Ca(OH)_{2(aq)} + CO_{2(g)} \rightarrow CaCO_{3(s)} + H_2O_{(l)}$

3. (i) (1) Reducing Agent: NH_3 (Ammonia)

NH_3 loses hydrogen (is oxidized) and reduces oxygen to water.

(2) Reducing Agent: H_2O (Water).

H_2O donates electrons to F_2, causing the reduction of F_2 to HF.

(3) Reducing Agent: CO (Carbon monoxide).

CO is oxidized to CO_2, reducing Fe_2O_3 to Fe.

(4) Reducing Agent: H_2 (Hydrogen gas).

H_2 is oxidized to H_2O, reducing O_2 to water.

(ii) A redox reaction is a chemical reaction which involves gain or loss of oxygen simultaneously.

4. (i) The black substance formed is copper (II) oxide. It is formed because upon heating, the copper metal melts gradually and turns black on the surface. This is because the copper powder present in the china dish reacts with the atmospheric oxygen and forms copper (II) oxide.

(ii) This substance can be reversed to its original form by reacting copper oxide with hydrogen or carbon.

5. (i) Bubbles of gas/evolution of gas

(ii) Change in colour. Zinc changes from silver grey to black.

(iii) Change in temperature.

6. (i) Test tube B

(ii) Copper is lower to Iron in the reactivity series so displacement reaction will be maximum.

(iii) $Fe_{(s)} + CuSO_{4(aq)} \rightarrow FeSO_{4(aq)} + Cu_{(s)}$

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. A chemical reaction is a process in which substances, known as reactants, are transformed into different substances, known as products. During a chemical reaction, the bonds between atoms in the reactants are broken, and new bonds are formed to create the products. This process often involves the exchange or sharing of electrons and leads to changes in the properties and composition of the substances involved.

(i) Activity to Show Change of Colour: Reaction Between Copper Sulphate and Iron

Procedure:

- Take a beaker and fill it with 100 ml of copper sulphate solution.
- Drop an iron nail or iron filings into the solution.
- Allow the setup to sit undisturbed for 15-20 minutes.
- **Observation:** Initially, the copper sulphate solution is blue due to the presence of Cu^{2+} ions. After some time, the iron nail or filings become coated with a reddish-brown substance, and the blue colour of the solution fades to a lighter green or may disappear altogether.

Chemical Reaction:

$Fe_{(s)} + CuSO_{4(aq)} \rightarrow FeSO_{4(aq)} + Cu_{(s)}$

The change in colour from blue to greenish or colourless indicates a chemical change has occurred, where copper sulphate has been converted to iron sulphate and copper metal.

(ii) Activity to Show Change in Temperature: Exothermic Reaction of Baking Soda and Vinegar

Procedure:

- Take a beaker and add 50 ml of vinegar to it.
- Record the initial temperature of the vinegar using a thermometer.
- Add a tablespoon of baking soda to the vinegar and immediately observe the reaction.
- **Observation:** As soon as baking soda is added to the vinegar, a vigorous fizzing reaction occurs, producing bubbles and foam. Measure the temperature of the solution during the reaction.

Chemical Reaction:

$$NaHCO_{3(s)} + CH_3COOH_{(aq)} \rightarrow CH_3COONa_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

The increase in temperature during the reaction demonstrates that a chemical change has taken place, with the reactants being transformed into new products and heat being released in the process.

2. (i) A reactant breaks down to give two or more products. A reaction which requires energy to split a compound or reactant in two or more simple substances.

(I) Water splits into hydrogen gas and oxygen gas.

Electrical energy

(II) Silver bromide decomposes into silver and bromine

Light energy

(ii) (I) Formation of calcium oxide:

$$CaCO_{3(s)} \xrightarrow{\text{Heat}} CaO(s) + CO_{2(g)}$$

It is an endothermic reaction/decomposition reaction. (II) Formation of calcium hydroxide:

$$CaO + H_2O \rightarrow Ca(OH)_2 + \text{Heat}$$

It is exothermic/combination reaction

3. (i) Change in Temperature: The reaction between calcium oxide (CaO) and water (H_2O) to form calcium hydroxide [$Ca(OH)_2$] is determined by change in temperature.

This is because the reaction between calcium oxide and water is highly exothermic and releases a lot of heat.

$$CaO + H_2O \longrightarrow Ca(OH)_2 + \text{Heat}$$

(ii) Evolution of gas: The reaction between zinc and hydrochloric acid to form zinc chloride and hydrogen gas is determined by evolution of gas. This is because hydrogen gas is evolved during the reaction.

$$Zn_{(s)} + 2HCl_{(aq)} \longrightarrow ZnCl_{2(aq)} + H_{2(g)}$$

(iii) Change in Colour: The reaction between lead nitrate [$Pb(NO_3)_2$] and potassium iodide (KI) is determined by the change in colour. This is because during the reaction exchange of ions between the reactants takes place leading to the formation of potassium nitrate (KNO_3) and a yellow precipitate of lead iodide (PbI_2).

$$Pb(NO_3)_{2(aq)} + 2KI_{(aq)} \longrightarrow PbI_{2(s)}(\downarrow) + 2KNO_{3(aq)}$$

Lead nitrate — Potassium iodide — Lead iodide (Yellow ppt.) — Potassium nitrate

4. Displacement reaction is a type of reaction in which a more reactive element displaces another less reactive element. The reactivity series of metals can be used to find out the displacement reaction.

Chemical equation for a displacement reaction in which Iron is a reactant:

$$Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$$

Zinc is another element whose behaviour is similar to that of iron in such reaction.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2\uparrow$$

This behaviour is not shown by Gold as it is the least reactive element.

2 CHAPTER

Acids, Bases and Salts

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (C) is correct

Explanation:

- A turns phenolphthalein pink, indicating that A is a basic solution, as phenolphthalein turns pink in solutions with a pH greater than 7.
- When B is added to A, the pink colour disappears, suggesting that B is acidic. The acid neutralizes the base, causing the pH to drop below the range where phenolphthalein is pink.

2. Option (D) is correct.

Explanation: Solid calcium oxide reacts vigorously with water to form Calcium hydroxide accompanied by the liberation of heat. From the information given above, it can be concluded that this is an exothermic reaction, and the solution formed is basic in nature, which means the pH is greater than 7.

3. Option (C) is correct

Explanation: Tamarind juice turns blue litmus red because it is acidic in nature. The acid primarily present in tamarind is tartaric acid, which gives it a sour taste and acidic properties.

4. Option (B) is correct

Explanation: The oxide that reacts with both HCl (acid) and KOH (base) to form corresponding acidic or basic salt and water is called as an amphoteric oxide. Among the given options, Al_2O_3 is an amphoteric oxide as it reacts with both acids and bases.

Reaction with HCl (acid):

$$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$$

Reaction with KOH (base):

$$Al_2O_3 + 2KOH \rightarrow 2KAlO_2 + H_2O$$

5. Option (B) is correct

Explanation: Natural indicators are substances obtained from natural sources that change color in the presence of acids or bases. Among the given options:

- Litmus is a natural indicator derived from lichens.
- Turmeric is a natural indicator derived from the turmeric plant.

6. Option (D) is correct

Explanation: An aqueous solution of the salt turns blue litmus red, indicating that the solution is acidic in nature. This happens when the salt is formed from a strong acid and a weak base, resulting in an acidic solution. Among the given options HCl (a strong acid) reacts with NH_4OH (a weak base) to form NH_4Cl, which hydrolyses in water to produce an acidic solution.

7. Option (A) is correct

Explanation: The salt present in tooth enamel is calcium phosphate, specifically hydroxyapatite, which is the crystalline form of calcium phosphate. This compound provides strength and rigidity to the enamel.

8. Option (C) is correct

Explanation: When NaCl (neutral salt) is dissolved in distilled water, it dissociates completely into Na^+ and Cl^- ions. Neither of these ions hydrolyses in water, meaning they do not react with water to change the concentration of H^+ or OH^- ions. The solution remains neutral with a pH of 7 at standard conditions (25°C).

9. Option (C) is correct

Explanation: Turmeric solution is a natural pH indicator that turns red in the presence of a base and remains yellow in neutral or acidic solutions. Among the given options, the liquid that turns turmeric solution red is ammonium hydroxide because it is a basic solution.

10. Option (B) is correct

Explanation: The acid present in nettle sting is methanoic acid (commonly known as formic acid), The presence of methanoic acid is responsible for the irritation and burning sensation caused by a nettle sting.

11. Option (C) is correct

Explanation: Bases are substances that release hydroxide ions (OH^-) in water or react with acids

to form salts and water. Among the given options, Sodium sulphate (Na_2SO_4) is a neutral salt formed from the reaction of a strong acid (H_2SO_4) and a strong base (NaOH). It does not release OH^- ions or behave as a base. Thus, sodium sulphate is not a base.

12. Option (B) is correct

Explanation:

Colour	Solution	Colour of pH Paper	Approximate pH Value	Nature of Solution	Correctness	Explanation
(A)	Lemon juice	Orange	3	Basic	Incorrect	Lemon juice is acidic, not basic, though the pH and color are correct.
(B)	Milk of magnesia	Blue	10	Basic	Correct	Milk of magnesia is basic, with correct pH value and color on pH paper.
(C)	Gastric juice	Red	6	Acidic	Incorrect	Gastric juice is acidic, but its pH is much lower (1-3), not 6 as stated.
(D)	Pure water	Yellow	7	Neutral	Incorrect	Pure water is neutral, but pH paper for neutral solutions usually shows green.

13. Option (C) is correct

Explanation: Washing soda is the common name for sodium carbonate decahydrate ($Na_2CO_3{\cdot}10H_2O$). It is a hydrated form of sodium carbonate, widely used in cleaning applications.

14. Option (D) is correct

Explanation: Tomatoes contain oxalic acid, which contributes to their slightly sour taste.

15. Option (D) is correct.

Explanation:

- **$FeSO_4$ (Iron (II) Sulphate heptahydrate):** In its hydrated form, $FeSO_4.7H_2O$ contains 7 molecules of water of crystallisation.
- **$CuSO_4$ (Copper (II) Sulphate pentahydrate):** In its hydrated form, $CuSO_4.5H_2O$ contains 5 molecules of water of crystallisation.
- **$CaSO_4$ (Calcium sulphate):** Commonly known as gypsum, in its hydrated form, $CaSO_4.2H_2O$ contains 2 molcules of water of crystallisation.
- **Na_2CO_3 (Sodium carbonate decahydrate):** In its hydrated form, $Na_2CO_3.10H_2O$ contains 10 molecules of water of crystallisation.

  Thus, Na_2CO_3 has the maximum number of water of crystallisation, i.e. 10 molecules.

16. Option (B) is correct

Explanation: Sodium hydroxide (NaOH) is an alkali because it dissolves in water and produces hydroxide ions. On the other hand, Ferric hydroxide ($Fe(OH)_3$) is not an alkali because it is not soluble in water, even though it is a base. This is because all alkalis are bases, but not all bases are alkalis.

17. Option (C) is correct

Explanation: Sodium carbonate decahydrate ($Na_2CO_3{\cdot}10H_2O$), also known as washing soda, is effective in removing both temporary and permanent hardness by precipitating calcium and magnesium ions.

18. Option (D) is correct

Explanation: Baking soda (Sodium hydrogen carbonate) is a base that is commonly used to delay the curdling of milk. When added to fresh milk, it increases the pH of the milk, making it more alkaline. This helps to prevent the milk from souring or curdling, thus extending its shelf life.

19. Option (C) is correct

Explanation: Hydronium ions are formed by the reaction between hydrogen chloride gas and water. When hydrogen chloride gas dissolves in water, it reacts with the water molecules to form hydronium ions (H_3O^+) and chloride ions (Cl^-) according to the following chemical equation:

$$HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$$

The reaction involves the donation of a proton (H^+) from HCl to water, forming the hydronium ion (H_3O^+).

20. Option (C) is correct

Explanation: Ammonium chloride (NH_4Cl) is acidic in nature because it is the salt of a strong acid (HCl) and a weak base (NH_3). When dissolved in water, it undergoes hydrolysis to produce hydronium ions (H_3O^+), making the solution acidic. Since the solution is acidic, the pH will be less than 7. The universal indicator paper turning pink confirms that the solution is acidic.

21. Option (A) is correct

Explanation: An indicator, phenolphthalein is a substance that changes colour when it interacts with an acid or a base. It will be pink in basic solutions and clear in acidic ones. When phenolphthalein is added, X turns pink, indicating that it is basic in nature, whereas Y does not change colour, indicating that it is acidic in nature.

The reaction of sodium hydroxide (strong base) and carbonic acid (weak acid) produces sodium carbonate. As a result, it is basic in nature.

The salt of a strong acid, hydrochloric acid (HCl), and a weak base, ammonium hydroxide (NH_4OH), is ammonium chloride (NH_4Cl). As a result, an ammonium chloride aqueous solution is acidic in nature.

22. Option (B) is correct.

Explanation: When sulphur is burned in air, it reacts with oxygen to form sulphur dioxide (SO_2):

$$S + O_2 \rightarrow SO_2$$

When water is added to the test tube containing the fumes (SO_2), it dissolves to form sulphurous acid (H_2SO_3) which is a weak acid:

$$SO_2 + H_2O \rightarrow H_2SO_3$$

When the solution formed by the dissolution of sulphur dioxide in water is tested with litmus paper:

- Blue litmus paper turns red, indicating the solution is acidic.
- Red litmus paper remains red, as acids do not change the colour of red litmus paper

23. Option (B) is correct

Explanation: (i) Hydrogen Carbonate of Sodium ($NaHCO_3$) does not contribute to water hardness.

(ii) Sulphate of Magnesium ($MgSO_4$) does contribute to water hardness.

(iii) Chloride of Calcium ($CaCl_2$) does contribute to water hardness.

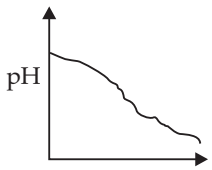
(iv) Carbonate of Sodium (Na_2CO_3) does not contribute to water hardness.

So, the correct choices are Chloride of Calcium and sulphate of magnesium.

24. Option (A) is correct

Explanation: When milk turns into curd, the pH of the milk typically decreases over time. This is due to the fermentation process where lactose (milk sugar) is converted into lactic acid by bacteria such as *Lactobacillus*. The increase in lactic acid lowers the pH, making the environment more acidic.

Graph A shows a continuous decrease in pH over time. This graph is consistent with what happens during the fermentation of milk into curd, as the production of lactic acid from lactose by bacteria should lead to a steady decline in pH.



A

25. Option (A) is correct

Explanation: Acids: When exposed to blue litmus paper, acids turn it red because of the acidic nature.

Bases: When exposed to red litmus paper, bases turn it blue because of the basic nature. This is the fundamental property of litmus paper when testing for acidity and basicity.

26. Option (D) is correct

Explanation: Plaster of Paris gets hard when mixed with water and this is the key property that makes Plaster of Paris effective as a building material. It allows for quick setting and forming of a hard layer, ideal for coatings, repairs, and finishing on walls and ceilings.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (D) is correct

Explanation: While diluting an acid, it is preferred that the acid is added to water rather than the water being added to the acid, keeping the solution continuously stirred. This is because adding water to a concentrated acid is highly exothermic and releases a large amount of heat, which can cause an explosion and acid burns on the skin, clothing, and other body parts. Thus, assertion is false but reason is true.

2. Option (B) is correct

Explanation: The acid must always be added to water with constant stirring because the process is highly exothermic and stirring continuously helps to evenly distribute the heat generated by the exothermic reaction, thus preventing localised overheating and possible violent reactions. When an acid is diluted with water, the concentration of ions per unit volume decreases because the acid is spread over a greater volume of solvent (water), thus lowering the concentration of the acid. Thus, both assertion and reason are true but reason is not the correct explanation of assertion.

3. Option (A) is correct

Explanation: Hydrogen chloride gas does not change the colour of dry blue litmus paper. This is because when HCl gas comes into contact with moist or wet litmus paper, it dissolves in the water present on the paper's surface and dissociates into H^+ and Cl^- ions. The presence of H^+ ions change the colour of blue litmus paper to red, indicating acidity. Thus, both assertion and reason are true and reason is the correct explanation of assertion.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i) Sodium chloride (NaCl) is formed from the reaction of:

- **Acid:** Hydrochloric acid (HCl)
- **Base:** Sodium hydroxide (NaOH)

$$NaOH + HCl \rightarrow NaCl + H_2O$$

(ii) Calcium sulphate ($CaSO_4$) contains:

- **Cation:** Calcium ion (Ca^{2+})
- **Anion:** Sulphate ion (SO_4^{2-})

(iii) (a) Salts having same cations but different anions belong to the same family of salts. Sodium chloride (NaCl) and washing soda ($Na_2CO_3 \cdot 10H_2O$) both belong to the same family of salts as they both have Na^+ as cation. They are formed by the neutralization reaction of a strong base (NaOH) with an acid.

- Sodium chloride is formed from HCl and NaOH.
- Washing soda is formed from H_2CO_3 (carbonic acid) and NaOH.

OR

(b) **pH Scale:** The pH scale is a logarithmic scale used to measure the acidity or basicity of aqueous solutions. It monitors the concentration of hydrogen ions (H^+) in a solution. The pH scale ranges between 0 and 14, where:

- pH less than 7 indicates acidity,
- pH equal to 7 indicates neutrality and
- pH greater than 7 indicates alkalinity or basicity.

The reaction of potassium hydroxide (KOH) and sulphuric acid (H_2SO_4) produces potassium sulphate (K_2SO_4).

The pH of aqueous solution of potassium sulphate is neutral with a pH of approximately 7, as it is formed by the reaction of a strong acid and a strong base.

2. (i) The solutions whose groups have pH value:
(1) Less than 7 are Group A and B
(2) Greater than 7 is Group C.

(ii) **pH Paper/Strips:** These are treated with a chemical that changes colour based on the pH of the solution it comes into contact with. It provides a quick and easy way to estimate the pH value.
pH Meter: A more accurate instrument that measures the voltage between two electrodes that is proportional to the pH of the solution. It provides a precise digital reading of the pH.

(iii) (a) Sour substances like lemon juice contain acids (e.g., citric acid in lemon) that can react with the copper oxide (tarnish) on the surface of copper vessels. The acid reacts with the copper oxide, forming a soluble copper compound that can be washed away, thus cleaning the vessel. For example, the reaction of citric acid with copper oxide can be represented as:

$$2CuO(s) + 2C_6H_8O_7(aq) \rightarrow Cu_2(C_6H_7O_7)_2(aq) + H_2O(l)$$

OR

(b) **Importance of pH in our daily life**

(1) Health and Medicine: The pH of the stomach is crucial for digestion and for maintaining a barrier against pathogens. Antacids are used to adjust the stomach's pH for comfort and health.

(2) Agriculture: Soil pH greatly influences plant growth. It affects the availability of nutrients and the activity of soil bacteria. Farmers adjust soil pH through the application of lime or fertilisers to optimise conditions for crop growth.

3. (i) Liquid 2 (pH = 12) has the lowest concentration of hydrogen ions because the lowest concentration of hydrogen ions corresponds to the liquid with the highest pH value.

(ii)
- No, gloves are not for keeping hands warm in this context.
- Yes, forceps provide better grip and help avoid contamination of the pH paper.
- Yes, gloves protect hands from potentially corrosive or harmful liquids.

(iii) (a) The pH of distilled water is 7 (neutral). On dipping in distilled water, the pH paper would turn green (neutral colour on the pH scale).

OR

(b) City B's rainwater (pH = 5) is more acidic than City A's rainwater (pH = 6) because a lower pH indicates higher acidity.

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. When solid sodium chloride is reacted with concentrated sulphuric acid, the gas evolved in the reaction is hydrogen chloride (HCl) gas.

(i) The gas evolved is hydrogen chloride (HCl) gas.

(ii) When tested with blue litmus paper:

(1) Dry blue litmus paper: No change will be observed because dry hydrogen chloride gas does not have acidic properties.

(2) Wet blue litmus paper: The blue litmus paper will turn red, indicating that the gas is acidic when dissolved in water to form hydrochloric acid.

Conclusion: Hydrogen chloride gas exhibits acidic properties when dissolved in water, turning wet blue litmus paper red.

2. (i) The compound 'X' is Plaster of Paris and its Chemical Formula is $CaSO_4 \cdot \frac{1}{2} H_2O$

(ii) **Baking Soda:** The chemical name for baking soda is sodium bicarbonate, with the formula $NaHCO_3$. It is a single chemical compound, consisting of sodium (Na), hydrogen (H), carbon (C), and three oxygen (O) atoms.

Baking powder: Baking powder is a mixture of two main components - baking soda (sodium bicarbonate) and an acidic compound, typically cream of tartar (potassium bitartrate). Some commercial baking powders also contain other acid salts, such as sodium aluminium sulphate.

3. (i) $CuSO_4 \cdot 5H_2O \xrightarrow{\Delta} CuSO_4 + 5H_2O$

Copper sulphate (Blue) — Anhydrous copper sulphate (White)

This equation represents the heating of hydrated copper sulphate, where it loses its water molecules and turns from blue to anhydrous white copper sulphate.

(ii) $2NaHCO_3(s) \xrightarrow{\Delta} Na_2CO_3(s) + H_2O(l) + CO_2(g)$

Sodium bicarbonate — Sodium Carbonate — Water — Carbon dioxide

This equation shows the thermal decomposition of sodium bicarbonate (baking soda) into sodium carbonate, water vapor, and carbon dioxide gas, typically occurring during baking.

4. (i) The compound formed is copper chloride and the colour of the solution is bluish-green.

(ii) $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$

5. X = NaCl (Sodium chloride);
Y = H_2 (Hydrogen gas);
Z = Cl_2 (Chlorine gas);
B = Bleaching powder ($CaOCl_2$)

$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$
(X) (Z) (Y)

$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$
(B)

6. (i) 'Y' is calcium sulphate hemihydrate, commonly known as plaster of Paris. $\left(CaSO_4 \cdot \frac{1}{2}H_2O\right)$

'X' is gypsum. ($CaSO_4.2H_2O$)

(ii) 'X' (gypsum) can be reobtained from 'Y' plaster of paris by the process of hydration. When plaster of paris is mixed with water, it reabsorbs the water molecules and becomes gypsum.

$CaSO_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O \rightarrow CaSO_4.2H_2O$

7. (i) M is highly acidic so it produces more H^+ ions hence it gives red colour with universal indicator.

(ii) If M and N are mixed neutralisation takes place and a neutral salt is produced which gives green colour with universal indicator. As M is highly acidic and N is highly basic so the salt produced is a neutral salt.

8. (i) Dipti will be able to identify the solution containing dilute sodium hydroxide by mixing pairs of the substances.

(ii) The observation that will help her make this identification is the formation of a salt and water, which is indicative of a neutralisation reaction. When an acid is mixed with a base (sodium hydroxide), they will neutralise each other, resulting in the formation of water and a salt. This reaction is exothermic, so she will also observe a temperature rise.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. (i) The pH of a sample of tomato juice is 4.6. This indicates that the juice is likely to taste sour and it is slightly acidic. Acids typically taste sour, which explains the sourness of tomato juice.

(ii) A strong acid (e.g., HCI) completely ionises in water, meaning it dissociates entirely into hydrogen ions (H^+) and the corresponding anions. A weak base (e.g., NH_4OH) partially ionises in water, meaning only a small fraction of its molecules produce hydroxide ions (OH^-) while the rest remain undissociated.

(iii) Acid rain (pH < 5.6), caused by SO_2 and NO emissions, lowers the pH of water bodies, making them acidic. This disrupts the reproductive, respiratory, and metabolic functions of aquatic life. It also dissolves toxic metals like aluminium, further harming fish and amphibians, and creates an inhospitable environment for survival.

2. The common name of compound $CaSO_4.\frac{1}{2}H_2O$ is Plaster of Paris and its chemical name is calcium sulphate hemihydrate.

Plaster of Paris is prepared by heating gypsum to about 373 K (100°C). During this procss, gypsum loses water molecules and forms calcium sulphate hemihydrate.

$$CaSO_4.2H_2O \xrightarrow{373\ K} CaSO_4.\frac{1}{2}H_2O + \frac{3}{2}H_2O$$

When Plaster of Paris reacts with water, it reabsorbs water molecules and forms gypsum ($CaSO_4.2H_2O$) again. This reaction is responsible for the hardening of Plaster of Paris.

$$CaSO_4 \cdot \frac{1}{2}H_2O + \frac{3}{2}H_2O \rightarrow CaSO_4.H_2O$$

3. The pH of a solution is a measure of its acidity or alkalinity on a scale ranging from 0 to 14. It represents the concentration of hydrogen ions (H^+) present in the solution. A pH value:

- Less than 7 indicates an acidic solution.
- Equal to 7 indicates a neutral solution (pure water).
- Greater than 7 indicates an alkaline (basic) solution.

City B's water is more acidic, as a lower pH value indicates a higher concentration of hydrogen ions ($[H^+]$).

If the rain from city B (pH 5.3) flows into a pond, it lowers the pond's pH, making the water more acidic. Acidic water disrupts enzyme activity and metabolism

in aquatic organisms, releases toxic metals like aluminium that poison aquatic life, and damages their respiratory and reproductive systems. This creates an inhospitable environment, threatening the survival of aquatic species.

4. (i) (a) **Acid:** Hydrochloric acid (HCl) and **Base:** Sodium hydroxide (NaOH)

(b) **Acid:** Sulphuric acid (H_2SO_4) and **Base:** Ammonium hydroxide (NH_4OH)

(ii) **Sodium chloride (NaCl):** It is neutral in nature because it is formed from a strong acid (HCl) and a strong base (NaOH), resulting in a salt that does not affect the pH of water.

Ammonium sulphate ($(NH_4)_2SO_4$): It is acidic in nature because it is formed from a strong acid (H_2SO_4) and a weak base (NH_4OH). The stronger acidic component dominates, making the salt acidic.

5. (i) (a) Production of too much acid in stomach during indigestion leads to pain and irritation. Antacid is given in such case to neutralize the acid of the stomach. The antacids neutralise the excess acid. Magnesium hydroxide (milk of magnesia) is a mild base, often used for this purpose.

(b) In case of a honeybee, sting formic acid is released into the skin which causes pain and irritation. To reduce the pain caused due to the sting, bases like baking soda are used which neutralize acid and relieve the pain. Stinging hair of nettle leaves inject methanoic acid causing burning pain. It is also treated with rubbing mild base.

(ii) When the milk is turned into curd then its pH value decreases. This is due to the production of lactic acid in curd which is acidic in nature.

6. (i) Bacteria present in the mouth produce acid by degradation of sugar and food particles which remain in the mouth after eating. When the pH in the mouth falls below 5.5, tooth decay starts. The acid produced in the mouth attack the enamel thereby, creating tooth decay.

(ii) The basic salt X obtained by heating baking soda followed by crystallisation is sodium carbonate (Na_2CO_3). Sodium carbonate has two industrial uses:

(1) Glass manufacturing: Sodium carbonate is used in the production of glass as a fluxing agent. It helps to lower the melting point of the glass mixture, allowing it to be moulded and shaped easily. It also aids in the removal of impurities from the glass.

(2) Water treatment: Sodium carbonate is used in water treatment processes to adjust the pH of water. It can help neutralize acidic water and prevent corrosion in pipes and equipment.

(iii) Copper sulphate crystals turn white on heating due to the loss of water molecules. Copper sulphate crystals contain water molecules as part of their structure, and when heated, these water molecules are driven off, leaving behind an anhydrous form of copper sulphate. The anhydrous copper sulphate is white in colour, as opposed to the blue colour of the hydrated copper sulphate crystals.

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

(i) $NaCl(aq) + H_2O(l) \rightarrow NaOH(aq) + \frac{1}{2}Cl_2(g) + \frac{1}{2}H_2(g)$

Gases Evolved:

(i) **Anode (positive electrode):** Chlorine gas (Cl_2) is evolved.

(ii) **Cathode (negative electrode):** Hydrogen gas (H_2) is evolved.

Product Formed: When the gases chlorine and hydrogen combine, they form hydrogen chloride (HCl).

$$Cl_2(g) + H_2(g) \rightarrow 2HCl(g)$$

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) **(1) Strongly acidic** → Solution B with pH 1.
(2) Strongly alkaline → Solution C with pH 13.
(3) Weakly acidic → Solution A with pH 4.
(4) Neutral → Solution D with pH 7.
(5) Weakly alkaline → Solution E with pH 10.
The pH can be arranged in the increasing order of the concentration of hydrogen ions as:
C < E < D < A < B

(ii) (1) **An Acidic Salt:**
Name: Ammonium chloride
Formula: NH_4CI
Parent Acid: Hydrochloric acid (HCI)
Parent Base: Ammonium hydroxide (NH_4OH)

(2) **A Basic Salt:**
Name: Sodium carbonate
Formula: Na_2CO_3
Parent Acid: Carbonic acid (H_2CO_3)
Parent Base: Sodium hydroxide (NaOH)

2. (i) When heated, the hydrated crystals of ferrous sulphate ($FeSO_4 \cdot 7H_2O$) lose their water molecules, forming anhydrous ferrous sulphate and releasing water vapour, which condenses as droplets. Thus, the water droplets observed in the tube are due

to the loss of water of crystallisation from ferrous sulphate crystals.

(ii) Initially, green crystals of ferrous sulphate ($FeSO_4 \cdot 7H_2O$) will turn into a white solid (anhydrous $FeSO_4$) as it loses water. Upon further heating, the anhydrous $FeSO_4$ decomposes, producing a brown residue of ferric oxide (Fe_2O_3).

(iii) Each molecule of ferrous sulphate ($FeSO_4$) crystal has 7 molecules of water of crystallisation.

Molecular formulas of crystalline forms:

(I) Copper sulphate: $CuSO_4.5H_2O$

(II) Sodium carbonate: $Na_2CO_3.10H_2O$

(iv) **Preparation:** Plaster of Paris ($CaSO_4 \cdot \frac{1}{2} H_2O$) is obtained by heating gypsum ($CaSO_4 \cdot 2H_2O$) to about 373 K. During heating, gypsum loses its water of crystallization to form Plaster of Paris.

$$CaSO_4.2H_2O \xrightarrow[373\ K]{\Delta} CaSO_4 \cdot \frac{1}{2} H_2O + 1\frac{1}{2} H_2O$$

Uses of Plaster of Paris:

1. Used for making moulds, statues, and decorative items.
2. Used for repairing fractures in bones by forming orthopaedic casts.

3. (i) X : Tartaric acid (found in tamarind).
Y : Baking soda (Sodium bicarbonate).
Z : Baking powder (a mixture of baking soda and a mild edible acid like tartaric acid).

Chemical formula of 'Y': $NaHCO_3$ (Sodium bicarbonate).

(ii) **Preparation of 'Y' (Baking soda):**

- Baking soda ($NaHCO_3$) is prepared by reacting sodium chloride (NaCl) with carbon dioxide (CO_2), water (H_2O), and ammonia (NH_3):

$$NaCl + H_2O + CO_2 + NH_3 \rightarrow NaHCO_3 + NH_4Cl$$

When baking powder (Z) is added to dough and heated, baking soda ($NaHCO_3$) reacts with the acid (tartaric acid or others) in the mixture to produce carbon dioxide gas (CO_2). The CO_2 gas forms bubbles in the dough, causing it to expand and making the cake soft and spongy.

$$NaHCO_3 + H^+ \rightarrow CO_2 + H_2O + Na^+$$

(iii) Magnesium hydroxide is a mild base that is used as an antacid as it neutralises excess stomach acid and provides relief from acidity. Its chemical formula is $Mg(OH)_2$.

4. (i) **Observation:** Bubbles of gas are released.

Reason: When metals react with acids, they produce hydrogen gas is (H_2) as a by-product. This gas released in the form of bubbles.

(ii) No, the original metal cannot be recovered by evaporating the acid. This is because the process involves a chemical change, not a physical one. When a metal reacts with an acid, it forms a salt and releases hydrogen gas. The metal is chemically transformed into ions that are part of the salt, so evaporation will only leave behind the salt, not the original metal.

(iii)
- When a metal 'dissolves' in an acid, it undergoes a chemical reaction, forming a new compound (a salt) and releasing hydrogen gas.
- When sugar dissolves in water, it is a physical change where sugar molecules disperse into the water without forming a new substance. Sugar can be recovered by evaporation, while the metal cannot.

3 CHAPTER

Metals and Non-metals

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (C) is correct.
Explanation: X (2, 8, 7): Elements with 7 electrons in their outermost shell need 1 more electron to achieve a stable noble gas configuration. Such elements are typically non-metals.
Y (2, 8, 2): With 2 electrons in its outermost shell, Y tends to lose these electrons to achieve stability. Elements with 1 or 2 outer electrons are typically metals.
Z (2, 8): Z has a completely filled outer shell, making it stable and non-reactive, indicating that it is a noble gas.
Thus, X is a non-metal, and Y is a metal.

2. Option (C) is correct
Explanation: Mercury (Hg) is a metal that exists in a liquid state at room temperature. Bromine (Br_2) is a non-metal that exists in a liquid state at room temperature.

3. Option (C) is correct
Explanation: Copper (Cu) is found in ores like chalcopyrite ($CuFeS_2$) and cuprite (Cu_2O) as well as in nature or free state.
Silver (Ag) is found in the free state as native silver and in the combined state in ores like argentite (Ag_2S).
Gold and platinum, being highly unreactive, are typically found in the free state only.

4. Option (B) is correct
Explanation: Aluminium (Al) is a metal 'X' used in the Thermite process because of its high reactivity and ability to reduce metal oxides to pure metals by releasing a significant amount of heat.
Oxide 'Y' is aluminium oxide (Al_2O_3) which is formed when aluminium 'X' reacts with oxygen. Aluminium oxide is amphoteric in nature because it reacts with both acids and bases.

5. Option (A) is correct
Explanation: Lithium is the lightest metal and the least dense solid element. It is a soft, silver- white metal belonging to the alkali metal group of chemical elements.

6. Option (C) is correct
Explanation: Non-metals typically have 5, 6, or 7 electrons in their outermost shell. This is because non-metals tend to gain electrons to complete their octet (8 electrons in the outermost shell) during chemical reactions. For example, non-metals like N_2, O_2, F_2 contain 5, 6 or 7 number of electrons respectively in their outermost shell.

7. Option (C) is correct
Explanation: Amphoteric oxides are oxygen compounds, which show both basic and acidic characteristics. These oxides undergo a neutralisation reaction to produce water and salt.
Reaction with acid:
$ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$
Reaction with base:
$ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$

8. Option (B) is correct
Explanation: Some metal oxides, such as aluminium oxide, zinc oxide shows both acidic as well as basic behaviour. Such metal oxides that react with both acids and bases to produce salt and water are known as amphoteric oxides.
Aluminium oxide reacts with base as follows:
$Al_2O_3 + 2NaOH \rightarrow \underset{\text{(Sodium aluminate)}}{2NaAlO_2} + H_2O$
ZnO is an oxide that can react with base, as shown by the equation given below:
$ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$
MgO (Magnesium oxide) and CaO (Calcium oxide) are basic oxides. They react only with acids, not with bases.

9. Option (C) is correct
Explanation: During Galvanisation, metal zinc is used for coating iron and steel objects to prevent them from rusting.

10. Option (C) is correct
Explanation: Lead is malleable, it is easily bent, soft, dense, and a poor conductor of electricity.

11. Option (B) is correct
Explanation: For copper to deposit on a silver plate, the silver plate would need to be more reactive than copper to displace it in the solution. However, silver is less reactive than copper, so it cannot displace copper ions to form a deposit on the plate. This explains why no deposition of copper is observed on the silver plate before starting the current.

12. Option (B) is correct

Explanation: Aluminium (Al) reacts with water (H_2O) to form aluminium oxide (Al_2O_3) and hydrogen gas (H_2). The balanced equation should include hydrogen gas on the product side.

The balanced chemical reaction is:

$2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$

Thus, X is H_2 (hydrogen gas).

13. Option (D) is correct

Explanation: Aluminium is a highly reactive metal and is found in the combined state in ores like bauxite ($Al_2O_3.2H_2O$). It is extracted through electrolysis of molten aluminium oxide (Al_2O_3) mixed with cryolite to reduce the melting point. The process requires a significant amount of electricity.

14. Option (D) is correct

Explanation: Q: The zinc coating prevents contact of iron with air (True): The zinc coating forms a physical barrier, preventing oxygen and moisture from coming into contact with the iron, thereby slowing rusting.

R: Zinc undergoes corrosion more easily than iron (True): Zinc is more reactive than iron (higher in the reactivity series), so if the zinc coating is scratched, zinc undergoes oxidation (corrosion) preferentially, protecting the iron underneath.

15. Option (C) is correct

Explanation: Magnesium does not react with cold water but reacts with hot water, forming magnesium hydroxide ($Mg(OH)_2$) and releasing colourless hydrogen gas bubbles. Magnesium starts floating because of the bubbles of hydrogen gas sticking to its surface.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (B) is correct

Explanation: Different metals have different reactivities with water and dilute acids because the chemical reactivity of metals varies based on their position in the reactivity series. Highly reactive metals (e.g., sodium) react vigorously, while less reactive metals (e.g., copper) show little to no reaction. Metal extraction methods are determined by their reactivity- electrolysis for highly reactive metals (e.g., aluminium) and reduction for less reactive ones (e.g., iron). Thus, both the assertion and reason are true, but reason does not correctly explains the assertion as the assertion is about the reactivity of metals with water and acids whereas reason is about how metals are extracted from ores.

2. Option (C) is correct

Explanation: When a zinc strip is placed in copper sulphate solution, the blue colour of the solution gradually fades as zinc being more reactive than copper displaces copper, forming colourless zinc sulphate. A reddish-brown layer of copper is deposited on the zinc strip because zinc is more reactive than copper. This higher reactivity of zinc also explains why copper sulphate cannot be stored in a zinc vessel. Thus, assertion is true but reason is false.

3. Option (C) is correct

Explanation: The extraction of metals from their sulphide ores cannot take place without roasting, as this process is essential for converting sulphide ores into metal oxides by heating them in the presence of oxygen. These oxides can then be easily reduced to obtain the metal. However, the reason is incorrect because roasting does not directly convert sulphide ores into metals; it only produces the intermediate metal oxides. Thus, while the assertion is true, the reason is false.

4. Option (D) is correct

Explanation: Sodium oxide (Na_2O) is not an amphoteric oxide; it is a basic oxide. It reacts with acids to form salts and water but does not react with bases. Amphoteric oxides are those that react with both acids and bases to form salts and water. Thus, assertion is false but reason is true.

5. Option (A) is correct

Explanation: When a piece of lead is added to an aqueous solution of copper sulphate, a displacement reaction takes place as lead is more reactive than copper hence lead displaces copper from the copper sulphate solution. This results in a colourless solution ($PbSO_4$).

$$CuSO_4 + Pb \rightarrow PbsO_4 + Cu$$

Thus, both assertion and reason are true and reason is the correct explanation of assertion.

6. Option (C) is correct

Explanation: The assertion that copper ions migrate from the anode to the cathode during electrorefining of copper is true because in electrorefining, copper metal is oxidised at the anode, releasing copper ions (Cu^{2+}) into the solution. These ions then migrate towards the cathode, where they are reduced back to solid copper. However, the reason is false, because in the electrorefining process metal ions accept electrons at the 'cathode', not the anode. At the anode, copper is oxidized (loses electrons) to form copper ions, while at the cathode, copper ions gain electrons and are deposited as pure copper. Thus, assertion is true but reason is false.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i)
- The cathode is made of pure copper.
- The anode is made of impure copper.

(ii) The solution used is acidified copper sulphate solution. Its formula is $CuSO_4$.

(iii) (a) During electrolytic refining, an electric current is passed through the electrolytic cell, causing copper from the impure anode to dissolve into the solution as copper ions (Cu^{2+}). These ions migrate towards the cathode, where they gain electrons and deposit as pure copper. Impurities either settle at the bottom as anode mud or remain dissolved in the solution.

- **At the anode (oxidation):**
  Impure copper dissolves into the solution as copper ions:
  $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$
- **At the cathode (reduction):**
  Copper ions from the solution gain electrons and deposit as pure copper:
  $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$
  Pure

OR

(b) Observations in Beakers A and B:

- **Beaker A (Zinc strip in copper sulphate):** The blue colour of the solution fades, and a reddish- brown coating of copper forms on the zinc strip. This happens because zinc is more reactive than copper and displaces copper from its sulphate solution.
  $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$
- **Beaker B (Silver strip in copper sulphate):** No change is observed. Silver does not react with copper sulphate because silver is less reactive than copper and cannot displace it from its sulphate solution.

2. (i) The metal sample that reacted the fastest with dilute hydrochloric acid and caused the highest temperature rise was likely magnesium. Magnesium is highly reactive with hydrochloric acid, producing hydrogen gas rapidly and releasing a significant amount of heat, making its reaction more vigorous compared to aluminium and iron.

(ii) All three metals, i.e., magnesium, aluminium and iron react with dilute hydrochloric acid (HCl) because they are more reactive than hydrogen.

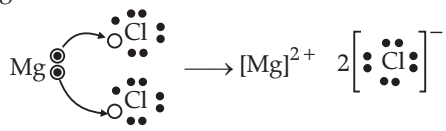
$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$
$$2Al + 6HCl \rightarrow 2AlCl_2 + 3H_2$$
$$Fe + 2HCl \rightarrow FeCl_2 + H_2$$

(iii) (a) Hydrogen gas is not evolved when a metal reacts with dilute nitric acid because nitric acid is a strong oxidizing agent. Instead of releasing hydrogen gas, the hydrogen is oxidised to form water, and the reaction produces the corresponding nitrate salt along with nitrogen oxides (e.g., nitrogen dioxide, NO_2) as the products.

OR

(b) The type of reaction on the basis of which reactivity of metals is decided is a displacement reaction. In a displacement reaction, a more reactive metal displaces a less reactive metal from its compound in aqueous solution. To determine which metal is more reactive, you can carry out displacement reactions between metals X and Y with solutions of salts containing the ions of both metals. If metal X displaces metal Y from its salt solution, then metal X is more reactive than metal Y and vice versa.

3. (i) Transfer of electrons during the creation of magnesium chloride:



(ii) **Properties of Ionic Compounds:**

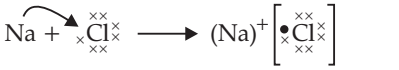
(1) Solubility: Ionic (electrovalent) compounds are generally soluble in water but remain insoluble in non-polar solvents like kerosene, petrol, and similar substances.

(2) Electrical Conductivity: Ionic compounds do not conduct electricity in their solid state because the ions are fixed in position within the crystal lattice. However, they conduct electricity when dissolved in water or in their molten state, as the ions become free to move and carry charge in these conditions.

(iii) (a) Sodium (Na) atom has one electron in its outermost shell. It loses this electron, achieving a stable octet configuration and forms a positively charged sodium ion (Na^+). On the other hand, chlorine (Cl) atom has seven electrons in its outermost shell and needs one more to complete its octet. It gains the electron lost by sodium, forming a negatively charged chloride ion (Cl^-). These oppositely charged ions attract each other due to electrostatic forces, resulting in the formation of the ionic compound sodium chloride (NaCl).

$$\underset{2,8,1}{Na} \rightarrow \underset{2,8}{Na^+} + e^-$$
(Sodium cation)

$$Cl + e^- \rightarrow \underset{2,8,8}{Cl^-}$$
(chloride anion)



OR

(b) (1) The conduction of electricity through a solution involves the movement of charged particles. A solution of an ionic compound in water contains ions, which move to the opposite electrodes when electricity is passed through the solution. Ionic compounds in the solid state do not conduct electricity because movement of ions in the solid is not possible due to their rigid structure. But ionic compounds conduct electricity in the molten state. This is possible in the molten state since the elecrostatic forces of attraction between the oppositely charged ions are overcome due to the heat. Thus, the ions move freely and conduct electricity.

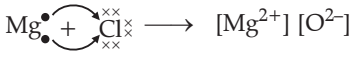
(2) When electricity is passed through a solution of sodium chloride in water, hydrogen gas is released twice as much as oxygen gas is released at the anode.

4. (i) **Electronic Configuration of Sodium (Na):** 2, 8, 1
Sodium can lose 1 electron from its 3s orbital to achieve the stable octet configuration of neon (Ne), its nearest noble gas. Thus, sodium loses 1 electron to have a stable octet.

(ii) **Electronic Configuration of Chlorine (CI):** 2, 8, 7
Chlorine can gain 1 electron to complete its 3p orbital, achieving the stable octet configuration of argon (Ar), its nearest noble gas. Thus, after gaining one electron, chlorine will attain the octet configuration of argon.

(iii) (a) $\underset{[2,8,2]}{Mg} \longrightarrow \underset{[2,8]}{Mg^{2+}} + 2e^-$

$\underset{[2,6]}{O} + 2e^- \longrightarrow \underset{[2,8]}{O^{2-}}$



$Mg^{2+} + O^{2-} \longrightarrow MgO$

OR

(b) (1) **Sodium chloride (NaCl):**
- **Cation:** Sodium ion (Na^+).
- **Anion:** Chloride ion (Cl^-)

(2) **Potassium nitrate (KNO_3)**
- **Cation:** Potassium ion (K^+).
- **Anion:** Nitrate ion (NO_3^-)

5. (i) Iron is placed in the middle of the reactivity series of metals. It is less reactive than metals like sodium and calcium but more reactive than metals like copper and gold.

Forms in which iron ores are found in nature:
- Hematite (Fe_2O_3)
- Magnetite (Fe_3O_4)
- Limonite ($FeO(OH).nH_2O$)
- Siderite ($FeCO_3$)

(ii)

	Roasting	Calcination
1.	Roasting is done in case of sulphide ores.	Calcination is done in case of carbonate ores.
2.	In this, the ore is heated in the presence of excess air to convert it into its oxide compound.	The carbonate ore is heated in the absence of air (limited supply of air) to convert into its oxide.
3.	The gas given out is SO_2 (sulphur dioxide) gas.	The gas given out is CO_2 (carbon dioxide) gas.
4.	Example: $2ZnS + 3O_2 \xrightarrow{Heat} 2ZnO + 2SO_2\uparrow$	Example: $ZnCO_3 \xrightarrow{Heat} ZnO + CO_2\uparrow$

(iii) (a) Rusting of iron can be prevented by the following two ways:
(1) By coating the surface of iron with paint, air and moisture cannot come in contact with it, and hence, no rusting takes place.
(2) Applying grease or oil on the surface of the iron: This method also prevents air and moisture from coming in contact with the iron, and hence, no rusting takes place.

OR

(b) Aluminium is used in thermite welding to join railway tracks or cracked machine parts because it reacts exothermically with iron oxide to produce molten iron, which fuses the parts together. This process is known as the thermite reaction.

$Fe_2O_3 + 2Al \longrightarrow 2Fe + Al_2O_3$

This reaction produces a significant amount of heat, melting the iron and allowing it to flow and fill the gaps in the broken parts, creating a strong, welded joint.

6. (i) The ore of Mercury is Cinnabar (HgS), and Mercury is present in it as mercuric sulphide.

(ii) When zinc carbonate ($ZnCO_3$) is heated strongly in a limited supply of air, it undergoes thermal decomposition to form zinc oxide (ZnO) and carbon dioxide (CO_2). The reaction is as follows:

$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$

(iii) (a) (I) The metal A is Aluminum (Al). The reaction taking place is the Thermit reaction.
(II) The chemical equation for the thermit reaction is:

$Fe_2O_3 + 2Al \longrightarrow 2Fe + Al_2O_3 + Heat$

OR

(b) We cannot use carbon to obtain sodium from sodium oxide because sodium is more reactive than carbon, and thus carbon cannot reduce sodium oxide.

Reactions during electrolytic reduction of sodium chloride:
- At the cathode (reduction): $Na^+ + e^- \longrightarrow Na$
- At the anode (oxidation): $2Cl^- \longrightarrow Cl_2 + 2e^-$

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. Some metals react with acids to produce a salt and hydrogen gas. For example, when magnesium reacts with hydrochloric acid, magnesium chloride (a salt) and hydrogen gas are produced. The chemical equation for this reaction is:

$Mg + 2HCl \longrightarrow MgCl_2 + H_2$

To detect the presence of hydrogen gas, bring a burning match or candle near the mouth of the test tube where the reaction is occurring. If hydrogen gas is present, it will ignite and produce a characteristic 'pop' sound. This is due to hydrogen's high

flammability, which causes it to react with oxygen in the air and form water vapour when ignited, creating a popping sound.

2. **Ductility** can be defined as the property of a metal by virtue of which it can be stretched or drawn into a thin wire without breaking.

Malleability can be defined as the property of a metal by virtue of which it can be beaten, rolled, or pressed into thin sheets without breaking.

Gold (Au) is an element that exhibits both ductility and malleability. Gold's ability to exhibit both ductility and malleability is due to the nature of its metallic bonding, where the atoms are arranged in a close-packed structure and can slide over each other with relative ease, allowing the metal to deform without breaking.

3. (i) (a) When zinc metal is placed in copper(II) sulphate ($CuSO_4$) solution, zinc displaces copper from the solution. The copper(II) sulphate solution, which is blue due to the presence of Cu^{2+} ions, changes to colourless as $ZnSO_4$ forms in the solution. Copper metal is deposited as a reddish-brown solid.

$$\underset{\text{Copper sulphate (Blue)}}{Zn(s)} + \underset{}{CuSO_4(aq)} \longrightarrow \underset{\text{Zinc Sulphate (Colourless)}}{ZnSO_4(aq)} + \underset{\text{Copper (Reddish-brown Solid)}}{Cu(s)}$$

(b) In the reaction between sodium chloride and silver nitrate ($AgNO_3$), a white ppt of silver chloride (AgCl) is formed.

$$\underset{\text{Silver nitrate}}{AgNO_3(aq)} + \underset{\text{Sodium chloride}}{NaCl(aq)} \longrightarrow \underset{\text{Silver chloride (White ppt.)}}{AgCl(s)(\downarrow)} + \underset{\text{Sodium nitrate}}{NaNO_3(aq)}$$

(ii) (a) When a zinc plate is dipped in ferrous sulphate ($FeSO_4$) solution, zinc displaces iron from the solution. This causes the pale green colour of the ferrous sulphate solution to disappear as zinc sulphate, which is colourless, is formed. Iron is deposited as a solid on the zinc plate.

(b) $\underset{\text{Ferrous sulphate (Pale green)}}{Zn(s)} + \underset{}{FeSO_4(aq)} \rightarrow \underset{\text{Zinc Sulphate (Colurless)}}{ZnSO_4(aq)} + Fe(s)$

4. **Metal 'A':** Reacts violently with cold water and the gas evolved catches fire: Sodium reacts vigorously with cold water, producing hydrogen gas that often catches fire.

Metal 'B': When dipped in water, starts floating. Calcium reacts with water, forming calcium hydroxide and hydrogen gas. The hydrogen gas formed makes the calcium float on the water.

Metal 'C': Does not react either with cold or hot water, but reacts with steam. Zinc does not react with cold or hot water but reacts with steam to form zinc oxide and hydrogen gas.

Metal 'D': Does not react with water at all. Gold is a noble metal and does not react with water.

So, the identified metals are:

Metal 'A': Sodium (Na)

Metal 'B': Calcium (Ca)

Metal 'C': Zinc (Zn)

Metal 'D': Gold (Au)

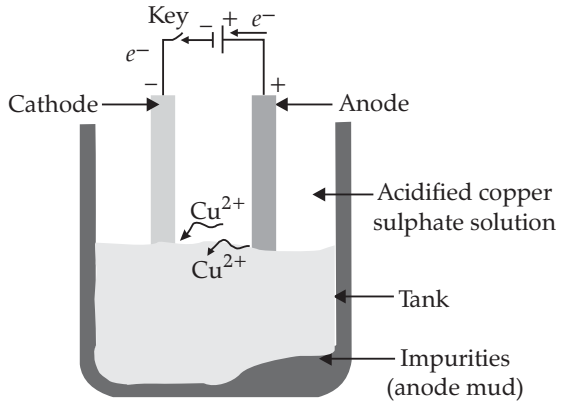
5. (i) (1) Sodium chloride imparts a yellow colour to the flame. This is due to the excitation of sodium ions, which emit a characteristic bright yellow light when heated.

(2) Calcium chloride imparts an orange-red colour to the flame. This is due to the excitation of calcium ions, which emit an orange-red light when heated.

(ii) No, these compounds are not soluble in organic solvents such as kerosene or petrol. Sodium chloride and calcium chloride are both ionic compounds, and ionic compounds are generally soluble in polar solvents like water. Kerosene and petrol are non-polar solvents, and non-polar solvents do not effectively dissolve ionic compounds due to the lack of strong interactions between the solvent molecules and the ions. Therefore, sodium chloride and calcium chloride are insoluble in non-polar solvents like kerosene and petrol.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1.



Electrolytic refining of copper

When electric current passes through the electrolyte (acidified copper sulphate solution), the impure copper anode releases copper ions (Cu^{2+}) into the solution. These positive copper ions migrate towards the pure copper cathode, where they gain electrons and are deposited as pure copper. Simultaneously, the impurities from the anode either dissolve into the electrolyte or settle as sludge (anode mud) at the bottom of the tank. This process results in the purification of copper, where the cathode grows with deposited pure copper.

At anode: $Cu \rightarrow Cu^{2+} + 2e^-$

At cathode: $Cu^{2+} + 2e^- \rightarrow Cu$

2. (i) **Mercury (Hg):** Mercury is obtained by the reduction of its ore, cinnabar (HgS), through roasting in the presence of air. Mercury lies low

in the reactivity series, so it can be easily reduced by heating its sulphide ore in air. The sulphur in cinnabar combines with oxygen to form sulphur dioxide (SO_2), leaving behind pure mercury.

$$HgS + O_2 \longrightarrow Hg + SO_2$$

(ii) Copper (Cu): Copper is extracted by the reduction of its oxide ores, such as cuprite (Cu_2O), or directly from sulphide ores like chalcopyrite ($CuFeS_2$) through roasting and smelting. Copper is moderately reactive and does not require very strong reducing agents. It can be obtained by heating its oxide with carbon or through self-reduction of sulphides.

$$2Cu_2O + C \longrightarrow 4Cu + CO_2$$

OR

$$2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$$
$$2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$$

(iii) Sodium (Na): Sodium is extracted by the electrolysis of molten sodium chloride (NaCl). Sodium is highly reactive and cannot be reduced using carbon or other chemical reducing agents. Hence, it requires a strong method like electrolysis. During electrolysis, sodium ions are reduced at the cathode to form sodium metal.

3. (i) Silver (Ag): When silver is exposed to atmospheric air for some time, it undergoes a chemical reaction with sulphur compounds (i.e., hydrogen sulphide) present in the air, leading to the formation of silver sulphide (Ag_2S). As silver sulphide is a black compound, so the change in appearance observed on the surface of silver objects is the formation of a black tarnish layer. Change:

$$4Ag + 2H_2S + O_2 \longrightarrow 2Ag_2S + 2H_2O$$

(ii) **Copper (Cu):** When copper is exposed to the atmosphere, it undergoes corrosion and turns green in colour. This happens because the metal reacts with moisture and atmospheric gases such as carbon dioxide (CO_2) and oxygen (O_2). As a result, a mixture of copper carbonate ($CuCO_3$) and copper hydroxide [$Cu(OH)_2$] forms on the surface of the copper. This green layer, known as patina, acts as a protective coating that prevents further corrosion of the metal.

$$2Cu + H_2O + CO_2 + O_2 \longrightarrow Cu(OH)_2 + CuCO_3$$

(iii) Iron (Fe): When iron is exposed to atmospheric air for some time, it undergoes oxidation reactions with oxygen and moisture to form hydrated iron(III) oxide [$Fe_2O_3.xH_2O$] (rust). Rust appears as a reddish-brown flaky layer on the surface of iron objects. The formation of rust is a common example of corrosion, which weakens the structure of iron and eventually leads to its deterioration if not prevented.

$$4Fe + xH_2O + 3O_2 \longrightarrow 2Fe_2O_3.xH_2O$$

4. The ore of mercury is Cinnabar (HgS). It is found in nature as mercuric sulphide (HgS).

The extraction of mercury from cinnabar ore involves two steps.

(1) The concentrated mercury (II) sulphide ore is roasted in the air to form mercuric oxide (HgO).

(2) This mercuric oxide formed is then reduced to mercury on further heating to about 300°C.

$$2\,HgS_{(s)} + 3O_{2(g)} \xrightarrow{\Delta} 2\,HgO_{(s)} + 2\,SO_{2(g)}$$
$$2\,HgO_{(s)} \xrightarrow{\Delta} 2\,Hg_{(l)} + O_{2(g)}$$

Conditions Required:

- The roasting is carried out in a controlled furnace at a high temperature.
- Sufficient oxygen supply is essential for the reaction to occur efficiently.

Through this process, mercury is obtained in its liquid metallic state, which is then purified further if needed.

5. Roasting and calcination are two different processes used in metallurgy to extract metals from their ores. Here are the main differences between roasting and calcination:

(1) Temperature: Roasting is carried out at a high temperature, typically above 600°C, whereas calcination is conducted at a relatively lower temperature, usually below 600°C.

(2) Gas Environment: Roasting is performed in the presence of excess oxygen or air, while calcination is usually carried out in the absence or limited supply of air, resulting in a reducing or inert atmosphere.

In both roasting and calcination, metal reduction occurs as part of the process to obtain the desired metal. The reduction is accomplished by using a reducing agent, which reacts with the metal oxide present in the roasted or calcined ore.

Let's take an example of the roasting of a sulfide ore to extract copper:

Roasting of copper iron sulfide ore ($CuFeS_2$):

$2CuFeS_2(s) + 3O_2(g) \rightarrow 2CuS(s) + 2FeO(s) + 2SO_2(g)$

In this case, the ore, copper iron sulfide ($CuFeS_2$), is heated in the presence of oxygen (O_2). The sulfur in the ore combines with oxygen to form sulfur dioxide (SO_2) gas, which escapes into the atmosphere. The copper sulfide (Cu_2S) is left behind as a solid, and the iron in the ore is converted to iron oxide (FeO).

LONG ANSWER TYPE QUESTIONS (5 Marks)

1.

- **Element X (At. No. 12):** Electronic configuration: 2, 8, 2
- **Element Y (At. No. 17):** Electronic configuration: 2, 8, 7

Formation of Ionic Compound:

- Element X loses two electrons to form a X^{2+} ion:

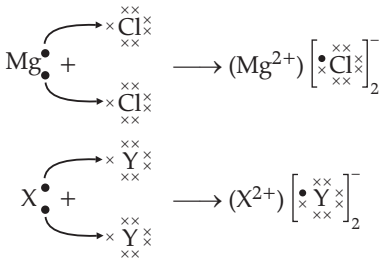
$$X \longrightarrow X^{2+} + 2e^-$$

- Element Y gains one electron to form a Y^- ion:

$$Y + e^- \longrightarrow Y^-$$

- Since X^{2+} requires two Y^- ions to balance its charge, the formula of the compound is XY_2.

Thus, the ionic compound XY_2 formed above is Magnesium chloride ($MgCl_2$).



Effect of Passing Electric Current through Aqueous Solution of $MgCl_2$:

When $MgCl_2$ is dissolved in water, it dissociates into its constituent ions:

$$MgCl_2 \longrightarrow Mg^{2+} + 2Cl^-$$

At Cathode: The Mg^{2+} ions migrate to the cathode. At the cathode, these ions gain electrons and are reduced to form magnesium metal.

$Mg^{2+} + 2e^- \longrightarrow Mg$ (Metal deposited at cathode)

At Anode: The Cl^- ions migrate to the anode. At the anode, these ions lose electrons and are oxidised to form chlorine gas.

$2Cl^- \longrightarrow Cl_2 + 2e^-$ (Chlorine gas released at anode)

Ions Reaching Electrodes:

(i) **Cathode (Negative Electrode):** Mg^{2+} ions are reduced to magnesium metal.

(ii) **Anode (Positive Electrode):** Cl^- ions are oxidised to chlorine gas.

2. (i) **Two metals of Moderate reactivity:**

- Two metals of moderate reactivity are iron (Fe) and zinc (Zn).
- Zinc is more reactive than iron.

Experimental Demonstration in School Laboratory:

The reactivity of these metals can be demonstrated using a displacement reaction:

- Take solutions of zinc sulphate ($ZnSO_4$) and iron sulphate ($FeSO_4$) in separate test tubes.
- Add a strip of iron to the zinc sulphate solution and observe. There will be no reaction as iron is less reactive than zinc.
- Add a strip of zinc to the iron sulphate solution. Zinc will displace iron from its solution because zinc is more reactive than iron.

  $Zn + FeSO_4 \longrightarrow ZnSO_4 + Fe$

  This confirms that zinc is more reactive than iron.

(ii) Some metals of moderate reactivity, such as zinc and iron, are found in the Earth's crust as carbonates. The extraction involves the following processes:

(1) Conversion of Carbonates to Oxides (Calcination):

- The carbonate ore is heated in the absence of air (calcination) to convert it into metal oxide.
- Example for zinc carbonate ($ZnCO_3$):

  $ZnCO_3 \xrightarrow{\text{Heat}} ZnO + CO_2$

(2) Reduction of Oxides to Metals:

- The metal oxide is reduced using a suitable reducing agent, such as carbon (coke), to obtain the pure metal.
- Example for zinc oxide (ZnO):

  $ZnO + C \xrightarrow{\text{Heat}} Zn + CO$

4 CHAPTER

Carbon and Its Compounds

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (C) is correct

Explanation: Carbon compounds are bad conductors of electricity as most carbon compounds do not have free electrons or ions. Carbon compounds, consist of covalent bonds resulting in weak inter molecular forces, e.g. Van der Waals forces.

2. Option (A) is correct

Explanation:

(a) Each successive member in a homologous series differs by one —CH_2 group (14 u in molecular mass) in alkanes, alkenes, and alkynes.

(b) As molecular mass increases in a homologous series, intermolecular forces (e.g., Van der Waal's forces) increase, leading to higher melting and boiling points. Thus, melting point and boiling point increases with increasing molecular mass.

(c) The difference in molecular mass between successive members of a homologous series is 14 u (due to the —CH_2 group).

(d) C_2H_2 (ethyne) and C_3H_4 (propyne) are indeed successive members of the alkyne.

Hence, the correct options are option (a) and (b).

3. Option (B) is correct

Explanation: Among the given options, the hydrocarbon C_7H_{14} is different because it does not follow the general formula for alkanes (C_nH_{2n+2}) and belongs to a different class of hydrocarbons, i.e., alkenes. Whereas, all the other options (C_4H_{10}, C_5H_{12} and C_2H_6) are alkanes.

4. Option (B) is correct

Explanation:

- Benzene is a cyclic compound with six carbon atoms arranged in a hexagonal ring. Each of the 6 carbon atoms is bonded to 1 hydrogen atom through a C-H single bond (Total: 6 single bonds). In the ring, 3 carbon-to-carbon bonds are single bonds (Total: 3 single bonds). This means there are total 9 single bonds in the ring.
- In the benzene ring, there are 3 C=C double bonds (alternating in the ring structure). This means, in total there are 3 double bonds.

5. Option (C) is correct

Explanation: Hydrocarbons are organic compounds composed solely of carbon and hydrogen atoms. The presence and arrangement of carbon-carbon bonds, including single, double, and triple bonds, determine the classification and properties of different hydrocarbon compounds.

- Ethyne (C_2H_2) contains only a triple bond no single C – C bonds.
- Propyne (C_3H_4) contains a triple bond but only one single C – C bond.
- Butyne (C_4H_6) contains two single C – C bonds and one triple bond.
- Benzene (C_6H_6) contains alternating single and double bonds, no triple bond.

6. Option (C) is correct

Explanation: In the formation of an ethyne molecule, each carbon atom shares three electrons with the other carbon atom to form three covalent bonds. Additionally, each carbon atom shares one electron with a hydrogen atom to form a covalent bond. Thus, the total number of electrons shared in the formation of an ethyne molecule is:

3 (covalent bonds between the two carbon atoms) × 2 (number of carbon atoms) + 2 (covalent bond between each carbon atom and a hydrogen atom) × 2 (number of hydrogen atoms) = 6 + 4 = 10.

7. Option (D) is correct

Explanation: When an organic compound undergoes complete combustion in the presence of an adequate supply of oxygen, it produces only carbondioxide (CO_2) and water (H_2O).

- Alkanes (P) are hydrocarbons that combust completely to form CO_2 and H_2O.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

- Alcohols (Q) also undergo complete combustion to form CO_2 and H_2O.

$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$$

- Aldehydes (R) combust completely, producing CO_2 and H_2O.

$$CH_3CHO + \frac{5}{2}O_2 \longrightarrow CO_2 + 2H_2O$$

Thus, the compound belong to any of the series.

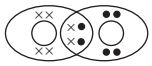
8. Option (C) is correct

Explanation: Allotropy refers to the existence of an element in different physical forms, such as diamond, graphite, and fullerness in the case of carbon. While allotropy affects the physical properties of carbon, it does not contribute to the large number of carbon compounds formed due to bonding properties.

9. Option (B) is correct

Explanation: When 1 mole of ethene undergoes an addition reaction to become a saturated compound, which in this case is ethane, it reacts with 1 mole of hydrogen (H_2). Therefore, the reaction would be $C_2H_4 + H_2 \longrightarrow C_2H_6$. On the other hand, ethyne (acetylene), which is C_2H_2, requires 2 moles of hydrogen to become saturated, so its reaction is $C_2H_2 + 2H_2 \longrightarrow C_2H_6$. Thus, the number of moles of hydrogen consumed is different for the two reactions, with ethene consuming 1 mole and ethyne consuming 2 moles. However, both reactions produce the same amount of the saturated compound ethane; hence, the number of moles of the saturated compound formed is the same. Therefore, the correct answer is that only the number of moles of hydrogen consumed will be different for the two reactions.

10. Option (A) is correct



Explanation: In an oxygen molecule (O_2), each oxygen atom has 6 valence electrons and requires 2 more electrons to complete its octet. To achieve this, the two oxygen atoms share two pairs of electrons, forming a double covalent bond. This double bond allows both oxygen atoms to have a stable octet configuration. Additionally, each oxygen atom retains two lone pairs of electrons (4 non-bonding electrons). The correct Lewis structure therefore shows a double bond between the oxygen atoms and two lone pairs on each atom, as depicted in option (A).

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (A) is correct.

Explanation: The assertion states that some vegetable oils are healthy, which is true because unsaturated fats found in vegetable oils are considered healthier than saturated fats due to their positive effects on heart health and cholesterol levels. The reason also supports this by explaining that vegetable oils generally have long unsaturated carbon chains, as they are composed of fatty acids with long chains of carbon atoms and a carboxyl group at one end. These chains often contain double bonds, making them unsaturated and contributing to their health benefits. Therefore, both the assertion and the reason are true, and the reason correctly explains the assertion.

2. Option (A) is correct

Explanation: The assertion that soaps do not form lather with hard water is true. This is because hard water contains dissolved salts of calcium and magnesium, which interfere with soap's ability to form foam. Instead of producing lather, soap reacts with these salts to form an insoluble precipitate called scum. Thus, both the assertion and the reason are true, and the reason is the correct explanation of assertion.

3. Option (B) is correct

Explanation: Ethyne, also known as acetylene, produces a high-temperature flame (approximately 3200°C) when burned in oxygen. This makes it suitable for cutting and welding metals.

Reason is true because ethyne is a member of the alkyne family, characterized by a carbon-to-carbon triple bond, but this fact about its unsaturation and triple bond does not explain why it is used for cutting and welding. The primary reason ethyne is used for welding is its high heat of combustion and not its molecular structrure.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i) The first two members of the homologous series having the functional group —Br are:
- CH_3Br (methyl bromide)
- C_2H_5Br (ethyl bromide)

(ii) (a) Aldehyde group
(b) Ketone group

(iii) (a) When 5% alkaline potassium permanganate is added drop by drop to warm ethanol, the purple colour of $KMnO_4$ is gradually decolorised. This indicates that ethanol is being oxidised.

$$CH_3CH_2OH + [O] \xrightarrow{\text{alkaline } KMnO_4} CH_3COOH + H_2O$$

$KMnO_4$ acts as an oxidising agent in the reaction, converting ethanol into acetic acid.

OR

(b) When ethanol is heated at 443 K with excess concentrated H_2SO_4, ethene is formed.

$$C_2H_5OH \xrightarrow{\text{Conc. } H_2SO_4,\ 443K} CH_2 = CH_2 + H_2O$$

Conc. H_2SO_4 acts as a dehydrating agent, removing water from ethanol to form ethene.

2. (i) Hydrocarbons are organic compounds that consist only of carbon and hydrogen atoms only. They can be classified as alkanes, alkenes, or alkynes, depending on the type of bonding

between carbon atoms. For example, methane (CH_4) and ethene (C_2H_4) are hydrocarbons.

(ii) The two properties of carbon by virtue of which it can form a large number of compounds:

1. **Catenation:** Carbon atoms can form long chains or rings by bonding with other carbon atoms.
2. **Tetravalency:** Carbon has a valency of four, allowing it to form stable covalent bonds with other elements like oxygen, hydrogen, nitrogen, sulphur, and chlorine.

(iii) 1. **Aldehydes:** Functional group is —CHO.

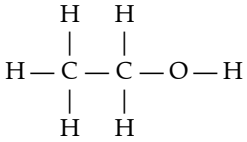
2. **Ketones:** Functional group is —C = O.

When ethanoic acid reacts with ethanol in the presence of an acid catalyst (like concentrated H_2SO_4), an ester is formed:

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{Conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$$

This reaction is called esterification.

3. (i) $CH_3—CH_2—OH$



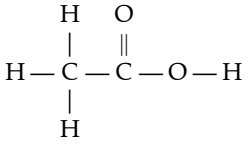
(ii) When ethanol burns in the presence of sufficient oxygen, it undergoes complete combustion to form Carbon dioxide (CO_2) and Water (H_2O).

(iii) (a) When 5% solution of alkaline potassium permanganate is added to warm ethanol, ethanol is oxidized to ethanoic acid (acetic acid) and the purple color of potassium permanganate is decolorised.

$$CH_3CH_2OH + [O] \xrightarrow{KMnO_4/\text{alkaline}} CH_3COOH + H_2O$$

Structure of the product (ethanoic acid):

$CH_3—C(=O)—OH$



Role of $KMnO_4$: Potassium permanganate acts as an oxidizing agent, supplying oxygen for the reaction.

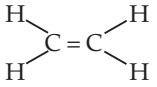
OR

(b) When ethanol is heated with excess conc. H_2SO_4 at 443 K, ethanol is dehydrated (loses water) to form ethene.

$$CH_3CH_2OH \xrightarrow{\text{Conc. } H_2SO_4,\ 443K} CH_2 = CH_2 + H_2O$$

Structure of the product (ethene):

$CH_2 = CH_2$



Role of Conc. H_2SO_4: Concentrated sulfuric acid acts as a dehydrating agent, removing water from ethanol to produce ethene.

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. A commercially important carbon compound having the functional group —OH is ethanol. Its molecular formula is C_2H_5OH.

2.

Saturated hydrocarbons	Unsaturated hydrocarbons
Burns in air with a clean, blue flame due to complete combustion.	Burns in air with a sooty, yellow flame. The soot is caused by incomplete combustion due to a higher carbon content.

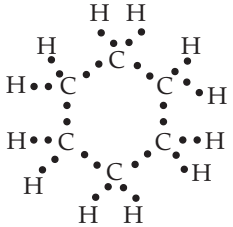
When a saturated hydrocarbon (alkanes) undergoes complete combustion, it produces Carbon dioxide (CO_2), Water (H_2O) and Energy (heat and light).

3. Carbon compounds generally have low melting and boiling points because they are covalent in nature, with weak intermolecular forces such as Van der Waal's forces, which require less energy to break. Additionally, carbon compounds are non-conductors of electricity because they lack free ions or electrons to carry charge, as covalent bonds involve the sharing of electrons, keeping them tightly bound.

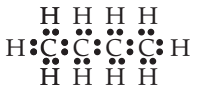
4. (i) CH_4

(ii) C_3H_8

5. (i)



(ii)



SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. The conversion of ethanol (C_2H_5OH) to ethanoic acid (CH_3COOH) is considered an oxidation reaction because the process involves the addition of oxygen to ethanol. The hydroxyl group (—OH) in ethanol is oxidized to a carboxylic group (—COOH). Alkaline potassium permanganate ($KMnO_4$) is used as the oxidizing agent for this reaction.

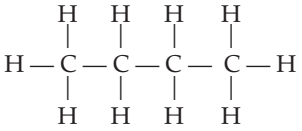
$$CH_3CH_2OH + 2[O] \xrightarrow{KMnO_4} CH_3COOH + H_2O$$

The reaction in which ethanol is converted to ethanoic acid is a controlled oxidation reaction that occurs in the presence of an oxidising agent such as potassium permanganate ($KMnO_4$), resulting in the formation of ethanoic acid (CH_3COOH). In contrast, when ethanol burns in the presence of oxygen, it undergoes complete combustion, producing carbon dioxide (CO_2) and water (H_2O) along with the release of energy as heat and light. The conversion to ethanoic acid is a mild reaction that changes the functional group, whereas combustion is an exothermic reaction that completely breaks down ethanol into simpler molecules. The former adds oxygen selectively to ethanol, while the latter completely oxidizes it.

2. (i) (I) Heteroatom is oxygen O

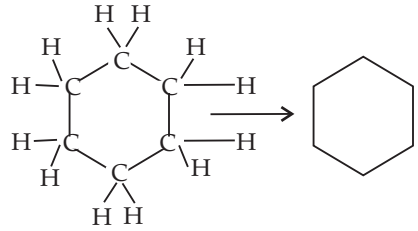
(II) Functional group is alcohol —OH.

(ii)

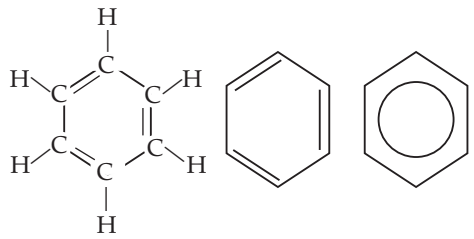


Butane (C_4H_{10}): $CH_3—CH_2—CH_2—CH_3$

(iii) (I)



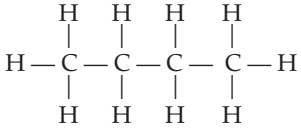
(II)



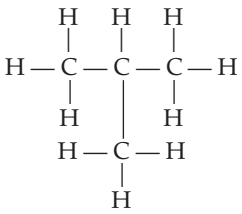
Benzene is unsaturated because it contains alternating double bonds within its ring structure.

3. Two different possible structures of a saturated hydrocarbon having four carbon atoms in its molecule are shown below:

(i) *n*-butane



(ii) Isobutane



These structures having same molecular formula and different structural formula are called isomers.

Molecular formula—C_4H_{10}

Common Name—Butane

Molecular formula of its alkyne—C_4H_6 [Butyne]

4. (i) Carbon compounds generally have low melting points and boiling points because the force of attraction between the molecules of carbon compounds is not very strong. These weak intermolecular forces make them very easy to pull apart from each other.

(ii) Carbon compounds are covalent in nature. Covalent compounds do not dissociate into ions in aqueous solution and also it does not have free electrons. Since there is no flow of charge, it is a poor conductor of electricity.

(iii) The most common type of bond formed by carbon is a covalent bond. In most cases, carbon shares electrons with other atoms. This is because carbon has 4 valence electrons and so to complete its octet configuration, either it need to gain 4 more electron or lose 4 electron.

5. (i) The organic compound 'X' is ethanol (C_2H_5OH)

(ii) Reaction of Ethanol with Sodium:

$$2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa^+ + H_2$$

$$C_2H_5OH \xrightarrow[443\ K]{\text{Conc. } H_2SO_4} CH_2 = CH_2 + H_2O$$

Role of Concentrated Sulphuric Acid: Concentrated sulphuric acid acts as a dehydrating agent in the second reaction, removing a water molecule from ethanol (C_2H_5OH) to facilitate the formation of ethene ($CH_2 = CH_2$).

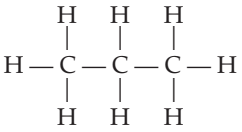
6. (i) Carbon compounds are exceptionally stable due to carbon's ability to form strong covalent bonds, its small atomic size, and its unique property of catenation (bonding with other carbon atoms). Additionally, the high bond energies of carbon-carbon and carbon-hydrogen bonds contribute to their stability.

(ii)

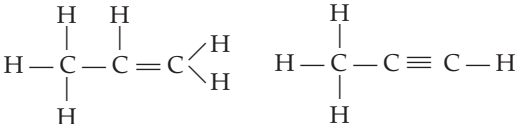
Saturated Organic Compounds	Unsaturated Organic Compounds
1. These organic compounds contain single carbon-carbon covalent bond (C – C).	These organic compounds contain at least one double (C = C) or triple covalent bond (C≡C).

2.	Due to the presence of all single covalent bonds, these compounds are less reactive.	Due to the presence of double and triple bonds, these compounds are more reactive.
3.	Saturated compounds undergo substitution reactions.	Unsaturated compounds undergo addition reactions.
	Example, $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ (Chloromethane)	Example, $C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2$ (Ethene, Dichloroethene)
4.	The number of hydrogen atom is more when compared to its corresponding unsaturated hydrocarbon.	The number of hydrogen atom is less when compared to its corresponding unsaturated hydrocarbon.

Structure of saturated hydrocarbon:

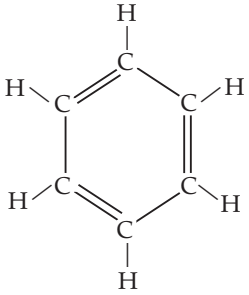


Structure of unsaturated hydrocarbon:



7. (i) Molecular formula of benzene—C_6H_6

Structure of benzene:



(ii) In the structure formula of benzene there are 3 double bonds and 9 single bonds present.

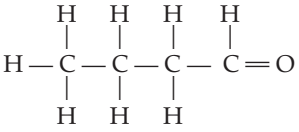
(iii) Organic compounds of carbon and hydrogen containing one or more triple bonds are called alkynes. Their general formula is C_nH_{2n-2}.

8. (A) Functional group: Aldehyde

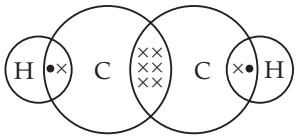
(B) General formula: $C_nH_{2n}O$

(C) It forms the part of the homologous series of the aldehydes as these compounds differ from each other by —CH_2 unit.

Structure of 4th member of this series is:



9. (i) **Electron Dot Structure of Ethyne**



(ii)

Property	Ionic Compounds	Covalent Compounds
Electrical Conductivity	Poor conductors in solid state, but conduct electricity in molten state or aqueous solutions.	Bad conductors of electricity.
Melting and Boiling Points	High melting and boiling points due to strong ionic bonds.	Relatively low melting and boiling points due to weaker intermolecular forces.

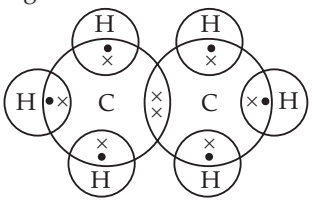
LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) Keerthi's thinking is correct. Substitution reactions occur in saturated hydrocarbons (alkanes) because they have single bonds between carbon atoms. In these reactions, one or more hydrogen atoms in the hydrocarbon are replaced by another atom or group of atoms, typically by halogens, through the process of substitution.

On the other hand, unsaturated hydrocarbons (alkenes and alkynes), which have double or triple bonds, generally undergo addition reactions rather than substitution reactions. In addition reactions, atoms or groups are added to the carbon atoms involved in the multiple bonds.

(ii) Methane (CH_4) and Propane (C_3H_8), along with their isomers, are used as fuels because combustion of these hydrocarbons produces carbon dioxide (CO_2), water (H_2O), and a large amount of heat energy, which makes them efficient fuels for cooking, heating, and industrial purposes.

The lower homologue of propane is ethane has the following electron dot structure:



Characteristics of Homologues of a Given Homologous Series:

(1) Homologues in a homologous series have the same functional group, giving them similar chemical properties.

(2) Each successive homologue in the series differs by a —CH_2 group in their molecular formula, leading to a gradual change in physical properties such as melting point, boiling point, and solubility.

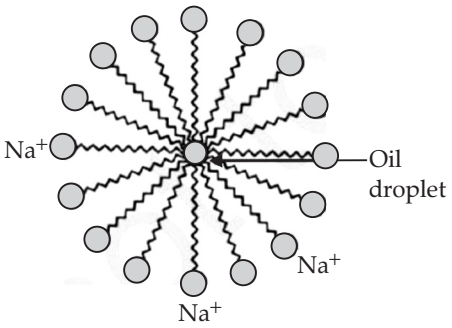
(iii) The mixture of ethyne and oxygen in sufficient amounts undergoes complete combustion to fire a clean blue flame. This oxygen-ethyne flame is extremely hot and generates a very high temperature, making it suitable for welding metals. In contrast, a mixture of ethyne and air is not used for welding because when ethyne burns in air, it undergoes incomplete combustion, resulting in a sooty flame. This flame is not hot enough to melt metals, making it unsuitable for welding purposes.

2. (i) 'B' (the sodium salt of a long-chain sulphonic acid) is preferred for cleansing action in the presence of hard water (which contains calcium and magnesium ions). This is because the calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions in underground water form insoluble salts with carboxylic acids (in soap, 'A'), leading to the formation of scum, which reduces its effectiveness.

However, the Ca^{2+} and Mg^{2+} salts of sulphonic acid (in detergent, 'B') are soluble in water, meaning that 'B' does not form scum and remains an effective cleansing agent even in hard water. Therefore, 'B' is more effective in the presence of calcium and magnesium salts.

(ii) Soaps are molecules with two distinct ends that have different properties. One end is hydrophilic (water-attracting) and dissolves in water, while the other end is hydrophobic (water- repelling) and dissolves in hydrocarbons or oils.

Soap molecules are sodium or potassium salts of long-chain carboxylic acids. The ionic end of the soap dissolves in water, while the hydrocarbon chain dissolves in oil. As a result, soap molecules form structures called micelles, where the hydrophobic ends surround the oil droplet and the ionic, hydrophilic ends face outward into the water. This creates an emulsion of oil in water. The formation of soap micelles enables the dirt and grease to be suspended in water, allowing them to be washed away, leaving clothes clean.



(iii) $CH_3COOCH_3 + NaOH \rightarrow CH_3COONa + CH_3OH$

This process is called saponification, where the ester reacts with sodium hydroxide (NaOH) to produce soap (sodium salt of carboxylic acid, CH_3COONa) and methanol (CH_3OH).

3. (i) A functional group is a specific group of atoms within a molecule that is responsible for the molecule's characteristic chemical reactions.

Functional Groups in the Given Compounds:

Compound (I): —C=O group (Ketone functional group).

Compound (II): —COOH group (carboxylic acid functional group).

(ii) Ethanol (C_2H_5OH) is oxidized to acetic acid (CH_3COOH) in the presence of acidified potassium dichromate ($K_2Cr_2O_7$).

$$C_2H_5OH + 2[O] \xrightarrow{K_2Cr_2O_7./H_2SO_4} CH_3COOH + H_2O$$

This reaction is considered an oxidation because ethanol (C_2H_5OH) loses hydrogen atoms and the oxygen atoms from the oxidizing agent are added to the alcohol molecule to form acetic acid.

(iii) $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

Ethanoic acid — Sodium hydroxide — Sodium ethanoate — Water

4. (i) Preparation of Soap: Soap is prepared through a process called saponification, which involves the hydrolysis of fats or oils (esters) with an alkali like sodium hydroxide (NaOH). When animal fat or vegetable oil (ester) is heated with a concentrated sodium hydroxide solution, the ester breaks down into soap and glycerol (an alcohol).

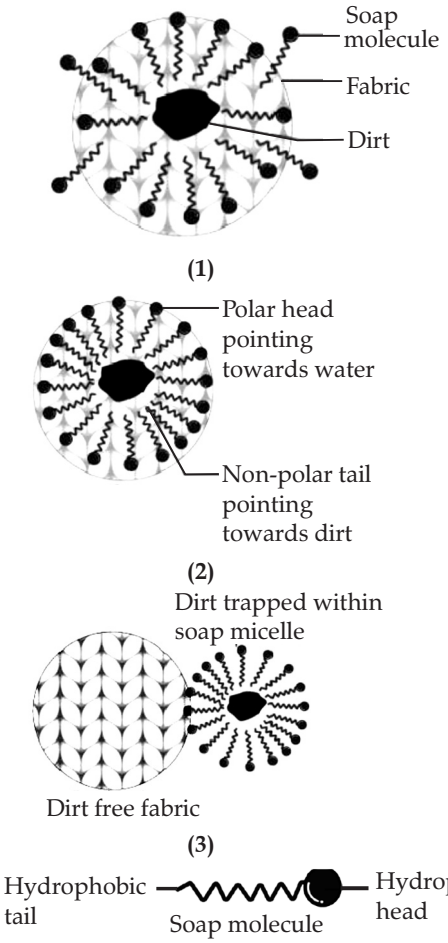
The chemical equation is as follows:

$$C_3H_5(OOCC_{17}H_{35})_3 + 3NaOH \rightarrow C_3H_5(OH)_3 + 3C_{17}H_{35}COONa^+$$

Esters of Fatty Acids — Sodium hydroxide — Glycerol — Sodium stearate

(ii) Cleansing action of Soaps: The cleansing action of soap works due to its unique molecular structure, with a hydrophilic (water-attracting) head and a hydrophobic (water-repelling) tail. When soap is added to water, the hydrophobic tails attach to the oily dirt, while the hydrophilic heads remain in the water. This creates spherical structures called micelles, where the dirt is trapped in the center. These micelles remain suspended in water as a colloidal solution,

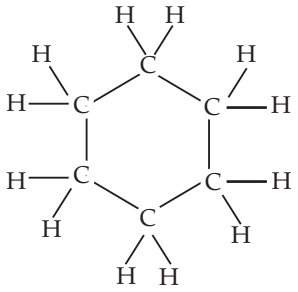
allowing the dirt and grease to be emulsified and washed away during rinsing. This mechanism helps soap effectively remove oily dirt from surfaces or clothes.



5. (i) Carbon has 4 electrons in its outermost shell and requires 4 more electrons to complete its octet. To form a C^{4+} cation, carbon would need to lose 4 electrons. However, removing 4 electrons requires a large amount of energy, making it energetically unfavourable. Whereas, to form a C^{4-} anion, carbon would need to gain 4 electrons. This would create strong repulsion among the electrons, and the nucleus cannot stabilize such a high negative charge. Instead, carbon forms covalent bonds by sharing electrons with other atoms, fulfilling the octet rule without gaining or losing electrons.

(ii) A homologous series is a group of organic compounds with the same general formula and similar chemical properties. Each successive member differs by a $—CH_2$ unit (methylene group). The molecular formula of any two consecutive members of homologous series of aldehydes are: $CH_3—CHO$ (ethanal) and $CH_3—CH_2—CHO$ (proponal).

(iii)



6. (i) Compound A is ethanol (C_2H_5OH).
Compound B is ethene (C_2H_4).
Compound C is ethane (C_2H_6).

(ii) $\underset{(A)}{C_2H_5OH} \xrightarrow[443\ K]{H_2SO_4} \underset{(B)}{C_2H_4} + H_2O$

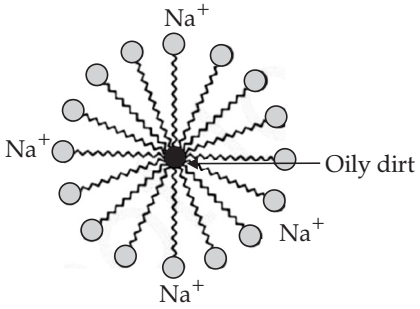
(iii) When ethane undergoes combustion, it reacts with oxygen to produce carbon dioxide, water, and heat.

$$2C_2H_6 + 7O_2 \longrightarrow 4CO_2 + 6H_2O + \text{heat}$$

(iv) One industrial application of the hydrogenation reaction is the conversion of unsaturated vegetable oils into saturated fats (vanaspati ghee). This is done by adding hydrogen (H_2) to the double bonds in the presence of a nickel (Ni) catalyst, turning the liquid oil into a semi-solid fat.

(v) When compound A (ethanol) reacts with sodium, the products formed are sodium ethoxide (C_2H_5ONa) and hydrogen gas (H_2).

7. (i) Soap has unique molecular structure with a hydrophobic part tail and a hydrophilic part head. When the soap comes in the contact with oily dirt, then hydrophobic tail attach to the oily dirt. This creates a spherical structure called micelles.



(ii) (1) In test tube Y more amount of foam will form, because detergents are better cleansing agent than soap. Detergents do not form insoluble calcium and magnesium salts with hard water.

(2) Curdy scum is formed in the test tube X because soap droplet forms insoluble precipitate of calcium and magnesium ion present in hard water.

8. X: The acid X is likely to be a carboxylic acid, such as acetic acid (CH_3COOH).

Y: The alcohol Y is likely to be a simple alcohol, such as ethanol (C_2H_5OH).

Z: The sweet-smelling substance Z is an ester, specifically ethyl ethanoate ($CH_3COOC_2H_5$).

Chemical Equation:

$$\underset{\text{Acetic acid}}{CH_3COOH} + \underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow[\text{heat}]{H^+} \underset{\text{Ethyl ethanoate}}{CH_3COOC_2H_5} + H_2O$$

X Y Z

The reaction is Esterification Reaction.

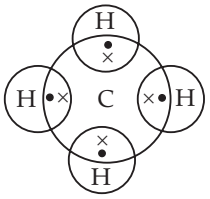
The substance Z, ethyl acetate, on treatment with sodium hydroxide (NaOH) produces the alcohol (Y) ethanol, and sodium ethanoate (CH_3COONa). This reaction is called as saponification reaction. The chemical equation for the reaction can be represented as:

$$\underset{Z}{CH_3COOC_2H_5} + NaOH \rightarrow \underset{Y}{C_2H_5OH} + \underset{\text{Sodium ethoxide}}{CH_3COONa}$$

The term "saponification" comes from the Latin word "sapo", which means soap. This is because the reaction is commonly used in the production of soap, where fats (which are esters) are hydrolyzed by a strong base (such as NaOH) to form soap and glycerol.

9. (i) The simplest saturated hydrocarbon is methane (CH_4).

Electron Dot Structure



Each hydrogen atom shares one electron with the carbon atom, forming covalent bond with single bond.

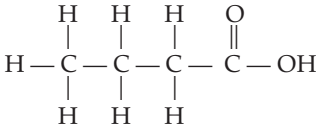
Type of bond: Covalent bond.

(ii) Natural Gas and CNG

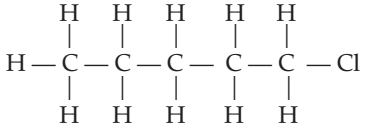
(iii) Methane belongs to the homologous series of alkanes. The general formula for alkanes is C_nH_{2n+2}, where n is the number of carbon atoms.

(iv) Methane burns with a clean blue flame. This indicates complete combustion, producing mainly carbon dioxide and water as it reacts efficiently with oxygen.

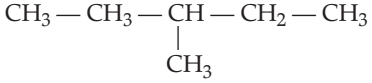
10. (i) (A) Butanoic acid



(B) Chloropentane



(ii) Structure (i) represents 2,3-dimethyl butane, while Structure (ii) corresponds to 2,2-dimethyl butane. Both are isomers of the compound with the chemical formula C_6H_{14}. Another isomer of this compound is 3-methylpentane, as shown below:



3-methyl pentane

(iii)

Saturated Carbon Compounds	Unsaturated Carbon Compounds
Saturated carbon compounds always follow the general formula C_nH_{2n+2}.	Unsaturated carbon compounds follow specific general formulae depending on the type of bond present. If there is a carbon-carbon double bond, they adhere to the formula C_nH_{2n}. If a carbon-carbon triple bond is present, the formula becomes C_nH_{2n-2}.

11. (i) Alcohols react with sodium leading to the formation of sodium ethoxide and evolution of hydrogen gas.

$$2Na + 2\,CH_3CH_2OH \longrightarrow \underset{\text{(Sodium ethoxide)}}{2CH_3CH_2O^-Na^+} + H_2\uparrow$$

(ii) 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.

(iii) Reaction to give unsaturated hydrocarbon: Heating ethanol at 443 K with excess concentrated sulphuric acid results in the dehydration of ethanol to give ethene—

$$\underset{}{CH_3—CH_2OH} \xrightarrow[443\ K]{\text{Hot Conc. } H_2SO_4} \underset{\text{Ethene}}{CH_2 = CH_2} + H_2O$$

The concentrated sulphuric acid can be regarded as a dehydrating agent which removes water from ethanol.

(iv) When treated with sodium hydroxide, which is an alkali, the ester is broken down into an alcohol and the sodium salt of a carboxylic acid. This reaction is called saponification as it is widely used in soap production. Soaps are essentially sodium or potassium salts of long-chain carboxylic acids. The reaction is as follows:

$$\underset{\text{Ethyl ethanoate (Ethyl acetate)}}{CH_3COOC_2H_5} + \underset{\text{Sodium hydroxide}}{NaOH} \xrightarrow{\text{heat}} \underset{\text{Sodium ethanoate (Sodium acetate)}}{CH_3COO^-Na^+} + \underset{\text{(Ethyl alcohol)}}{C_2H_5OH}$$

12. (i) **'X':** Ethanol (C_2H_5OH)

'Y': Ethanoic acid (CH_3COOH)

'Z': Ethyl ethanoate ($CH_3COOC_2H_5$)

(ii) (1) Conversion of 'X' (ethanol) to 'Y' (ethanoic acid):

$C_2H_5OH + [O] \xrightarrow{\text{acidified } K_2Cr_2O_7} CH_3COOH + H_2O$

(2) Formation of 'Z' (ethyl ethanoate) from 'X' and 'Y':

$C_2H_5OH + CH_3COOH \xrightarrow{\text{conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$

(iii) (1) Acidified potassium dichromate acts as an oxidizing agent, converting ethanol to ethanoic acid.

(2) Concentrated sulphuric acid acts as a dehydrating agent and a catalyst, promoting the esterification reaction between ethanol and ethanoic acid.

(iv) Saponification reaction.

13. (i) $C_2H_5OH \xrightarrow[443\,K]{\text{conc.}H_2SO_4} C_2H_4 + H_2O$

(ii) $H_2C = CH_2 \xrightarrow[Ni/Pd]{H_2} CH_3 - CH_3$

(iii) $C_2H_6 + Cl_2 \xrightarrow{\text{Sunlight}} C_2H_5Cl + HCl$

(iv) $CH_3CH_2OH \xrightarrow[\text{Acidified } K_2Cr_2O_7]{\text{Alkaline } KMnO_4} CH_3COOH$

(v) $CH_3COOH + C_2H_5OH \xrightarrow[\text{heat}]{\text{Acid}} CH_3COOC_2H_5 + H_2O$

14. (i) Since acid and base react to form salt and water, compound A will naturally be acidic due to the presence of a carboxylic acid group.

Chemical equation for acid and base reaction:

Acid + Base $\longrightarrow$ Salt + Water

$HX + M\,OH \longrightarrow MX + HOH$

$CH_3COOH(aq) + NaOH(aq) \longrightarrow CH_3COONa\,(aq) + H_2O$ (1)

Thus, Compound A is CH_3COOH (acetic acid). It is acidic in nature containing a carboxyl functional group.

(ii) (1) **Compound B:** C_2H_6O, identified as ethanol (CH_3CH_2OH).

Compound C: The sweet-smelling compound formed is ethyl acetate ($CH_3COOCH_2CH_3$).

(2) The acid (e.g., HCl) acts as a catalyst in the esterification process, facilitating the reaction between the carboxylic acid (A) and alcohol (B) to form the ester (C).

(3) $CH_3COOH + CH_3CH_2OH \xrightarrow{H^+} CH_3COOCH_2CH_3 + H_2O$

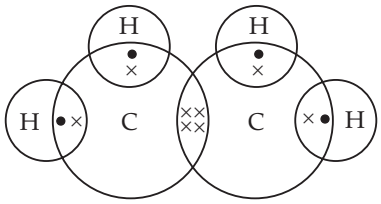
This is an example of Fischer esterification.

15. (i) **Compound Formed:** Ethene (C_2H_4) is formed when ethanol is heated at 443 K in the presence of concentrated H_2SO_4.

$C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4,\,443\,K} C_2H_4 + H_2O$

Role of H_2SO_4: Concentrated H_2SO_4 acts as a dehydrating agent as it removes a water molecule (H_2O) from ethanol, facilitating the formation of ethene.

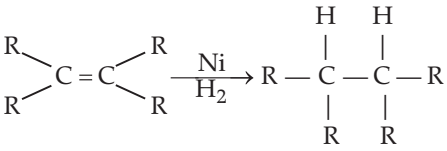
Electron dot structure of Ethene C_2H_4



(ii) Hydrogenation is the process of addition of hydrogen (H_2) to unsaturated compounds like alkenes or alkynes in the presence of a catalyst (such as nickel, palladium, or platinum).

$C_2H_4 + H_2 \xrightarrow{Ni} C_2H_6$

In this reaction, ethene (C_2H_4) reacts with hydrogen to form ethane (C_2H_6). This process converts the double bond in ethene into a single bond in ethane.



Industrial Applications:

- **Petrochemical Industry:** Hydrogenation is used to convert unsaturated hydrocarbons (alkenes and alkynes) into saturated hydrocarbons (alkanes like paraffin or cycloalkanes).
- **Food Industry:** Hydrogenation is used to convert vegetable oils (unsaturated fats) into solid or semi-solid fats, such as margarine and vanaspati (vegetable ghee).

16. A: Propionic acid (CH_3CH_2COOH) – a carboxylic acid, as it reacts with sodium and NaOH.

B: Sodium propanoate (CH_3CH_2COONa)—a sodium salt formed when A reacts with sodium or NaOH.

C: Ethanol (C_2H_5OH)—an alcohol

D: Ethyl propanoate ($CH_3CH_2COOC_2H_5$)—an ester formed when A reacts with C in the presence of concentrated H_2SO_4.

Chemical Reactions:

1. **Reaction of A (Propionic acid) with Sodium:**
   $CH_3CH_2COOH + 2Na \rightarrow CH_3CH_2COONa + H_2$
2. **Reaction of A (Propionic acid) with NaOH:**
   $CH_3CH_2COOH + NaOH \rightarrow CH_3CH_2COONa + H_2O$
3. **Esterification of A with C (Ethanol) to form D (Ethyl propanoate):**

   $CH_3CH_2COOH + C_2H_2OH \xrightarrow{\text{conc. } H_2SO_4} CH_3CH_2COOC_2H_5 + H_2O$
4. **Saponification of D (Ethyl propanoate) with NaOH:**

   $CH_3CH_2COOC_2H_5 + NaOH \rightarrow CH_3CH_2COONa + C_2H_2OH$

5 Life Processes

CHAPTER

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (D) is correct
Explanation: During the aerobic respiration of glucose in human cells, glucose is completely oxidised into carbon dioxide and water, and this process occurs in the mitochondria after glycolysis. This yields the maximum ATP per molecule of glucose, typically around 36-38 ATP molecules. In contrast, Ethanol and Carbon dioxide in yeast cells and Lactic acid in muscle cells are products of anaerobic form of respiration, which produces only 2 ATP per glucose molecule.

2. Option (B) is correct
Explanation: The left ventricle is responsible for pumping oxygenated blood into the aorta, which distributes it to all parts of the body through the systemic circulation. When the left ventricle contracts, it generates the pressure needed to force oxygen-rich blood into the aorta and then to the rest of the body. In contrast, the left atrium only receives oxygenated blood from the lungs via the pulmonary veins and pushes it into the left ventricle during its contraction. The right atrium and right ventricle handle deoxygenated blood. The right atrium receives deoxygenated blood from the body, and the right ventricle pumps it to the lungs via the pulmonary artery for oxygenation.

3. Option (C) is correct
Explanation: Stomata closes when the plant does not need carbon dioxide for photosynthesis (such as during the night or in conditions where photosynthesis is not active). This helps the plant conserve water.
Stomatal closure occurs when water flows out of the guard cells, causing them to become flaccid. This happens because of a decrease in turgor pressure in the guard cells.

4. Option (D) is correct
Explanation: Translocation is the process by which the soluble products of photosynthesis, such as sugars, are transported through the plant. This transport occurs primarily in the phloem tissue, from the leaves (where photosynthesis occurs) to other parts of the plant that need energy or storage.

5. Option (C) is correct
Explanation: (i) The right atrium receives deoxygenated blood from different parts of the body through the vena cava, not oxygenated blood from the lungs.
(ii) The left atrium transfers oxygenated blood to the left ventricle, which then sends it to various parts of the body.
(iii) The right atrium receives deoxygenated blood from different parts of the body through the vena cava.
(iv) The left atrium transfers oxygenated blood to the left ventricle, which then sends it to the aorta, and the aorta distributes it to different parts of the body.
Based on this information, statements (ii) and (iii) are true.

6. Option (B) is correct
Explanation: When a person breathes in (inhales), the ribs lift up and out due to the contraction of the intercostal muscles. This increases the volume of the chest cavity. The diaphragm also contracts and flattens, moving downward, which further increases the volume of the thoracic cavity and allows the lungs to expand and fill with air.

7. Option (B) is correct
Explanation: • Proteins are broken down into amino acids during digestion. The process begins in the stomach and continues in the small intestine with the help of enzymes like pepsin and trypsin.
- Carbohydrates are broken down into glucose (a type of sugar) through the action of enzymes like amylase, which starts in the mouth and continues in the small intestine.
- Fats are broken down into fatty acids and glycerol by enzymes called lipases, primarily in the small intestine.

8. Option (C) is correct
Explanation: The correct path of air takes during inhalation in the human respiratory system is as follows:

1. **Nostrils:** Air enters through the nostrils (or mouth), where it is filtered, warmed, and moistened.
2. **Pharynx:** The air then passes into the pharynx, which is the throat area that connects the nasal cavity to the larynx and esophagus.
3. **Larynx:** From the pharynx, the air passes into the larynx, also known as the voice box, which contains the vocal cords. The larynx also directs air toward the trachea.
4. **Trachea:** The air moves down the trachea (windpipe), which is a tube that leads to the lungs.
5. **Alveoli:** Finally, the air travels into the bronchi, then to smaller bronchioles, and eventually reaches the alveoli, where gas exchange occurs (oxygen enters the blood, and carbon dioxide is removed).

9. Option (B) is correct
Explanation: In plants, waste products like resins and gums are metabolic by-products that are often stored in parts of the plant where they do not interfere with vital processes. Old xylem serves as a storage site for these waste products because old xylem is no longer functional for water conduction, and storing waste products there prevents them from affecting the active tissues of the plant.

10. Option (D) is correct
Explanation: *Rhizopus* is a type of fungus that breaks down organic material outside its body through external digestion. The fungus releases digestive enzymes into the surrounding environment to break down food (e.g., decaying plant material). Once the food is broken down into simpler molecules, the fungus absorbs the nutrients. This process is characteristic of saprophytic organisms like *Rhizopus*.

11. Option (D) is correct.
Explanation: The villi of the small intestine primarily absorb nutrients such as amino acids, sugars, and fatty acids from the digested food. Water absorption largely occurs in the large intestine, not in the small intestine. The small intestine absorbs some water, but the majority of water absorption happens in the large intestine before waste is excreted from the body.

12. Option (B) is correct
Explanation: Sphincter muscles are present at the exit of stomach and anus. The role of sphincter muscles present at the exit of stomach is that it is responsible for regulating the opening of stomach into small intestine so that small quantities of food move to small intestine at a time. The anal sphincter controls the release of feces from the body.

13. Option (B) is correct
Explanation: Label IV corresponds to the guard cells surrounding the stomatal pore. These are the actual structures controlling gaseous exchange, as the stomata open and close based on the turgidity of the guard cells. Massive gaseous exchange for photosynthesis occurs primarily through the stomatal openings controlled by these guard cells.

14. Option (C) is correct
Explanation: During vigorous exercise, when the supply of oxygen to the muscles is insufficient to meet the energy demands, the cells switch to anaerobic respiration. In this process:
- Pyruvate (produced from glucose during glycolysis) is converted into lactic acid in the absence of sufficient oxygen.
- The accumulation of lactic acid in the muscles causes a drop in pH, leading to muscle fatigue and cramps.

15. Option (B) is correct
Explanation: The diagram shows water being absorbed from the roots and then transported upward through the plant, with water vapor being released from the leaves. This process is transpiration, which is the loss of water in the form of water vapor through stomata in the leaves. This process is crucial for maintaining water flow, delivering minerals to different parts of the plant, and cooling the plant.

16. Option (B) is correct.
Explanation: The opening and closing of stomata are controlled by the guard cells, which surround each stomatal pore. The process depends on the movement of water:
- When guard cells take in water (due to osmotic changes), they become turgid. This causes the stomatal pore to open.
- When guard cells lose water, they become flaccid, and the stomatal pore closes.

17. Option (B) is correct
Explanation: Transpiration is the process by which plants lose water in the form of water vapor from their aerial parts, mainly through small pores called stomata present on the leaves. This loss of water is important for temperature regulation as it helps in cooling down the plant's surface, similar to sweating in humans.

18. Option (B) is correct
Explanation: (1) Nucleus: The big dot visible inside the guard cell is the nucleus, which regulates cellular activities.
(2) Chloroplast: The green oval-shaped structures in the guard cells are chloroplasts, which allow guard cells to perform photosynthesis.
(3) Vacuole: The large central structure in the guard cell is the vacuole, responsible for storing water and helping in stomatal movement.
(4) Guard Cell: The entire bean-shaped cell is the guard cell, which surrounds the stomatal pore.

19 . Option (D) is correct
Explanation: The breakdown of glucose begin with glycolysis, which occurs in the cytoplasm of the cell. During glycolysis, one molecule of glucose ($C_6H_{12}O_6$) is broken down into two molecules of pyruvate (pyruvic acid, $C_3H_4O_3$). In both aerobic and anaerobic respiration, glycolysis is the common initial step. The end product of glycolysis is always pyruvate regardless of whether oxygen is present (aerobic) or absent (anaerobic).

20. Option (C) is correct
Explanation: During night time, photosynthesis stops because light is not available. However, plants continue to respire, and the CO_2 produced during respiration is released into the environment. As a result, the net release of CO_2 is higher during the night compared to the daytime.

21. Option (C) is correct
Explanation: The urine formed in nephron is collected through collecting ducts. These collecting ducts fuse to form minor calyces which are followed by major calyces. These major calyces join the kidney pelvis. Urine flows into ureters from kidney pelvis. Then the ureter transports urine into the urinary bladder. The urethra is a long tube which connects urinary bladder to the urinary meatus for removal of urine from the body. In males, urethra travels through the penis and meet the urethral meatus located at the tip of the penis. In females, urethra connects to the urethral meatus above the vagina. The urethra is also known as the urinary opening. So, the correct pathway or passage of urine is Collecting duct → Ureter → Bladder → Urethra.

22. Option (C) is correct
Explanation: The kidneys act as natural dialysis chambers in the human body. They play a crucial role in filtering waste products, excess ions, and water from the bloodstream to form urine. This process helps maintain the body's internal balance of fluids and electrolytes while removing metabolic waste and toxins from the body.

23. Option (B) is correct
Explanation: Capillaries are the smallest blood vessels in the body and are responsible for facilitating the exchange of gases, nutrients, and waste products between the blood and tissues. Their thin walls are indeed permeable to gases such as oxygen and carbon dioxide, allowing for the diffusion of these gases between the bloodstream and surrounding tissues. Therefore, option (B) is supported by the diagram, which likely depicts the intricate network of capillaries within the circulatory system.

24. Option (B) is correct.
Explanation: When gaseous exchange in the lung capillaries decreases, the immediate effect will be that pulmonary veins will receive blood with less oxygen. This is because less oxygen will be able to diffuse from the alveoli into the bloodstream. As a result, the blood returning to the heart via the pulmonary veins will have lower oxygen levels.

25. Option (C) is correct
Explanation: The pancreas secretes various digestive enzymes, including lipase, which is responsible for the digestion of fats. When the pancreas is malfunctioning, such as in the case of Mr. Ayub, the production and secretion of lipase may be impaired. As a result, the breakdown of dietary fats into smaller molecules for absorption in the small intestine will be compromised.

26. Option (A) is correct.
Explanation: The respiratory tract is lined with tiny hair-like structures called cilia, which play a crucial role in trapping dust particles, bacteria, and other harmful substances, preventing them from entering the lungs. Smoking damages and destroys these cilia, impairing their ability to clear mucus and debris from the airways effectively.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (A) is correct
Explanation: In the human heart, the ventricles have thicker muscular walls than the atria. This is true because the ventricles are responsible for pumping blood with significant force. The left ventricle pumps oxygenated blood to the entire body (systemic circulation), and the right ventricle pumps deoxygenated blood to the lungs (pulmonary circulation). So, they have thicker muscular walls to generate the force needed. Thus, both assertion and reason are true and reason is the correct explanation of assertion.

2. Option (C) is correct.
Explanation: Blood clotting prevents excessive loss of blood because it is a physiological process that helps prevent excessive loss of blood when blood vessels are injured. It involves the formation of a blood clot or thrombus to seal the wound and stop bleeding. Blood clotting is primarily due to the interaction of various components in the blood, particularly platelets and clotting factors, rather than blood plasma and white blood cells. Thus, assertion is true but reason is false.

3. Option (C) is correct
Explanation: The inner walls of the small intestine have finger-like projections called villi, which increase the surface area for efficient absorption of nutrients. These villi are richly supplied with blood vessels that transport absorbed nutrients to every cell of the body, where they are utilised for energy, tissue building, and repair. The large surface area provided by the villi is essential for the effective absorption of nutrients, which is the function of the villi in the small intestine. Hence, the function of villi is to increase the surface area for absorption of nutrients, not to complete the digestion of food.

4. Option (D) is correct
Explanation: The walls of the ventricles are thicker than those of the atria because the ventricles need to pump blood with higher force to various body organs. The atria, on the other hand, only need to pump blood to the adjacent ventricles, which requires much less force. Thus, assertion is false but reason is true.

5. Option (C) is correct.
Explanation: *Amoeba,* a unicellular organism, uses finger-like projections called pseudopodia to capture food particles. The pseudopodia extend from the cell surface, surround the food particle, and form a food vacuole inside the cell for digestion, making the assertion true. However, the reason is false because not all unicellular organisms take in food through the entire cell surface. For example, in *Paramecium*, food is taken in at a specific spot called the oral groove, and cilia help move food particles to this location. Therefore, the reason does not apply universally to all unicellular organisms. Thus, assertion is true but reason is false.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i) (1) The artery that brings oxygenated blood to the kidney is the renal artery.
(2) The cluster of thin-walled blood capillaries present in the Bowman's capsule is known as the glomerulus.
(ii) The organ which stores urine in the human excretory system is the urinary bladder. The urinary bladder is under nervous control. The process of urination is regulated by signals from the nervous system.
(iii) (a) Two major steps involved in the formation of urine include:
- **Filtration:** Occurs in the glomeruli of the kidneys, where blood plasma is filtered into the Bowman's capsule, removing waste but retaining essential substances.
- **Reabsorption and Secretion:** Takes place in the renal tubules, where necessary nutrients and water are reabsorbed back into the bloodstream, and additional wastes are secreted into the tubular fluid to form urine.

OR

(b) Selective reabsorption in the nephron occurs primarily in the tubular part of nephron, renal tubules, where substances like glucose, amino acids, salts, and a significant amount of water are reabsorbed from the initial filtrate. The amount of water reabsorbed depends on the body's excess water and the amount of dissolved waste to be excreted. Factors influencing the amount of water reabsorbed include the body's hydration levels and the concentration of waste substances in the blood, which need to be filtered out and excreted.

2. (i) The salivary glands are present in the buccal cavity. The secretion of these glands, saliva, contains the enzyme salivary amylase, which acts on starch and breaks it down into maltose (a simpler sugar).
(ii) The two organs with sphincter muscles at their exit are the stomach and anus.
(iii) (a) (1) If mucus is not secreted by the gastric glands, the stomach lining would be exposed to the acidic gastric juice containing hydrochloric acid and digestive enzymes like pepsin. This would lead to the erosion of the stomach lining, potentially causing ulcers and damage to the stomach wall.
(2) If villi are absent in the small intestine, the surface area for nutrient absorption would be drastically reduced. This would result in poor absorption of nutrients into the bloodstream, leading to malnutrition and other health issues.

OR

(b) Bile juice, produced by the liver, does not contain any digestive enzymes. However, it plays a crucial role in digestion by:
1. **Emulsifying fats:** Bile breaks down large fat globules into smaller droplets, increasing the surface area for the enzyme lipase to act upon.
2. **Neutralising acidity:** Bile is alkaline and helps neutralise the acidic chyme (partially digested food) coming from the stomach, creating an optimal pH for enzymes in the small intestine to function efficiently.

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. The steps for the synthesis of glucose by the plants are:
Step 1: Absorption of light energy by chlorophyll.
Step 2: Conversion of light energy to chemical energy and splitting of water.
Step 3: Reduction of carbon dioxide into carbohydrates.
Special feature of Desert Plants: In desert plants, the stomata open during the night to reduce water loss, allowing carbon dioxide to be absorbed and stored as organic acids. During the day, when the stomata are closed to conserve water, the stored carbon dioxide is released and used in photosynthesis.

2. (i) Salivary amylase: Breaks down starch which is a complex molecule into simpler sugar like maltose.
(ii) Pepsin: Helps to digest proteins in stomach.

(iii) Trypsin: It helps in digesting proteins to amino acids.

(iv) Lipase: Breaking down of emulsified fats to fatty acids and glycerol, enabling fat digestion and absorption.

3.

S. No.	Feature	Alveoli	Nephron
1.	Structure and Location	Tiny sac or balloon like structure located in the lungs at the end of bronchioles.	Nephron Tubular structures located in kidneys.
2.	Function	Responsible for gas exchange (oxygen and carbon dioxide) between the air and blood.	Responsible for filtering blood to form urine and remove waste product.

4. The process involved in transporting food prepared by photosynthesis to other parts of the plant is called translocation. It occurs in the phloem and involves the movement of sugars (mainly sucrose) from the leaves (source) to storage organs or growing parts (sinks). The process is driven by pressure flow, where sugars are actively loaded into the phloem, causing water to enter by osmosis. This creates high pressure, pushing the sugar solution to the sink, where it is utilised or stored.

5. *Amoeba* exhibits holozoic nutrition, where it engulfs food particles using finger-like projections called pseudopodia through phagocytosis, forming a food vacuole. Inside the vacuole, digestive enzymes break down complex food into simpler substances, which are absorbed into the cytoplasm for energy and growth. The undigested material is expelled out of the cell by exocytosis.

6. Athletes sometimes suffer from muscle cramps while running due to the accumulation of lactic acid in their muscles. This happens when the oxygen supply to the muscles is insufficient, forcing them to switch from aerobic respiration to anaerobic respiration for energy production.

In aerobic respiration, glucose is completely broken down in the presence of oxygen, producing carbon dioxide, water, and a large amount of energy. However, in anaerobic respiration, glucose is only partially broken down, resulting in the formation of lactic acid and a smaller amount of energy. The buildup of lactic acid in the muscles causes pain and cramps.

7. The other name for lymph is tissue fluid or interstitial fluid.

Functions of Lymph:

(i) It carries digested and absorbed fats from the intestine to the bloodstream.

(ii) It drains excess fluid from the extracellular spaces back into the blood.

8. The pathway of urine in our body starting from the organ of its formation to its excretion is

Kidney → Ureters → Urinary bladder → Urethra.

If the tubular part of the nephron does not work properly, the following issues can occur:

(i) Reduced Filtration: Impaired tubular function can decrease the filtration of waste products, leading to the accumulation of toxins in the body.

(ii) Electrolyte Imbalance: Tubules play a crucial role in maintaining electrolyte balance; malfunction can cause disruptions in levels of sodium, potassium, and other ions.

9. (i) Vena Cava:

Type of Blood: Deoxygenated

Path: From the body (various organs and tissues) to the right atrium of the heart.

(ii) Pulmonary Artery:

Type of Blood: Deoxygenated

Path: From the right ventricle of the heart to the lungs for oxygenation.

10. (i)

$$\text{Glucose (6-Carbon Molecule)} \xrightarrow[\text{Cytoplasm}]{\text{In}} \text{Pyruvate (3-Carbon Molecule)} + \text{Energy} \longrightarrow$$

$$\xrightarrow[\text{(in Mitochondria)}]{\text{Presence of Oxygen}} \text{Carbon Dioxide + Water + Energy}$$

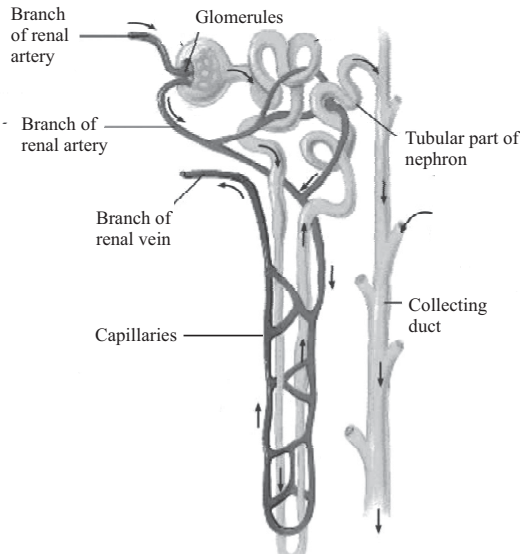
(ii)

$$\text{Glucose (6-Carbon Molecule)} \xrightarrow[\text{Cytoplasm}]{\text{In}} \text{Pyruvate (3-Carbon Molecule)} + \boxed{\text{Energy}} \longrightarrow$$

$$\xrightarrow[\text{(in our Muscle Cells)}]{\text{Lack of Oxygen}} \text{Lactic acid + Energy (3-Carbon Molecule)}$$

11. The part of the human excretory system where nephrons are found are Kidneys.

Structure of Nephron: Nephron is the basic filtration unit in the kidney. It consists of a tubule which is connected with a collecting duct at one end and a cup shaped structure at the other end, called Bowman's capsule. Every Bowman's capsule contains a cluster of capillaries called glomerulus within the cup-shaped structure.



Function of Nephron: The blood enters into glomerulus through afferent arteriole of renal artery and leaves it through efferent arteriole. This causes filtration of the blood. Then the filtrate passes into the tubular part of the nephron. Here, useful substances such as glucose, amino acids, salts and some water are re-absorbed into the blood by the capillaries surrounding the nephron tubule. The filtrate which remains after the re-absorption is called the urine, which is collected from nephron by the collecting duct to carry it to the urinary bladder and then to the urethra.

12. (i) Birds and mammals are warm-blooded animals that can maintain a stable body temperature despite changes in the external environment. To do so, they need a higher energy output from cellular respiration, which requires more oxygen. The separation of oxygenated and deoxygenated blood in these animals is crucial for ensuring efficient oxygen delivery to tissues. This separation helps maintain a high metabolic rate, which is essential for regulating body temperature in varying climatic conditions.

(ii) Animals like amphibians (e.g., frogs) and reptiles (e.g., lizards) can tolerate some mixing of oxygenated and deoxygenated blood streams due to their three-chambered heart. The body temperature of these animals is dependent on the environment, as they are cold-blooded (ectothermic) animals. Their body temperature changes with external environmental conditions, as they lack internal mechanisms to regulate it. These animals often rely on behaviors like basking in the sun to warm up or seeking shade to cool down.

13. (i) Renal Artery: It brings the blood containing nitrogenous waste into the kidney.

(ii) Urethra: Urine can pass through this tube and leave the body.

(iii) Glomerulus: The glomerulus is a network of capillaries in the kidney where blood filtration occurs.

(iv) Tubular part of nephron: Selective reabsorption of useful materials. The necessary salts and water content from the filtered blood are absorbed and reabsorbed with its assistance. As a result, they preserve the blood's osmolarity.

14. The plant kept in the dark could not survive for long because it could not perform photosynthesis, which requires sunlight to produce glucose (food) and oxygen. Without sunlight, the plant was unable to generate its own food and oxygen, relying on the energy stored in its reserves. However, without photosynthesis, the plant could not replenish these reserves, leading to energy depletion. In contrast, the plant in sunlight continued to photosynthesise, producing both food and oxygen, which sustained its energy needs and survival.

15. The three events that occur during the process of photosynthesis are:

(i) Absorption of light energy by chlorophyll.

(ii) Conversion of light energy to chemical energy and splitting of water molecules into hydrogen and oxygen.

(iii) Reduction of carbon dioxide to carbohydrates.

16. Leaves help in excretion through two primary mechanisms:

(i) Transpiration: Leaves release water vapor into the atmosphere through tiny openings called stomata. This process not only helps in regulating water balance but also aids in the removal of some waste products. For example, excess salts and other small metabolic by-products can be expelled from the plant through transpiration.

(ii) Gaseous Exchange (Respiration): During respiration, plants release carbon dioxide (CO_2) as a waste product. This is excreted through small pores called stomata on the leaf surface.

17. In the human digestive system, the enzymes pepsin and trypsin are secreted by the stomach and pancreas respectively.

18. The enzyme present in the fluid in our mouth is salivary amylase.

Salivary amylase is produced by the salivary glands. If the salivary glands stops secreting salivary amylase, the digestion of starch in the mouth would be impaired. Salivary amylase breaks down starch into simpler sugars like maltose. Without this enzyme, starch would not be broken down efficiently in the mouth, leading to slower or incomplete digestion of starch.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. (i) Variegated leaves are leaves that have both green and non-green (white or yellow) parts. The green parts contain chlorophyll, while the non-green parts do not. Example: *Croton* or Money Plant.

(ii) When a leaf is boiled in alcohol, the leaf loses its green colour and becomes pale or colourless because alcohol removes chlorophyll. On the other hand, the solution turns green as the chlorophyll dissolves in the alcohol.

(iii) Carbohydrates produced during photosynthesis are stored in the plant as starch. Chlorophyll is necessary for photosynthesis because it absorbs sunlight, which provides the energy needed to convert carbon dioxide and water into glucose during the process. Without chlorophyll, photosynthesis cannot occur.

2. The process that allows water to reach the topmost leaves of a plant is called ascent of sap, which occurs through transpiration pull and involves the following steps:

(i) Absorption by roots: Water is absorbed by root hairs from the soil through osmosis and enters the xylem vessels in the roots.

(ii) Transportation through xylem: The water moves upward through the xylem vessels due to transpiration pull, capillary action, and root pressure.

(iii) Transpiration pull: Water evaporates from the stomata in the leaves during transpiration. This creates a suction force (transpiration pull) that draws water up from the roots to the leaves.

(iv) Cohesion and adhesion: The cohesion (water molecules sticking together) and adhesion (water molecules sticking to xylem walls) help maintain the continuous column of water as it travels upward.

3. (i) The alveoli in the lungs are responsible for gas exchange, primarily oxygen and carbon dioxide, between the air and blood. They are surrounded by a rich network of blood capillaries to ensure efficient gas exchange. Oxygen inhaled into the alveoli diffuses into the blood through these capillaries, while carbon dioxide produced during cellular respiration diffuses from the blood into the alveoli for exhalation. The close proximity of capillaries to the alveoli allows for quick and efficient exchange of gases, facilitating oxygen absorption and carbon dioxide removal.

(ii) The respiratory pigment haemoglobin in the blood has a high affinity for oxygen because of its ability to form an oxygen-haemoglobin complex in the presence of high oxygen concentration in the lungs. Haemoglobin carries oxygen efficiently to body tissues. Carbon dioxide is primarily transported in the blood as bicarbonate ions or dissolved in plasma, with only a small amount binding to haemoglobin.

(iii) During anaerobic respiration in human beings, lactic acid (a 3-carbon molecule) is formed as the end product instead of CO_2. This happens because, in the absence of oxygen, glucose is only partially broken down to generate energy. The process does not involve the complete breakdown of glucose into carbon dioxide, as in aerobic respiration.

4. (i) The movement that occurs all along the gut in the human digestive system is called peristalsis. It helps in digestion by:

(a) Pushing food along the digestive tract from the oesphagus to the stomach, intestines, and eventually the anus.

(b) Mixing food with digestive juices in the stomach and intestines, aiding in the breakdown of food into smaller molecules for absorption.

(c) Facilitating the absorption of nutrients by keeping the food in contact with the intestinal walls.

(ii) Bile juice is stored in the gall bladder in the human body.

Two roles of bile juice:

(a) Bile juice emulsifies fat and breaks down large fat globules into smaller droplets, increasing the surface area for the enzyme lipase to act upon, aiding in fat digestion.

(b) Bile is alkaline and helps neutralise the acidic food coming from the stomach, creating an optimal pH for enzymes in the small intestine to function efficiently.

5. (i) ATP serves as the main energy currency in cellular respiration, storing and transferring energy for various cellular activities. Adenosine Triphosphate (ATP) plays a crucial role in the process of cellular respiration, which is the process by which cells generate energy.

(ii) Plants take in oxygen through stomata, which are tiny pores on their leaves that regulate gas exchange with the atmosphere. To optimise oxygen intake, plants adjust the size and number of stomata based on environmental conditions like light, temperature, and humidity. Additionally, plants use their root systems to absorb oxygen from the soil and have symbiotic relationships with soil microorganisms to help absorb and fix atmospheric nitrogen. Oxygen intake is essential for plant respiration, which releases energy from stored sugars to support growth and metabolism. Overall, plants have evolved various adaptive mechanisms to ensure adequate oxygen intake for their survival and metabolic processes.

(iii) The direction of gas diffusion in plants depends on the concentration gradient of the gases:

Concentration Gradient: Gases move from areas of higher concentration to lower concentration. For example, CO_2 diffuses into the leaf when its concentration is higher outside, and O_2 diffuses out when its concentration is higher inside.

Stomatal Opening: The opening and closing of stomata, regulated by factors like light and humidity, influence gas exchange. Open stomata allow gases to diffuse based on the concentration gradients.

6. (i) The carbohydrates like starch (in plants) and glycogen (in animals) serve as the internal energy reserve because they are polymer of glucose and their hydrolysis provide glucose molecules to provide energy at the time of need.

(ii) Desert plants perform photosynthesis using a special process called CAM photosynthesis. They keep their stomata closed during the day to prevent water loss and open them at night to take in carbon dioxide (CO_2). The CO_2 is stored in the form of acids. During the day, when sunlight is available, the stored CO_2 is released inside the plant and used for photosynthesis. This helps desert plants conserve water while still making their food.

7. (i) Glycolysis is the initial step in the breakdown of glucose in animal cells. It takes place in the cytoplasm of cells. After glycolysis, pyruvic acid enters into mitochondria and cycles through Krebs cycle.

(ii) ATP is the energy currency of the cell because it donates its phosphoryl groups to release energy, which is used for various cellular processes. Upon hydrolysis, ATP releases a high amount

of negative Gibbs free energy, driving important biosynthetic reactions in metabolic pathways.
The adenine and ribosyl groups in ATP enable it to attach to enzymes, regulating their activities and facilitating various biochemical processes.

(iii) The residual volume of air in a breathing cycle is the amount of air that remains in the lungs after maximum exhalation. It prevents lung collapse and ensures continuous gas exchange between breathes.

8. ● Take a healthy potted plant with variegated leaves (leaves that are partly green and partly white).
- Ensure the plant is kept in darkness for 24-48 hours to de-starch the leaves.
- Select a leaf from the plant and cover a part of it with black paper or aluminium foil, ensuring no sunlight reaches that part.
- Place the plant in sunlight for several hours to allow photosynthesis to occur in the exposed parts of the leaf.
- After sufficient exposure, pluck the covered leaf from the plant.
- Boil the leaf in water for a few minutes to kill it.
- Immerse the leaf in alcohol (using a water bath) to remove the chlorophyll, making it pale or white.
- Rinse the leaf in warm water to soften it.
- Place the leaf in an iodine solution.
- Areas that turn blue-black indicate the presence of starch, while areas without a colour change indicate the absence of starch.

9. (i) *Paramecium* is a single-celled protozoan. The hair-like structures called cilia present on the *paramecium* help in collecting the food and movement. They sweep the food inside the *paramecium* through the oral groove.

(ii) **(a) Hydrochloric acid:** The hydrochloric acid (HCl) present in the stomach creates an acidic pH which is required to activate the enzyme pepsin from its inactive form pepsinogen. It also plays a role in killing any germs that may have entered the alimentary canal.

(b) Trypsin: Trypsin is an enzyme secreted by the pancreas into the small intestine. It helps to digest proteins by breaking them down into smaller peptides and amino acids.

(c) Muscular walls of stomach: The muscles of the stomach wall contract periodically and thereby help in the churning and mixing of food with the digestive enzymes and HCl acid. It pushes food forward by peristalsis. It helps in chemical digestion.

(d) Salivary amylase: Salivary amylase is an enzyme secreted by the salivary glands. It breaks down starch into smaller sugar molecules such as maltose.

10. (i) A mechanism in which blood circulates twice through the heart in one complete cycle is known as double circulation. Systemic circulation and pulmonary circulation are two pathways in which the blood flows in double circulation. Double circulation is present in birds and mammals.

(ii) The separation of the right and left sides of the human heart is crucial for maintaining efficient circulation and oxygenation of blood. This separation is achieved by a muscular wall called the septum, which divides the heart into two halves. The separation prevents oxygenated and deoxygenated blood from mixing allowing a highly efficient supply of oxygen to the body. This is useful in animals that have high energy needs (birds and mammals) which constantly use energy to maintain their body temperature.

11. (i) **Experiment:**
1. Take a boiled potato and mash it. Separate the mashed potato into three equal parts and place each part into test tubes A, B, and C.
2. In test tube A, add a few drops of iodine solution.
3. In test tube B, first add a few drops of iodine solution and then introduce saliva into the tube.
4. In test tube C, keep the mashed potato without adding any iodine or saliva as a control set.
5. Observe the changes in the test tubes.

Observation:
1. Test tube A: The iodine solution turns blue in color, indicating the presence of starch.
2. Test tube B: After adding saliva, the blue color starts to fade. This happens because the starch in the boiled potato is being broken down into simpler sugars, such as maltose, by the action of the enzyme salivary amylase present in saliva.
3. Test tube C: No color change is observed since no iodine or saliva is added, and no reaction occurs.

Inference: The reduction in blue color in test tube B shows that salivary amylase in saliva breaks down starch into simpler sugars, like maltose, during the digestion process. This demonstrates the role of saliva in the initial breakdown of starch in the mouth.

(ii) Bile is the digestive juice secreted by the liver. Although it does not contain any digestive enzymes, it plays an important role in the digestion of fats. Bile juice has bile pigments such as bilirubin and biliverdin. These pigments break down large fat globules into smaller globules so that the pancreatic enzymes can easily act on

them. The process is known as emulsification of fats. Bile juice also makes the medium alkaline due to the presence of $NaHCO_3$ and also activates lipase.

12. Humans have a type of circulation called double circulation, where the heart receives blood twice to complete one full round of circulation. This process involves two separate circuits: the pulmonary circuit and the systemic circuit.

(i) Pulmonary Circuit: This involves the circulation of blood between the heart and the lungs.

(ii) Systemic Circuit: This involves the circulation of blood between the heart and the rest of the body.

Process of Blood Circulation:

(i) Deoxygenated blood from the body cells is carried by the veins to the heart.

(ii) The right atrium (auricle) receives the deoxygenated blood and pumps it through the tricuspid valve into the right ventricle.

(iii) From the right ventricle, the blood is pumped through the pulmonary artery to the lungs, where it gets oxygenated.

(iv) Oxygenated blood returns from the lungs through the pulmonary veins to the left atrium.

(v) The left atrium pumps the oxygenated blood through the mitral valve into the left ventricle.

(vi) The aorta, originating from the left ventricle, carries the oxygenated blood to all parts of the body through the systemic circuit.

This double circulation ensures that oxygenated and deoxygenated blood are kept separate, allowing for efficient oxygen delivery to tissues and removal of carbon dioxide.

13. Photosynthesis is a process in which sunlight is used to convert carbon dioxide and water into glucose (food) and oxygen.

- The chloroplast is the organelle and the organs in which photosynthesis take place is the leaves of the plant.
- The oxygen liberated come from splitting or hydrolysis of water in the chloroplasts.
- Carbohydrates produced during photosynthesis are often stored as starch in in various parts of the plant, such as the roots, stems, or leaves.

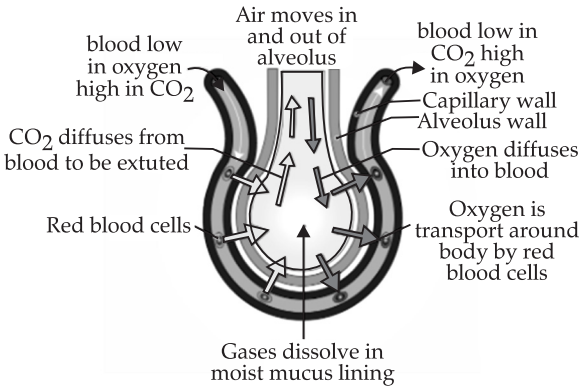
14. (i) The tiny sacs found in the lungs, which exchange carbon dioxide and oxygen are known as **alveoli**.

Structure of alveoli:

1. Alveoli are small, balloon-like structures that resemble clusters of grapes.
2. They are the smallest components of the respiratory system.
3. The alignment of alveoli takes place in the, to maximize the surface are for gas exchange.
4. They are positioned at the ends of the bronchial branches (the bronchioles), forming the last part of the respiratory tree.
5. The walls of the alveoli are extremely thin, composed of a single layer of epithelial cells, facilitating efficient gas exchange between the air and the blood.

Functions:

1. The alveoli are the sites where the exchange of gases (oxygen and carbon dioxide) takes place during breathing. Oxygen moves from the alveoli into the blood, and carbon dioxide moves from the blood into the alveoli to be exhaled.
2. The oxygen inhaled passes through the alveolar walls and into the bloodstream, where it is then transported by red blood cells to tissues throughout the body.
3. Carbon dioxide, a waste product from metabolism in the body, diffuses from the blood into the alveoli, where it is expelled from the body during exhalation.



(ii) Residual volume (RV) is the volume of air remaining in the lungs after maximum forceful expiration. In other words, it is the volume of air that cannot be expelled from the lungs, thus causing the alveoli to remain open at all times.

15. The two ways by which plants obtain carbon dioxide are as follows:

(i) Diffusion through Stomata: Carbon dioxide from the atmosphere diffuses into the leaves of plants through small openings called stomata. These stomata are primarily found on the underside of leaves and allow gases to pass in and out of the leaf tissue.

(ii) Diffusion through the Leaf Surface: While stomata are the main entry point for carbon dioxide, some carbon dioxide can also diffuse directly through the leaf surface. This is especially true for aquatic plants or plants with thin leaves, where the surface area can also allow for some gas exchange.

The opening and closing of the guard cells is caused by a change in their turgidity. The inner walls of the guard cells are thick and elastic, while the outer walls are thin.

At the time of the opening of the stomata, the turgidity of the guard cells increases. As a

result, the outer walls bulge and the inner walls become crescent-shaped. The stomatal opening is facilitated by the radial arrangement of the microfibrils.

At the time of the closing of the stomata, the guard cells lose their turgidity, the outer and inner walls retain their original shapes, and the microfibrils get arranged longitudinally.

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. Aim: To show that carbon dioxide (CO_2) is necessary for photosynthesis.

Procedure:

- Take a potted plant and keep it in complete darkness for 24 hours to deplete its starch reserves.
- Insert one of the leaves into a conical flask containing potassium hydroxide (KOH) solution, which absorbs carbon dioxide from the air inside the flask.
- Seal the mouth of the flask with a cork split to allow only the leaf to stay inside the flask while the rest of the leaf remains outside.
- Cover the plant with a transparent polythene bag and seal it to prevent the entry of additional CO_2 from the surroundings.
- Allow another leaf from the same plant to remain outside the flask, exposed to normal air with carbon dioxide.
- Place the plant in sunlight for 4-6 hours. After exposure, pluck both leaves and boil them in alcohol to remove chlorophyll. Rinse them in water and test for the presence of starch by adding iodine solution.

Observations: The leaf that was exposed to normal air (control) turns blue-black when iodine is applied, indicating the presence of starch.

The leaf inside the KOH flask does not turn blue-black and remains pale brown, indicating the absence of starch.

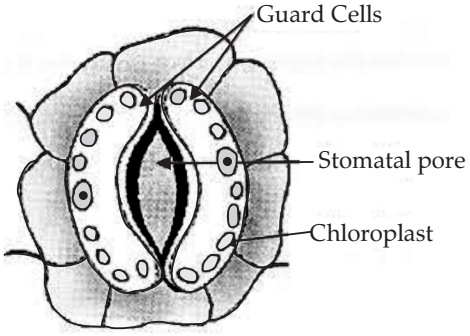
Conclusion: The leaf inside the conical flask with KOH does not photosynthesise because the carbon dioxide was absorbed by KOH. The control leaf turns blue-black, showing starch formation due to photosynthesis. This experiment proves that carbon dioxide is essential for photosynthesis.

2. (i) In diagram (I), atmospheric air contains a lower concentration of carbon dioxide (approximately 0.04%).

In diagram (II), exhaled air contains a higher concentration of carbon dioxide (approximately 4%).

Due to the higher concentration of CO_2 in exhaled air, the lime water in diagram (II) turns milky faster than in diagram (I).

(ii)



Two functions performed by stomata:

1. **Gas exchange:** Stomata allow the exchange of gases-oxygen and carbon dioxide between the plant and the atmosphere for photosynthesis and respiration.
2. **Transpiration:** Stomata facilitates the loss of water vapour from the plant, helping in the cooling of the plant and the uptake of nutrients.

3. (i) The parts of the alimentary canal and their enzymes are:

A (Mouth/Oral cavity): Contains the enzyme salivary amylase (or ptyalin) which begins the digestion of starch into maltose.

B (Stomach): Contains the enzyme pepsin which breaks down proteins into peptides, and gastric lipase, which helps digest fats.

C (Pancreas) : The pancreatic juice has three pro-enzymes, i.e., trypsinogen, chymotrypsinogen, and procarboxypeptidase. These help in the digestion of starch, protein, fats, and nucleic acid.

(ii) The digested food is absorbed by the walls of the small intestine. The inner lining of the small intestine has numerous villi, which are finger-like projections that increase the surface area for absorption. The villi are richly supplied with blood vessels that transport the absorbed nutrients such as glucose, amino acids, fatty acids, and glycerol to every cell of the body via the bloodstream. These nutrients are utilised by the cells for obtaining energy, building new tissues, and repairing old tissues. This process ensures that the absorbed food is effectively distributed and used by the body for its various functions.

4. (i) **A:** Pulmonary artery

Function: Carries deoxygenated blood from the right ventricle to the lungs for oxygenation.

B: Aorta

Function: Carries oxygenated blood from the left ventricle to various parts of the body.

C: Capillaries in body organs

Function: Helps in material exchange such as gases, food etc. between blood and tissues.

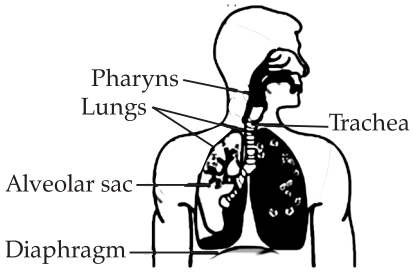
(ii) The separation of the right and left side of the heart is useful for birds as it prevents the mixing of oxygenated and deoxygenated blood, ensuring a highly efficient supply of oxygen to the body. This is crucial for birds, as they have high energy needs to support activities like flying and maintaining their constant body temperature (warm-blooded nature). The efficient oxygen supply enables birds to meet their high metabolic demands. Unlike reptiles and amphibians with three-chambered hearts (which tolerate some

mixing of blood), birds have a fully separated four-chambered heart, which supports double circulation, making their circulatory system highly effective.

5. (i) The difference in the rate of breathing between aquatic and terrestrial organisms arises because the amount of dissolved oxygen in water is much lower compared to the oxygen available in the air. Aquatic organisms, such as fish, need to breathe at a much faster rate to extract sufficient oxygen from the water. Fishes take in water through their mouths and force it over their gills, where the dissolved oxygen is absorbed by the blood.

On the other hand, terrestrial organisms breathe air, which contains a much higher concentration of oxygen. They use specialised respiratory organs with large surface areas, such as lungs, to efficiently exchange oxygen and carbon dioxide. Since, oxygen is readily available in the air, terrestrial organisms do not need to breathe as rapidly as aquatic organisms.

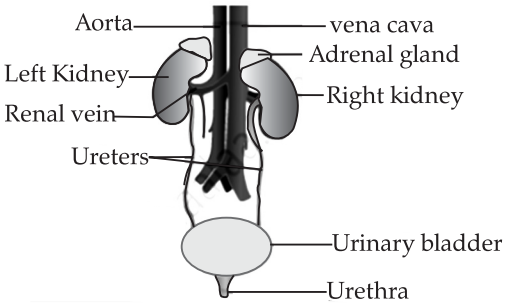
(ii)



6. (i) The human excretory system is composed of the following organs:

1. A pair of kidneys
2. A pair of ureters
3. A urinary bladder
4. A urethra

The typical structure of the human excretory system can be represented as follows:



(ii) Blood enters the kidneys through the renal artery, which branches into many capillaries associated with the glomerulus. Water and other solutes are transferred at the Bowman's capsule. In the proximal tubule, some substances such as amino acids, glucose, and salts are selectively re-absorbed and unwanted molecules are removed. In the loop of Henle, water is re-absorbed. From here, the filtrate moves upwards into the distal tubule, and on to the collecting duct. This duct collects urine from many nephrons.

6 CHAPTER

Control and Coordination

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (C) is correct
Explanation: The cerebellum is responsible for coordinating motor functions, including posture, balance, and coordination of voluntary movements. A dysfunction in the cerebellum would lead to difficulties in maintaining balance and posture, as well as problems with coordinated movement.

2. Option (C) is correct
Explanation: In a nerve cell, the neuromuscular junction is the site where the electrical impulse is converted into a chemical signal. The process begins when information is received at the dendritic tip of a neuron, which sets off a chemical reaction that creates an electrical impulse. This impulse travels from the dendrite to the cell body, and then along the axon to its terminal. At the axon terminal, the electrical impulse triggers the release of chemicals (neurotransmitters), which cross the synapse and start a similar electrical impulse in the dendrite of the next neuron. This process allows information to be transmitted along a chain of neurons.

3. Option (D) is correct
Explanation: Cytokinins are plant hormones that primarily promote cell division (cytokinesis) in plant cells. They play a key role in stimulating cell growth and differentiation, particularly in the root and shoot systems.

4. Option (C) is correct
Explanation: Abscisic acid (ABA) is a plant hormone that acts as a growth inhibitor and plays a critical role in stress responses in plants. Its effects include wilting of leaves.

5. Option (C) is correct
Explanation: When someone's hand touches a hot object unconsciously (like in a reflex action), the sequence of events follows a pathway called the reflex arc. The process works as follows:
1. **Receptors in the skin** detect the heat.
2. **Sensory neuron** carries the signal to the spinal cord.
3. **Relay neuron** in the spinal cord processes the signal.
4. **Motor neuron** sends the signal to the muscle.
5. **Effector muscle** (e.g., arm muscle) moves the hand away from the hot object.

6. Option (A) is correct
Explanation: The olfactory receptors, responsible for detecting smells, are located in the nose, within the nasal cavity. When these receptors are activated by odour molecules, they send signals to the brain, which interprets these signals as different smells.

7. Option (D) is correct
Explanation: Insulin is a hormone produced by the pancreas that helps regulate blood sugar levels. A person may be advised to take insulin injections if their pancreas is not secreting enough insulin or if their body is unable to effectively use the insulin it produces.

8. Option (D) is correct.
Explanation: Tropic movements in plants are directional growth responses to environmental stimuli. These movements occur as a result of differential growth in response to external stimuli, such as light, gravity, water, or touch.

9. Option (A) is correct
Explanation: Cytokinin is a plant growth hormone that is present in plant roots and shoots. It promotes cell division, cell growth and differentiation and facilitates the growth of a plant while working along with auxin.

10. Option (C) is correct
Explanation: Gustatory receptors, which are responsible for detecting taste, are primarily located on the taste buds found on the tongue. These receptors are essential for the sense of taste.

11. Option (C) is correct
Explanation: The cerebellum, located in the hind brain, is responsible for coordinating voluntary movements like walking in a straight line and riding a bicycle. It plays a key role in balance, motor control, and the smooth execution of motor activities. When you walk or ride a bicycle, the cerebellum helps maintain posture, balance, and fine-tunes your movements.

12. Option (B) is correct.
Explanation: Insulin is the hormone responsible for lowering blood sugar levels by facilitating the uptake of glucose into cells. Insufficient production of insulin leads to elevated blood sugar levels, as glucose

cannot effectively enter the cells and remains in the bloodstream.

13. Option (C) is correct

Explanation: Auxin, a hormone produced at the tips of the stems, inhibits the growth of lateral buds. By cutting off the tips, the gardener reduces auxin production on tips, which allows the lateral buds to grow and make the plant bushier.

14. Option (C) is correct.

Explanation: Auxin is a hormone produced at the shoot tip (Part X), and it helps the plant grow. When Geeta cut off part X, the source of auxin was removed. Without auxin, part Y could not elongate or bend toward the light, so it did not grow.

15. Option (B) is correct

Explanation: Chemotropism is when plants respond to chemical signals that guide their growth. In pollination, plants release specific chemicals that attract pollinators like bees and butterflies. These chemicals are unique to each plant species.

When pollinators detect these chemicals, they are drawn to the flowers and pick up pollen. When they visit another flower of the same species, the pollen is transferred to the stigma, ensuring pollination happens within the same species.

Therefore, chemotropism helps make sure pollen from one plant lands on the right flower of the same species. The other options (response to water, light, or gravity) do not play a role in this process.

16. Option (D) is correct

Explanation: The cerebellum is a part of the brain responsible for coordinating voluntary movements, balance, and motor skills. It helps control actions that require muscle coordination and fine motor control, such as walking, running, and jumping. Thus, among the given options, Jumping from a height is a voluntary action that requires coordination of muscles and balance functions controlled by the cerebellum.

17. Option (C) is correct

Explanation: A. Scurvy: Caused by a deficiency of vitamin C, not by a hormonal imbalance.

B. Typhoid: Caused by a bacterial infection (*Salmonella typhi*), not by a hormonal imbalance.

C. Diabetes: This is directly related to a hormonal imbalance as diabetes is caused by an imbalance of insulin, a hormone produced by the pancreas.

D. Common cold: Caused by viral infections, not by a hormonal imbalance.

18. Option (B) is correct

Explanation: The figure shows the movement of a stem, indicating that part X is influenced by the plant hormone auxin. Auxin regulates cell elongation and growth in a particular direction. When a plant is exposed to light, auxin tends to accumulate on the side away from the light source, causing the cells on that side to elongate more and the plant to bend towards the light. Now,

- **Option A:** Shows auxin uniformly distributed with equal cell sizes.
- **Option B:** Shows auxin concentrated on shaded side with larger cell sizes on same side.
- **Option C:** Shows auxin concentrated on light side with large cell sizes on same side.
- **Option D:** Shows auxin concentrated on light side with equal cell sizes on both side.

Since, the auxin distribution unevenly with more concentration on the shaded side causing the cell there to elongate and stem to bend towards the light. The correct representation would show accumulation of auxin and elongation of cell on same side opposite to the sun light. Therefore, the correct answer is option B.

19. Option (A) is correct.

Explanation: Plant stems grow upwards, which means they grow against gravity. This is called negative geotropism. It helps the plant reach for light and grow upwards, which is important for photosynthesis. The other options describe different types of plant movements: away from touch (thigmotropism), away from chemicals (chemotropism), and towards water (hydrotropism), but these are not related to the stem's movement against gravity.

20. Option (B) is correct

Explanation: The reflex arc is the neural pathway that mediates a reflex action. The correct sequence of the flow of information in the reflex arc is as follows:

1. **Receptor:** The sensory receptor detects a stimulus (e.g., heat, pain).
2. **Sensory Neuron:** The sensory neuron carries the information from the receptor to the spinal cord.
3. **Relay neuron:** In the spinal cord, the sensory neuron communicates with a relay neuron, which processes the information and directs it to the appropriate motor neuron.
4. **Motor Neuron:** The motor neuron carries the signal from the spinal cord to an effector (e.g., a muscle).
5. **Effector:** The effector (muscle or gland) produces a response (e.g., muscle contraction to withdraw a hand from a hot surface).

21. Option (B) is correct

Explanation: Reflex actions, particularly those in response to pain or heat, are typically processed in the spinal cord for a rapid response.

- **Cerebrum:** This is involved in higher brain functions like thought and action, not typically involved in the reflex arc.
- **Spinal cord:** This processes reflex actions quickly without involving the brain.
- **Pituitary gland:** This is an endocrine gland that produces hormones and is not involved in reflex arcs.
- **Hypothalamus:** This is involved in maintaining homeostasis and regulating bodily functions, not directly involved in reflex arcs.

22. Option (C) is correct.

Explanation: (A) The average height of boys is always greater than that of girls: This is incorrect because there are points on the graph (around ages 10-12) where the average height of girls is greater than that of boys.

(B) The average height of girls is greater than that of boys in adulthood: This is incorrect because by adulthood (ages 18-20), the average height of boys is greater than that of girls.

(C) The average height of girls during puberty is greater than that of boys: This is correct. The graph shows that during the puberty years (around ages 10-14), the average height of girls surpasses that of boys.

(D) The average heights of girls and boys are the same between 4 and 20 years: This is incorrect because the graph shows differences in average height between boys and girls at various ages within this range.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (B) is correct.

Explanation: The assertion is true because both plants and animals rely on chemical coordination through hormones to regulate various physiological processes. In plants, hormones like auxins control growth and response to light or gravity, while in animals, hormones such as insulin and adrenaline regulate metabolism and stress responses. Reason is also true but it does not explain the assertion correctly. In plants, hormones like auxins control directional growth (tropic movements). In animals, growth is not directional but occurs throughout the body.

2. Option (C) is correct.

Explanation: The assertion is correct because plant hormones are chemicals produced by plants that help co-ordinate growth, development, and responses to environmental stimuli. These hormones, such as auxins, gibberellins, and cytokinins, regulate various processes in plants. However, the reason is false. Abscisic acid (ABA) is not a hormone that promotes cell division; rather, it primarily helps plants respond to stress by inhibiting growth and inducing dormancy. ABA is involved in processes like stomatal closure and drought response, but it does not promote cell division. Thus, the assertion is true, but the reason is false.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i) The thyroid gland is located at the front portion of the neck, just below the larynx.

(ii) Thyroid hormones are crucial for controlling the basal metabolic rate. These hormones aid in the production of red blood cells. The metabolism of carbohydrates, proteins, and lipids is regulated by thyroid hormones.

(iii) (a) Hyperthyroidism is a condition that occurs when there is an excess of thyroxine in the body. It leads to an overactive metabolism, resulting in symptoms such as weight loss, increased heart rate, and nervousness.

OR

(b) The following ways can be used to control hypothyroidism:

(1) Taking proper medicines prescribed by the physician.

(2) By including iodised salt in our diet.

2. (i) The brain is protected from shocks and injuries through:

Skull: The bony structure of the skull acts as a hard, protective casing around the brain.

Meninges: Three layers of membranes, called meninges surround the brain and spinal cord, providing additional protection.

Cerebrospinal Fluid (CSF): This fluid, which circulates between the meninges and throughout the brain's ventricles, cushions the brain, absorbs shocks, and helps maintain stable pressure within the skull.

(ii) (1) Function of Sensory Neuron: Sensory neurons transmit information from sensory receptors (like those in the skin, eyes, ears) to the central nervous system (brain and spinal cord). In a reflex arc, they carry signals from the site of the stimulus to the spinal cord.

(2) Function of Motor Neuron: Motor neurons transmit information from the central nervous system to effectors such as muscles or glands. In a reflex arc, they carry signals from the spinal cord to the muscles to bring about a response, such as withdrawing a hand from a hot object.

(iii) (a) (1) Picking a Pencil: Part of the Brain Involved: Cerebrum (specifically the motor cortex)

Type of Action: Voluntary

(2) Vomiting: Part of the Brain Involved: Medulla oblongata

Type of Action: Involuntary

OR

(b) The central nervous system (CNS) communicates with the body through the peripheral nervous system (PNS). The CNS sends signals via motor neurons to muscles and glands to initiate actions and receives information from sensory neurons about the environment. This two-way communication allows the CNS to coordinate and regulate bodily functions, ensuring appropriate responses to stimuli and maintaining homeostasis. Two Components of this System are:

Central Nervous System (CNS): Comprised of the brain and spinal cord.

Peripheral Nervous System (PNS): Consists of all the nerves that branch out from the brain and spinal cord to the rest of the body.

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. Auxins are synthesised in the growing tips of shoots and roots, specifically in the meristematic tissues of plants. They promote phototropism by accumulating on the shaded side of the plant when exposed to directional light. This causes faster cell elongation on the shaded side, making the plant bend toward the light to maximize photosynthesis.

2. (i) Medulla

Location: The medulla is located in the hindbrain, just above the spinal cord.

Function: The medulla controls involuntary functions such as breathing, salivation, and blood pressure.

(ii) Cerebrum

Location: The cerebrum is located in the forebrain and makes up the largest part of the brain.

Function: The cerebrum is responsible for higher functions like thinking, learning, voluntary movements, memory, and sensory processing (e.g., vision, hearing, touch).

3. Auxin is the plant hormone responsible for promoting the growth of tendrils in pea plants, which helps the plant climb.

Auxin is produced at the tip of the plant's shoot. When a tendril touches a support, auxin moves to the side of the tendril opposite to the support. This causes the cells on that side to elongate faster, resulting in the tendril coiling around the support.

Tendrils are thin, thread-like growths on the stems or leaves of climbing plants. They are touch- sensitive and wrap around any object they come into contact with. This helps the plant climb and reach more sunlight for better growth, providing support as the plant grows upwards.

4. Label X represents the sensory neuron.

Function: It transmits sensory information from the receptor (in this case, the hand) to the spinal cord.

Label Y represents the motor neuron.

Function: It transmits motor commands from the spinal cord to the effector (in this case, the muscles of the hand) to produce a response.

5. (i) Maintaining body posture: Cerebellum (located in the hindbrain) is primarily responsible for coordinating voluntary movements and maintaining balance and posture.

(ii) Salivation: The medulla oblongata and the autonomic nervous system control salivation. The medulla oblongata is located in the lower part of the brainstem and also controls blood pressure and heart rate.

(iii) Hunger: Hypothalamus (located in the forebrain) plays a key role in regulating hunger and thirst.

(iv) Answering a question: Cerebrum (the largest part of the brain) is responsible for higher cognitive functions, including reasoning, thinking, mental ability, and speech.

6. (i) Insulin is a hormone produced by the pancreas that plays a crucial role in regulating blood sugar levels. When blood sugar levels rise after eating, insulin is released into the bloodstream. It facilitates the uptake of glucose into cells, particularly muscle and liver cells, where it is used for energy or stored as glycogen. Diabetes is the disease caused by the inability of the body to produce sufficient insulin, leading to high blood sugar levels.

(ii) The release of insulin is regulated by the levels of glucose in the blood. When blood glucose levels rise, such as after eating, beta cells in the pancreas detect this increase and secrete insulin. This is a feedback mechanism that helps maintain blood glucose levels within a narrow range. The amount of insulin released corresponds to the amount of glucose present in the blood.

7. The parts of the brain responsible for the following actions are:

(i) Maintaining posture and balance: The cerebellum is located at the back of the head. Its function is to co-ordinate voluntary muscle movements and to maintain posture, balance, and equilibrium.

(ii) Beating of heart: The medulla oblongata is located in the lower portion of the brainstem. It maintains heart rate and blood pressure. It's responsible for many reflexes in the body or involuntarily controls, such as vomiting, sneezing, and coughing

(iii) Thinking: The cerebrum is involved in higher brain functions such as thought, reasoning, problem-solving, and planning.

(iv) Blood pressure: The medulla oblongata is located in the lower portion of the brainstem. It maintains heart rate and blood pressure. It's responsible for many reflexes in the body or involuntarily controls, such as vomiting, sneezing, and coughing.

8.

Movement of leaves of a sensitive plant	Movement of a shoot towards light
It is a movement that is not related to growth.	It is the movement that is dependent on growth.
It is called thigmonasty. E.g. Touch me not leaves drooping on touch.	It is called phototropism. E.g Sunflower grows towards the sunlight.

9. Auxins are synthesised at the tips of roots and shoot in the plant body.

(i) Positive Phototropism [Organ: Shoots (stems)]: The shoots grow towards light, showing positive phototropism.

(ii) Negative Geotropism [Organ: Shoots (stems)]: The shoots grow upwards against the gravitational pull, exhibiting negative geotropism.

(iii) Positive Hydrotropism [Organ: Roots]: The roots grow towards moisture or water, showing positive hydrotropism.

10. A synapse is a small gap between two neurons where electrical signals are converted into chemicals to cross the gap and pass on the signal to the next neuron. This gap occurs between the axon of one neuron and the dendrite of another neuron. The synapse functions as a one-way valve, ensuring that impulses are transmitted in only one direction-from the axon of one neuron to the dendrite of the next. The chemicals responsible for this transmission are produced on the axon's side, which allows the electrical impulse to travel across the synapse and be converted back into an electrical signal in the receiving neuron.

11. (i) Auxin is a plant hormone that controls directional growth, such as phototropism and geotropism.

(ii)

Animal Growth Hormones	Plant Growth Regulators
Animal growth hormones are typically regulated by internal factors, such as feedback mechanisms involving the endocrine system, and are influenced by genetic and metabolic factors.	Plant growth regulators, such as auxins, are often controlled by external environmental stimuli like light, gravity, and water availability. For example, auxins redistribute in response to light, causing phototropism, and in response to gravity, causing geotropism.

12. (i) Ethylene is the plant hormone that facilitated the ripening of tomatoes.

(ii) The tomatoes in the paper bag ripened faster because the enclosed environment of the paper bag trapped the ethylene gas released by the tomatoes. This increased concentration of ethylene gas around the tomatoes accelerated the ripening process.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. Reflex action is defined as an unconscious automatic and involuntary response of effectors i.e. muscles and glands to a stimulus which is monitored through the spinal cord.

Significance: It protects us from any sudden stimulus which may harm us.

Path of a Reflex Action - Sneezing:

Stimulus (Irritant in Nasal Passage)
↓
Sensory Receptor (Nasal Nerve Endings)
↓
Sensory Neuron (Carries Signal to Spinal Cord)
↓
Spinal Cord (Relay Neuron)
↓
Motor Neuron (Carries Signal to Effector)
↓
Effector (Muscles Involved in Sneezing Diaphragm, Chest and Abdominal Muscles)
↓
Response (Sneezing)

2. (i) The two constitutents of the Central Nervous System (CNS) are:

1. Brain
2. Spinal Cord

Protection from Injuries

- **Brain:** The brain is protected by the skull (bone structure) and the meninges (protective membranes around the brain). Additionally, the cerebrospinal fluid (CSF) surrounds the brain, acting as a cushion to absorb shocks.
- **Spinal Cord:** The spinal cord is protected by the vertebral column (spine) and the meninges. It is also cushioned by cerebrospinal fluid (CSF) inside the vertebral canal.

(ii) Limitations of Electrical Impulses

1. They will reach only those cells that are connected by nervous tissue, not each and every cell in the animal body.
2. Once an electrical impulse is generated in a cell and transmitted, the cell will take some time to reset its mechanisms before it can generate and transmit a new impulse. In other words, cells cannot continually create and transmit electrical impulses,

3. Growth Hormone

Gland of Secretion: Growth hormone (GH) is secreted by the anterior pituitary gland.

(i) Role in Growth and Development: Growth hormone plays a key role in stimulating the growth of bones, muscles, and cartilage. It promotes cell division and protein synthesis, driving bone growth and the increase in height during childhood and adolescence. A deficiency of GH can result in growth retardation, while an excess can cause gigantism in children or acromegaly in adults.

(ii) **Regulation of Metabolism:** In addition to growth, growth hormone has significant metabolic effects. It stimulates the breakdown of fats to release energy and increases glucose production in the liver. It also reduces glucose uptake by tissues, which leads to increased blood glucose levels, contributing to the regulation of energy in the body.

Thyroxime Hormones

Gland of Secretion: Thyroid hormones, namely thyroxine are produced by the thyroid gland.

(i) **Role in Growth and Development:** These hormones are essential for normal growth and development, especially during foetal development and early childhood. They regulate the maturation of various tissues and organs, influencing the growth of bones, the development of the brain, and overall metabolic activity. Deficiency in thyroid hormones during development can lead to stunted growth and cognitive impairments.

(ii) **Regulation of Metabolism:** Thyroid hormones significantly influence metabolism by increasing the basal metabolic rate (BMR). They stimulate the breakdown of glucose, fats, and proteins to provide energy and enhance protein synthesis.

4. During scary or stressful situations, the adrenaline hormone is released by the adrenal glands (which are located on top of the kidneys).

How the body responds:

1. **Increased heart rate:** Adrenaline causes the heart to pump faster, which helps increase blood flow to muscles and vital organs, preparing the body for quick action.
2. **Dilation of airways:** It dilates the airways in the lungs, making it easier to breathe and increasing the oxygen supply to muscles.
3. **Increased blood flow to muscles:** The blood vessels to the muscles constrict, while those to non-essential areas (like the digestive system) constrict, redirecting blood to muscles so they are ready for action (known as the "fight-or-flight" response).
4. **Release of glucose:** Adrenaline stimulates the breakdown of glycogen in the liver into glucose, providing an immediate source of energy for quick physical response.
5. **Heightened alertness:** It increases the levels of alertness by boosting the activity of the brain, enabling the individual to react more quickly.

5. (i) **A:** Sensory neuron or Nerve
B: Relay neuron or Interneuron
C: Effector

(ii) The functions of A and C are as follows:
A: The sensory neuron carries impulses from receptor to spinal cord.
C: The effector organ responds to stimulus by contracting or secreting a product.

(iii) Animals have evolved reflex arcs because the brain's reasoning process is too slow for them. Many animals lack the intricate neuronal network required for thought, or have relatively few of them. Reflex arcs have probably developed as an efficient means of surviving in the absence of actual cognitive processes. However, reflex arcs continue to be more effective for fast responses even after the development of complex neuron networks.

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) The leaves of the 'chhui-mui' plant, also known as the 'sensitive' or 'touch-me-not' plant of the Mimosa family, begin to fold up and droop in response to touch stimulus (thigmonasty).

This movement is an immediate response to the stimulus of touch and does not involve growth. Unlike animals, plants lack nervous and muscle tissue, so they rely on electrical-chemical means to convey information from cell to cell.

In response to touch, certain plant cells change shape by altering the amount of water within them, resulting in swelling or shrinking. This change in cell shape leads to the rapid movement of the plant's leaves folding and drooping.

Thus, the stimulus is touch, and the cause of the rapid movement is the electrical-chemical communication between cells leading to changes in cell shape, without any growth involved in this movement.

(ii) The movement of plant parts in response to the direction of gravity is known as geotropism.

If the movement of the plant parts is towards the pull of gravity, it is known as positive geotropism; whereas if the movement of the plant parts is in the direction opposite to the pull of gravity, it is known as negative geotropism.

The movement of roots towards the soil is an example of positive geotropism, whereas the movement of plant stems away from the soil in the upward direction is an example of negative geotropism.

2. (i)

Aspect	Hormonal Coordination in Plants	Hormonal Coordination in Animals
Hormone Production	Hormones (phytohormones) are produced in all plant cells.	Hormones are produced by specialised endocrine glands.
Hormone Type	Plant hormones are simple organic substances (phytohormones).	Animal hormones are complex organic substances.
Hormone Transport	Hormones are transported through the phloem and xylem.	Hormones travel through the bloodstream.
Response Time	Plant responses to hormones are slower.	Animal responses are faster due to the circulatory system.
Influencing Factors	Hormone levels are not greatly influenced by external factors.	Hormone levels can be influenced by stress, infections, and minerals.
Function	Plant hormones regulate growth, development, and cell division.	Animal hormones control various physiological processes like metabolism, growth, and reproduction.

(ii) **(1) Intelligence:** Forebrain
(2) Riding a bicycle: Cerebellum (part of hindbrain)
(3) Vomiting: Medulla Oblongata (part of hindbrain).
(4) Controlling hunger: Hypothalamus (part of forebrain)

(iii) The brain and spinal cord are protected against mechanical injuries by several layers of protection. They are surrounded by a three-layered membrane called the meninges. The outer layer is tough and provides a strong protective covering, while the middle layer contains fluid that cushions the brain and spinal cord. The inner layer is delicate and closely attached to the brain and spinal cord. In addition to the meninges, the brain and spinal cord are surrounded by cerebrospinal fluid (CSF), which acts as a shock absorber. The brain is also protected by the bony skull, and the spinal cord is safeguarded by the vertebral column (spine), both of which provide structural barriers against physical damage. These layers work together to protect the brain and spinal cord from mechanical injury.

3. (i) Tropic movements are directional growth movements in plants that occur in response to external stimuli. These movements are usually directional, meaning the plant part moves in a specific direction in response to an environmental factor such as light, gravity, or touch. Some examples of tropic movements include:

- **Phototropism:** Plants respond to light
- **Geotropism:** Plants respond to gravity
- **Chemotropism:** Plants respond to chemicals
- **Thigmotropism:** Plants respond to touch
- **Hydrotropism:** Plants respond to water

Examples of Plant Hormones

1. **Inhibits Growth:** Abscisic acid (ABA) is a plant hormone that inhibits growth and helps plants cope with stress, like drought. It promotes the closing of stomata to prevent water loss.
2. **Promotes Cell Division:** Cytokinins are plant hormones that promote cell division, stimulate the growth of shoots, and delay aging (senescence) in plants.

(ii) The tendril of a pea plant exhibits thigmotropism, a type of tropic movement in response to touch or physical contact. Differential development on the tendril's in contact side causes directional movement. So, when the tendril touches an object, the cells on the side of the tendril that are in contact with the object elongate slower than the cells on the opposite side, causing the tendril to curl around the object.

Hormone Responsible: The plant hormone auxin is responsible for thigmotropism in tendrils. When a tendril meets support, it experiences uneven auxin distribution, resulting in directional growth and movement. This technique enables the tendril to effectively grab and climb a supporting framework.

4. (i) A reflex arc is the pathway taken by nerve impulses during a reflex action. It is a rapid, automatic response to a stimulus that does not require conscious thought, often to protect the body from harm.

Reflex arcs have evolved in animals primarily because the thinking process of the brain is not fast enough to respond immediately to certain stimuli that require quick action for survival or response.

Many animals, especially simpler ones, lack a complex neuron network capable of fast thinking. Reflex arcs provide a more efficient way of functioning by enabling quicker responses to stimuli, bypassing the slower thinking processes. This efficiency is vital for survival, allowing animals to respond instantly to dangers or other important stimuli. Even in animals with complex neural networks, reflex arcs remain crucial for ensuring immediate and efficient responses.

When you accidentally touch something hot, your body reacts quickly through a reflex action, skipping the slower thinking process of the brain. The sensation of heat is detected by nerve

endings, which send a signal through nerve cells to the spinal cord. This signal does not need to be processed by the brain to initiate a response. Instead, a reflex arc in the spinal cord immediately sends a signal back through motor nerves to the muscles, causing you to withdraw your hand from the hot object quickly. This process allows for a rapid response to avoid injury, demonstrating the efficiency of reflex arcs in providing quick reactions to potential harm without the need for conscious thought.

(ii) The part of the nervous system that helps in communication between the central nervous system (CNS) and other parts of the body is the peripheral nervous system. The two component of this system are cranial nerves that arise from the brain and spinal nerves that arise from the spinal cord. The peripheral nervous system facilitates the transmission of information and commands between the CNS and various body parts, enabling the brain to receive sensory information from the body and send motor commands to muscles and glands.

5. (i)

Nervous Control	Hormonal Control
(1) Signals are transported through nerve impulses in neurons.	Signals are transmitted via chemical hormones in the bloodstream.
(2) The nervous system provides quick responses that occur within milliseconds, making it effective for rapid coordination of activities.	Hormonal responses are generally slower, taking from seconds to minutes, or even days to manifest, but tend to having longer lasting effects.
(3) There is a higher degree of voluntary control in the nervous system, allowing for immediate and conscious action.	Hormonal control operate largely outside of conscious control, managing processes such as growth, metabolism and reproduction.

(ii) Auxins are plant hormones that play a crucial role in the phototropic response, which is the bending of plant shoots towards light. When a plant is exposed to unidirectional light, auxins are distributed unevenly in the plant shoot.

1. **Auxin Distribution:** In response to light, auxins move away from the light-exposed side of the shoot and accumulate on the shaded side.
2. **Cell Elongation:** Auxins promote cell elongation in plant tissues. The higher concentration of auxins on the shaded side causes cells on that side to elongate more than the cells on the light-exposed side.
3. **Bending Towards Light:** As the cells on the shaded side elongate more, the shoot bends towards the light source. This bending allows the plant to maximise light absorption for photosynthesis.

6. (i) (I) Over-secretion of growth hormone

- **Disorder:** Gigantism (in children) or Acromegaly (in adults)
- Gland: Pituitary gland

(II) Deficiency of oestrogen in females

- **Disorder:** Hypogonadism or Menopausal symptoms or Delay in puberty
- **Gland:** Ovaries

(III) Less secretion of thyroxine

- **Disorder:** Hypothyroidism or goitre
- **Gland:** Thyroid gland

(ii) The timing and amount of hormone release in our bodies are controlled by a process called feedback mechanisms. For example, when the level of thyroxine in the blood gets too low, a part of the brain called the hypothalamus sends a signal to the pituitary gland, another small gland in the brain. The pituitary gland then releases a hormone called TSH (thyroid-stimulating hormone). TSH travels through the blood to the thyroid gland and tells it to make and release more thyroxine. Once there is enough thyroxine in the blood, it sends a signal back to the hypothalamus and pituitary gland to stop releasing TSH.

7 How do Organisms Reproduce?

CHAPTER

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (D) is correct
   Explanation: *Plasmodium*, the parasite responsible for malaria, exhibits multiple fission, a type of asexual reproduction in which a single parent cell divides into numerous daughter cells simultaneously. During its life cycle, *Plasmodium* undergoes several rounds of multiple fission, particularly in the liver and red blood cells of the host. This process, produces numerous daughter cells called merozoites which are then released into the bloodstream, where they infect red blood cells, leading to the symptoms of malaria.
2. Option (C) is correct
   Explanation: The diagram represents budding in *Hydra*, a type of asexual reproduction. In this process, a small outgrowth or bud forms on the body of the parent *Hydra*. Over time, the bud matures, grows, and eventually detaches from the parent to live independently, completing the process of budding.
3. Option (C) is correct
   Explanation: In most flowers, petals are the parts that attract insects for pollination. They are typically brightly coloured and sometimes have patterns, which help draw the attention of pollinators like bees, butterflies, and other insects. The purpose of this attraction is to facilitate the transfer of pollen from one flower to another, aiding in fertilisation.
4. Option (A) is correct
   Explanation: Vegetative propagation is a method of asexual reproduction where new plants are produced from the vegetative parts of the parent plant, such as stems, roots, or leaves, rather than from seeds. Sugarcane, roses and grapes are examples of plants raised by vegetative propagation.
5. Option (C) is correct
   Explanation: Placenta has a large surface area (due to the presence of villi) to allow efficient exchange of glucose, oxygen, and other substances between the mother's blood and the embryo. A small surface area would limit the exchange and be detrimental to the developing foetus.
6. Option (A) is correct
   Explanation: The rapid spread of bread mould on a slice of bread is primarily due to the formation of a large number of spores and the presence of moisture and nutrients in the bread. Moulds, such as *Rhizopus*, produce many spores that are easily dispersed through the air. When these spores land on the moist, nutrient-rich surface of the bread, they germinate and grow. The bread provides the ideal conditions for mould growth, with its moisture and nutrients like starches, which support the development of the mould.
7. Option (C) is correct
   Explanation: In bread mould (such as *Rhizopus*), the structure labelled A is typically the hyphae, which are the thread-like structures that grow and spread across the surface of the bread. Hyphae absorb nutrients and help the mould grow. On the other hand, the tiny blob-on-a-stick structures labelled as B are sporangia, which contain cells, or spores, that can eventually develop into new *Rhizopus* individuals.
8. Option (D) is correct
   Explanation: *Bryophyllum* propagates through its leaves.
   The potato is a modified stem called a tuber.
   The money plant (*Pothos*) can propagate through its stems.
   Roses are typically propagated through their stems (cuttings) rather than roots.
9. Option (D) is correct
   Explanation: The flower may be unisexual when it contains either stamens or carpels. Papaya and watermelon are examples of plants which bear unisexual flowers.
10. Option (A) is correct
    Explanation: In humans, the typical chromosomal setup includes:
    - 22 pairs of autosomes (non-sex chromosomes)
    - 1 pair of sex chromosomes (XX for females, XY for males)

    When an X-bearing sperm fertilises the egg, the following occurs:
    - The egg contributes 22 autosomes + 1 X chromosome (total 23 chromosomes).
    - The X-bearing sperm contributes 22 autosomes + 1 X chromosome (total 23 chromosomes).

Therefore, the resulting zygote will have:
- 44 autosomes (22 pairs)
- 2 X chromosomes (XX)

Therefore, the correct answer is 44 + XX.

11. Option (D) is correct
Explanation: The number of chromosomes in parents and offspring of a particular species undergoing sexual reproduction remains constant because during meiosis, the chromosome number is reduced by half to form gametes (sperm and egg cells), which ensures that upon fertilisation, the resulting zygote has the same chromosome number as the parent organism.

12. Option (D) is correct
Explanation: The bacterial and the viral infections that may be caused due to unsafe sex are Syphilis and Warts respectively.

13. Option (C) is correct
Explanation: The flowers that contain the ovary, develops into a fruit after fertilisation. In the provided image, both X and Y contain ovaries, therefore, they would develop into a fruit.

14. Option (D) is correct
Explanation: Gonorrhoea is caused by the bacterium *Neisseria gonorrhoeae* and is sexually transmissible.

15. Option (A) is correct
Explanation: Fertilisation takes place in the fallopian tubes, which are part of the female reproductive system. During ovulation, an egg is released from the ovary and travels down the fallopian tube. If sperm meets the egg in the fallopian tube, fertilisation can occur. This is where the sperm combines with the egg to form a zygote, which will then move to the uterus to develop into a baby.

16. Option (D) is correct
Explanation: In the diagram, the part labelled as S is testis which is responsible for the secretion of testosterone in males.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (A) is correct
Explanation: Offsprings produced by asexual reproduction are genetically similar to the parents. The reason for this is that asexual reproduction involves only one parent, and there is no genetic recombination, which typically occurs in sexual reproduction. This means the genetic similarity of the offspring to the parent is directly linked to the fact that asexual reproduction involves only one parent. Thus, both assertion and reason are true and reason is the correct explanation of assertion.

2. Option (A) is correct
Explanation: *Amoeba* always produces two daughter amoebae while *Plasmodium* divides into many daughter cells. This is because binary fission in *amoeba* results in two daughter cells whereas, multiple fission in *Plasmodium* results in many daughter cells. Thus, both assertion and reason are true and reason is the correct explanation of assertion.

3. Option (A) is correct
Explanation: Oral contraceptive pills and copper-T do not prevent sexually transmitted diseases (STDs) because they are designed to prevent pregnancy by regulating hormones. Neither of these methods provides protection against sexually transmitted diseases. Sexually transmitted diseases are indeed transmitted by contact with the mucous membranes of the infected person. Thus, both assertion and reason are true and reason is the correct explanation of assertion.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i) All the cut pieces of *Planaria* A (L, M, and N) and Planaria B (O and P) can regenerate to form complete organisms.

(ii) An example of another organism that follows the same mode of reproduction as *Planaria* is *Hydra*.

(iii) (a) In regeneration, 'development' refers to the organised sequence of processes by which the cells that proliferate from a part of the organism undergo differentiation and specialisation to form the various cell types and tissues required to rebuild the lost or damaged part of the organism, ultimately resulting in the restoration of the organism's lost body parts or the creation of an entirely new organism.

(b)

	Regeneration	Fragmentation
Definition	Regeneration refers to an organism's ability to regrow or replace destroyed bodily parts.	Fragmentation is a type of asexual reproduction in which an organism divides into pieces, each with the potential to develop into a new individual.

Process	It involves the development of specialised cells at the site of injury, leading to the formation of new tissues and structures.	Fragments develop into new individuals without necessarily undergoing the specialisation of cells, as seen in regeneration.
Example	*Planaria* can regenerate into complete organisms from cut pieces.	Some species of flatworms, like the tapeworm, reproduce through fragmentation.

2. (i)

Self Pollination	Cross Pollination
Self pollination occurs when pollen from the anther of a flower is transferred to the stigma of the same flower or another flower on the same plant. The plant fertilises itself.	Cross pollination occurs when pollen from the anther of one flower is transferred to the stigma of a different flower, usually of a different plant of the same species, often with the help of pollinators like insects, birds, or wind.

(ii) The colourful part of the flower that attract insects is known as the corolla (made up of petals), which are typically bright and vibrant, making them appealing to insects. The bright colours, scent, and nectar of the petals help attract pollinators like bees, butterflies, and other insects. After fertilisation, the petals typically shrivel and fall off.

(iii) (a) Fertilisation is the process in which the male gamete (pollen) fuses with the female gamete (egg cell) to form a zygote, which then develops into a seed.

After fertilisation, the ovule develops a tough coat and is gradually converted into a seed. Whereas, the ovary grows rapidly and ripens to form a fruit.

OR

(b) In a germinating seed:

- The future shoot (stem and leaves) is known as the plumule.
- The future root is known as the radicle.

The cotyledon serves as the food store for the developing seedling.

3. (i) **Sexual propagation:** The seeds (which develop from the fertilised ovule).

Asexual propagation: Various vegetative parts such as roots, stem, and leaves. Common examples include cuttings (stem), grafts, and tubers (like potatoes).

(ii) (1) Flower: Rose

(2) Fruit: Banana

(iii) (a) The two advantages of growing plants by vegetative propagation are:

- **Faster Flowering and Fruiting:** Plants raised through vegetative propagation, such as sugarcane, roses, or grapes, can bear flowers and fruits earlier than those grown from seeds. This leads to quicker yields, which is beneficial for agricultural purposes.
- **Genetic Uniformity:** Since vegetative propagation produces genetically identical plants to the parent, all new plants will have the same desirable characteristics, such as fruit quality or flower colour.

OR

(b) Objective: To demonstrate how potatoes reproduce asexually using their buds (eyes).

Procedure:

- Look at the surface of the potato and identify the small buds or eyes.
- Cut the potato into pieces. Ensure some pieces have a bud (eye) and some do not.
- Spread cotton on a tray and moisten it with water.
- Put the potato pieces with buds on the cotton, ensuring they are kept moist. Over the next few days, observe the potato pieces for signs of growth.

Expected Result: The potato pieces with buds (eyes) will develop green shoots and roots, showing how asexual reproduction occurs. The pieces without buds will not sprout.

4. (i) *Leishmania* reproduces by binary fission, while *Plasmodium* reproduces by multiple fission.

(ii) One advantage of sexual reproduction over asexual reproduction is genetic diversity. Sexual reproduction combines the genetic material of two parents, resulting in offspring with greater genetic variation, which can enhance adaptability and survival in changing environments.

(iii) (a) (1) Colonies of yeast fail to multiply in water because they require a source of energy and nutrients, which is provided by the sugar in the sugar solution. In the presence of sugar, yeast can undergo fermentation, producing energy, and thus multiply.

(2) *Rhizopus* do not grow on a dry slice of bread because fungal spores require moisture for growth and reproduction. In the presence of moisture, fungal spores germinate and form hyphae (the filamentous structures of the fungus).

OR

(b) The filamentous structures identified in the dark green pond water are Spirogyra. These organisms multiply primarily through fragmentation, a form of asexual reproduction where the filaments break into smaller pieces, and each piece can grow into a new individual organism.

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. ***Leishmania*** reproduces asexually by binary fission. The division occurs in a definite orientation relative to the whip-like flagellum, ensuring the flagellum's proper inheritance and function in the daughter cells. *Plasmodium* reproduces asexually by multiple fission. In this process, the cell divides into many daughter cells simultaneously, producing numerous merozoites that infect red blood cells in the human host.
2. The statement "Stability of DNA in a species is ensured during sexual reproduction" is justified because, during sexual reproduction, two gametes (sperm and egg) fuse, each contributing half of the genetic material, resulting in a zygote with a stable diploid set of chromosomes. This process maintains the chromosome number across generations, ensuring genetic stability, while allowing for genetic variation through crossing over and recombination during meiosis.
3. The glands which add their secretions to the sperms are the prostate gland and the seminal vesicles.
   Functions
   (a) The secretions help in forming a fluid (semen) that makes it easier for the sperm to move through the male reproductive tract and into the female reproductive system.
   (b) The fluid contains nutrients that provide energy and nourishment to the sperm, supporting their motility and survival.
4. In sexually reproducing organisms, the number of chromosomes is re-established through the process of meiosis and fertilisation. During meiosis, gametes (sperm and egg cells) are produced with half the number of chromosomes (haploid), i.e., 23 chromosomes. When fertilisation occurs, the sperm and egg combine to form a zygote, restoring the original diploid number of chromosomes, i.e., 46 chromosomes.
5. The parts labelled in the diagram are:
   - **A:** Stigma
   - **B:** Pollen tube
   - **C:** Egg Cell

   Function of part B (Pollen tube): It carries the pollens to the egg cell for fertilisation.
6. **(i)** *Hibiscus* and Mustard flowers are bisexual because they both have male (stamens) and female (carpel) reproductive organs within the same flower, making them more likely to undergo **self-pollination**.
   (ii) The two reproductive parts of a bisexual flower are Stamen (male reproductive part) and Carpel (female reproductive part).
7. *Planaria* reproduces by regeneration because it has the ability to regrow lost body parts and form a complete organism from a fragment.
   An example of another organism that can reproduce by the same process is the *Hydra*.
8. **(i)** Reproductive parts of bread mould (*Rhizopus*) - Sporangium
   Non- reproductive parts of bread mould (*Rhizopus*) - Hyphae.
   (ii) The two advantages of vegetative propagation are:
   (1) The plants grown through vegetative propagation (e.g., sugarcane, roses, grapes) can produce flowers and fruits earlier than those grown from seeds, leading to quicker yields.
   (2) The plants produced through vegetative propagation are genetically identical to the parent plant. This ensures that the new plants inherit desirable traits, such as fruit quality or flower colour, maintaining uniformity in the crop.
9. Puberty is the period during which adolescents reach sexual maturity and become capable of reproduction. The two changes that are common to both boys and girls during early teenage years are:
   (1) Rapid increase in height and weight.
   (2) Development of secondary sexual characteristics
10. **(i)** Uterus.
    (ii) Fallopian tube.
    (iii) Ovary.
    (iv) Placenta.
11. **(i)** **Placenta:** The placenta facilitates the exchange of nutrients, gases, and waste products between the mother and the developing foetus.
    (ii) **Fallopian tubes:** The fallopian tubes transport the egg from the ovaries to the uterus. They are also the site where fertilisation occurs.
    (iii) **Uterus:** The uterus provides a nurturing environment for the fertilised egg to implant and develop into a foetus. It is the site of implantation. It also contracts during childbirth to help deliver the baby.
    (iv) **Ovary:** The ovaries produce and release eggs (ova) for fertilisation. They also produce female sex hormones, such as estrogen and progesterone, which regulate the menstrual cycle and support pregnancy.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. Fertilisation occurs when a sperm enters the fallopian tube and encounters a mature egg (oocyte). The process of fertilisation and foetal development can be summarised as follows:
   (1) **Fertilisation:** Sperm penetrates the egg, resulting in the creation of a zygote. The merging of genetic material restores diploid chromosomes and creates a new person.
   (2) **Zygote Formation:** The zygote undergoes rapid cell division through mitosis, forming a solid ball of cells called a morula.

(3) Blastocyst Formation: The morula transforms into a blastocyst, a fluid-filled structure with a central cell mass. The blastocyst moves via the fallopian tube and into the uterus.

(4) Implantation: The blastocyst connects to the endometrial lining of the uterus and implants. In this procedure, the blastocyst invades the uterine lining.

(5) Formation of Germ Layers: After implantation, the blastocyst develops into three germ layers (ectoderm, mesoderm, an endoderm) that produce numerous tissues and organs.

(6) Formation of embryo: The blastocyst develops into an embryo, and organogenesis begins. During this stage, the body's organs and structures begin to develop.

(7) Development of Foetus: The developing organism is called a fetus after the eighth week. During the fetal stage, organs and tissues develop and mature more.

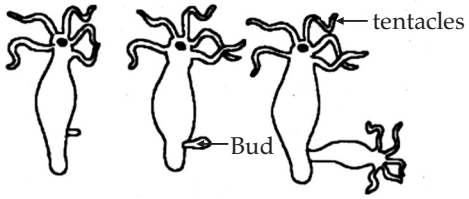
The placenta is a vital organ that forms during pregnancy and plays the following functions:

(1) It helps exchange nutrients, oxygen, and waste between the mother and the developing baby. The placenta provides the baby with essential nutrients and removes waste.

(2) It also produces hormones like hCG, progesterone, and estrogen, which are important for maintaining the pregnancy. These hormones prevent the release of eggs and help the uterine lining stay thick and supportive.

(3) The placenta also acts as a protective barrier, shielding the baby from harmful substances and preventing the mother's immune system from attacking the baby. In short, the placenta supports the baby's growth by providing nutrition, exchanging gases, and producing necessary hormones during pregnancy.

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



The cells used for reproduction in this process are regenerative cells.

3. (i) Roles of Seminal Vesicles

(a) These gland secrete a fluid which makes the transport of the sperms easier.

(b) The fluid nourishes the sperm.

Roles of Prostate Gland

(a) Like the seminal vesicles, the prostate gland also adds its fluid to the semen.

(b) The fluid nourishes the sperm and helps them move through the urethra.

(ii) Roles of oviduct (also known as Fallopian tube)

(a) The oviduct (also known as the Fallopian tube) carries the egg from the ovary to the uterus (womb). After ovulation, the egg is captured by the fimbriae at the end of the oviduct and then moved toward the uterus.

(b) The oviduct is the actual site where fertilisation occurs, if sperm are present. Fertilisation can take place in the oviduct before the egg continues its journey to the uterus.

(iii) Roles of Testes

(a) The testes are responsible for formation of sperms by the process of spermatogenesis.

(b) They are also responsible for producing the male sex hormone, testosterone.

4. (i) (1) Sepals: Sepals persist even after a fruit is formed in some plants because they provide protection to the developing fruit and seeds.

(2) Corolla (made up of petals): The colourful petals of a flower form the corolla and attract insects, helping in the process of pollination.

(3) Anther: The anther, located on the stamen, produces pollen grains that contain male germ cells.

(4) Ovule: After fertilisation, the ovule develops into a seed.

(ii) After pollination, the male germ cell (sperm) reaches the ovary via the pollen tube. This process happens as follows:

(a) The pollen grain lands on the stigma of the flower.

(b) The pollen grain grows a pollen tube down through the style toward the ovary.

(c) The male germ cell (sperm) travels through this tube and reaches the ovule inside the ovary.

Significance: This event is crucial for fertilisation to occur. The sperm cell fuses with the female germ cell (egg) inside the ovule. This fusion forms a zygote, which will eventually develop into a seed, allowing the plant to reproduce and continue its species.

5. Vegetative propagation is a form of asexual reproduction in plants where new plants grow from vegetative parts of the parent plant, such as stems, roots, or leaves, without the involvement of seeds.

Methods of vegetative propagation in plants:

(i) Layering: In layering, a lower branch of the plant is bent and buried under the soil, with the tip of the branch remaining above the ground. Over time, roots develop from the buried section of

the branch, eventually forming an independent plant. This method is commonly used for propagating jasmine and other ornamental plants.

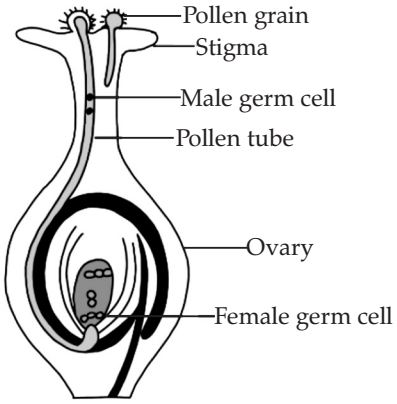
(ii) Grafting: Grafting involves joining two plants to grow together as a single plant. It is typically used for plants with a weak root system or those that do not root easily. The two plants are tied together to ensure direct contact between them. The new plant benefits from a strong root system and increased yield of fruits and flowers. This technique is commonly used for growing varieties of mango, lemon, grapes, and roses.

Advantages of Vegetative Propagation

(i) Rapid Multiplication: A large number of plants can be obtained in a short interval, making it an efficient method for quickly increasing plant populations.

(ii) Propagation of Seedless Plants: This method enables the propagation of seedless plants, such as certain varieties of grapes and bananas, which cannot be reproduced through seeds.

6. Upon touching a suitable stigma, the pollen grain absorbs water and nutrients, which initiates the formation of a pollen tube. This pollen tube grows down through the style towards the ovary. At its tip, the pollen tube carries two male gametes (sperm cells) and a tube nucleus. The pollen tube then enters the embryo sac within an ovule, usually through the micropyle. Upon reaching the embryo sac, the pollen tube bursts, releasing the two male gametes. One of these male gametes fuses with the egg cell to form a zygote.



This action is referred to as syngamy. When the second male gamete combines with the binucleate central cells, it creates the endosperm. This process, known as triple fusion, involves the fusion of three haploid nuclei. Thus, triple fusion is the union of a male gamete with two polar nuclei within the embryo sac of an angiosperm.

7. The process of spore formation takes place in many simple multicellular organisms.

(i) Organism using this process to reproduce: *Rhizopus* (a type of fungus).

(ii) Reproductive and non-reproductive parts of such organisms:

- **Reproductive part:** Sporangia (the structures that produce and contain spores).
- **Non-reproductive part:** Hyphae (the thread-like structures that make up the body of the fungus).

Two benefits to an organism that reproduces through spores:

(1) Survival in Harsh Conditions: Spores are often resistant to extreme conditions such as heat, drought, and radiation, allowing the organism to survive adverse environments.

(2) Efficient Dispersal: Spores can be easily dispersed by wind, water, or other agents, facilitating the spread of the organism to new locations and increasing its chances of survival and colonisation.

8. The placenta is a special disc-like structure embedded in the uterine wall, forming an intimate connection between the embryo and the uterine wall. It consists of blood spaces on the mother's side and thousands of villi (small projections) on the foetal side. These villi provide a large surface area, facilitating the exchange of nutrients and oxygen between the mother and the foetus.

Role of Placenta During Pregnancy: This multifunctional organ is crucial for the healthy growth and development of the foetus throughout pregnancy. The exchange of materials between the blood of the mother and the foetus occurs through the placenta. This structure not only provides essential nutrition to the foetus but also functions as its respiratory and excretory organ. By allowing the exchange of oxygen and carbon dioxide, the placenta ensures the foetus receives the oxygen it needs for development. Additionally, it facilitates the removal of waste products from the foetal blood into the mother's bloodstream, where they can be excreted by the mother's body.

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) Three techniques/devices Used by Human Females to Avoid Pregnancy are:

(1) Barrier Method (Condoms)

Function: Condoms create a mechanical barrier that prevents sperm from reaching the egg, serving as a method of contraception.

Side Effects: Generally minimal, but some individuals may experience irritation or allergic reactions to the material (such as latex).

(2) Hormonal Method (Pills)

Function: These pills alter the hormonal balance in the female body to prevent

the release of eggs, making fertilization impossible.

Side Effects: Hormonal contraceptives can cause side effects such as nausea, weight gain, mood changes, headaches, and a potential increase in the risk of blood clots due to changes in hormone levels.

(3) Surgical Method [IUD (Intrauterine Device) or Copper-T]

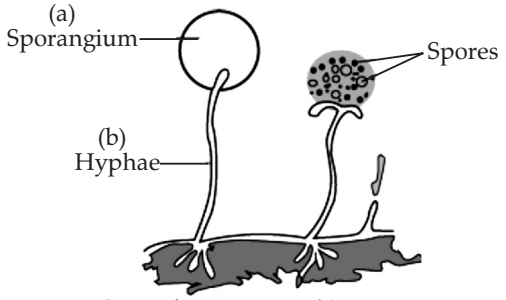
Function: These devices are inserted into the uterus to prevent pregnancy by either altering the uterine lining or preventing sperm from reaching the egg.

Side Effects: IUDs may cause side effects such as cramping, irregular bleeding, and irritation of the uterus. There is also a small risk of pelvic infections or the device being expelled.

(ii) (a) Fertilisation Takes Place: If fertilisation occurs, the sperm meets the egg in the oviduct, forming a zygote. The fertilised egg (zygote) travels to the uterus and implants itself in the uterine lining. The uterus, which has thickened and is richly supplied with blood, provides the necessary nutrients for the growing embryo. The placenta, a special tissue embedded in the uterine wall, allows the exchange of nutrients, oxygen, and waste between the mother and the embryo. The embryo continues to develop inside the mother's body for about nine months until birth.

(b) An Egg is Not Fertilised: If the egg is not fertilised, it dies after about one day. The uterus, having prepared itself to receive a fertilised egg, now sheds its thickened lining, as it is no longer needed. This lining, along with blood and mucous, is expelled through the vagina in a process called menstruation. This cycle typically occurs every month and lasts for about two to eight days.

2. (i)



Spore formtion in *Rhizopus*

(a) Reproductive parts of bread mould (*Rhizopus*) - Sporangium

(b) Non-reproductive parts of bread mould (*Rhizopus*) is Hyphae

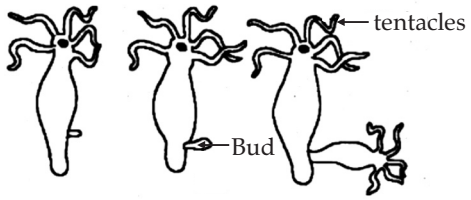
Rhizopus, like other fungi, needs moisture to grow and reproduce. On dry bread, the lack of moisture prevents the growth of hyphae and the absorption of nutrients, which stops the fungus from multiplying.

(ii) Reproduction in *Hydra* takes place through a process called budding. It occurs as follows:

(1) Budding: In *Hydra*, a bud forms as an outgrowth from a specific site on the parent's body. This happens due to repeated cell division at that particular spot.

(2) Development of Bud: The bud grows into a small, fully-formed individual while still attached to the parent. Over time, it develops all the necessary structures to function as an independent organism.

(3) Separation: Once the bud matures, it detaches from the parent and becomes a new, independent *Hydra*.



Budding in *Hydra*

3. (i) Spores are tiny, reproductive cells that can grow into new individuals under suitable conditions. In the case of fungi, spores are formed in sporangia, which are specialized structures that look like small blobs on a stick.

Spores have thick walls that protect them from harsh environmental conditions, such as dryness or temperature extremes. This protection allows them to survive until they come into contact with a moist surface, where they can begin to grow and develop into new *Rhizopus* individuals. The organism that multiplies using spores in this manner is *Rhizopus,* commonly known as bread mould.

Sporangium multiplies with the help of spores.

(ii) Two Reasons Why Some Plants Are Grown by Vegetative Propagation:

(1) Slow Germination and Maturation of Seeds: For certain plants, seeds take a long time to germinate and mature. Vegetative propagation allows for faster growth and earlier production of flowers and fruits. Sugarcane and potato are examples where vegetative propagation is preferred for quicker harvests.

(2) Retention of Parent Plant Characteristics: Vegetative propagation ensures that specific characteristics of the parent plant, such as fruit quality, flower colour, or disease resistance, are retained in the new plants. This is especially important for maintaining desirable traits in plants like roses or grapes.

Two Methods Used to Grow Plants Vegetatively:

(1) Layering: A method where a stem or branch of the plant is bent down to the ground and

covered with soil. It develops roots and can later be separated to grow as a new plant.

(2) Grafting: A technique where a part of one plant (called the scion) is joined with a part of another plant (called the rootstock), allowing them to grow together as one plant. This is commonly used in fruit tree cultivation.

4. (i) A: Pollen grain (containing the male gamete or sperm).

B: Pollen tube (the tube that grows from the pollen grain after it lands on the stigma and travels down the style toward the ovary.)

C: Female germ cell (egg cell) (Located inside the ovule within the ovary.)

When the pollen tube (B) reaches the female germ cell (C) in the ovule, fertilisation occurs. This fusion of the male and female gametes forms a zygote, which will develop into an embryo.

Significance of this Event:

- Fertilisation is essential for the formation of seeds. The zygote formed after fertilisation will develop into a seed containing the genetic material from both parents, ensuring genetic diversity and the continuation of the plant species.

(ii) After fertilisation, several changes occur in the flower. The zygote divides to form an embryo within the ovule, which develops a tough outer coat and becomes a seed. The ovary grows and ripens into a fruit, which protects the seeds. Meanwhile, the petals, sepals, stamens, style, and stigma wither and fall off, as they are no longer needed. The process of seed formation ensures protection, dispersal, and dormancy, and it contributes to genetic diversity. When conditions are right, the seed undergoes germination, where the embryo develops into a new plant.

5. (i) (1) The ovaries are responsible for the maturation of eggs.

(2) The fusion of the egg and sperm occurs in the fallopian tubes.

(3) The implantation of the zygote takes place in the lining of the uterus.

(ii) (1) When the egg is fertilised, the zygote travels to the uterus and implants in the thickened uterine lining, which has become rich in blood to support the growing embryo. The placenta forms, a disc-like structure that attaches to the uterine wall. The placenta provides nutrients and oxygen from the mother's blood to the embryo and removes waste products from the embryo's blood. This exchange happens through the villi in the placenta. The embryo develops inside the uterus for about nine months, and the baby is born as a result of rhythmic contractions of the uterine muscles.

(2) If the egg is not fertilised, it survives for about one day. The uterus still prepares itself monthly to receive a fertilised egg, making the lining thick and spongy. Since fertilisation did not occur, the uterine lining is no longer needed. It slowly breaks down and is shed through the vagina as blood and mucous. This process is called menstruation, and it typically lasts for about two to six days.

6. (i) (1) Unisexual Flowers: A flower that possesses either stamens or carpels but not both are called unisexual flowers. Examples include papaya, watermelon etc.

(2) Bisexual Flowers: A flower that possesses both stamens and carpels. Examples include mustard, Hibiscus etc.

(ii) A: Pollen grain

B: Stigma

C: Pollen tube

D: Female germ-cell

(iii) Pollination is the process by which pollen is transferred from the male part of a flower (anther) to the female part (stigma). This process can occur without fertilisation because pollination merely involves the transfer of pollen. Whereas, fertilisation is the process that occurs after pollination when the pollen grain germinates on the stigma, and the pollen tube grows down the style to reach the ovule in the ovary. The sperm cells travel through the pollen tube to fuse with the egg cell, leading to the formation of a zygote. Therefore, pollination is a prerequisite for fertilisation as it enables the sperm to reach the egg. Without pollination, the pollen would not reach the stigma, and fertilisation would not occur.

7. (i) The parts of a bisexual flower that are not directly involved in reproduction are:

- **Petals:** They attract pollinators through their colour and scent, but do not play a direct role in fertilisation.
- **Sepals:** They protect the flower bud before it opens, ensuring the flower remains safe during development but do not directly participate in reproduction.

(ii)

Self Pollination	Cross Pollination
This occurs when the pollen from the same flower or from a flower on the same plant fertilises the egg. The pollen is transferred from the stamen to the stigma of the same flower or another flower on the same plant.	This occurs when pollen is transferred from the stamen of one flower to the stigma of a different flower, either on the same plant or a different plant. This transfer is usually facilitated by external agents like wind, water, or animals.

Significance of Pollination:

(1) Genetic Diversity: Cross-pollination promotes genetic variation, which helps plants adapt to different environmental conditions.

(2) Seed and Fruit Formation: Pollination is essential for fertilisation, leading to the formation of seeds and fruits, ensuring the continuation of plant species.

(iii) After fertilisation, the ovule develops a tough coat and is gradually converted into a seed. Whereas, the ovary grows rapidly and ripens to form a fruit.

8. (i) (1) Regeneration: Many fully differentiated organisms have the ability to give rise to new individual organisms from their body parts, i.e., if the individual is somehow cut or broken up into many pieces, many of these pieces grow into separate individuals. For example, *Hydra* has the ability to regenerate lost body parts. If the *Hydra* is cut into pieces, each piece can regenerate the missing parts and grow into a new, complete individual. This process occurs because of specialised cells that proliferate and differentiate into various cell types, helping to rebuild the missing structures.

(2) Budding: Organisms such as *Hydra* use regenerative cells for reproduction in the process of budding. In *Hydra*, a bud develops as an outgrowth due to repeated cell division at one specific site. These buds develop into tiny individuals and when fully mature, detach from the parent body and become new independent individuals.

(ii) Vegetative propagation is a form of asexual reproduction in plants where new plants grow from parts of the parent plant such as roots, stems, or leaves. This can occur naturally or artificially through various methods like cuttings, grafting, layering, and tissue culture.

The two advantages of growing plants by vegetative propagation are:

(1) Faster Flowering and Fruiting: Plants raised through vegetative propagation, such as sugarcane, roses, or grapes, can bear flowers and fruits earlier than those grown from seeds. This leads to quicker yields, which is beneficial for agricultural purposes.

(2) Genetic Uniformity: Since vegetative propagation produces genetically identical plants to the parent, all new plants will have the same desirable characteristics, such as fruit quality or flower colour.

9. (i) (1) When the leaves of *Bryophyllum* fall on the soil, the buds produced in the notches along the leaf margin develop into new plants. These buds, after falling, take root in the soil and grow into independent, complete plants. The mode of reproduction in *Bryophyllum* is asexual reproduction through vegetative propagation.

(2) When *Planaria* is cut into many pieces, each piece has the ability to regenerate and grow into a complete organism. This process, known as regeneration, involves specialised cells that divide and proliferate. These cells then differentiate into various cell types and tissues, forming the missing parts and eventually developing into a fully functional organism. The mode of reproduction in *Planaria* is asexual reproduction through regeneration.

(3) The sporangia of *Rhizopus* release spores when they mature. These spores are protected by thick walls until they find a suitable, moist surface to grow. The spores germinate and develop into new *Rhizopus* individuals, all of which are genetically identical to the parent. This type of reproduction is asexual reproduction through spore formation.

(ii) Once fertilisation takes place in a flower, several changes occur which are as follows:

(1) Zygote formation: The male germ-cell (pollen) fuses with the female gamete (egg cell) in the ovule to form a zygote.

(2) Embryo development: The zygote divides and develops into an embryo inside the ovule.

(3) Ovule to seed: The ovule undergoes changes and develops a tough outer coat, gradually turning into a seed.

(4) Ovary to fruit: The ovary swells and ripens to form a fruit that contains the seeds.

(5) Other parts of the flower: The petals, sepals, stamens, style, and stigma may shrivel and fall off, as they are no longer needed for reproduction.

10. (i) Inheritance involves the transmission of genetic information from parents to offspring through genes. Genes code for proteins, which are responsible for various structural and functional aspects of an organism's body. Variations in the genes inherited can lead to differences in the types and functions of proteins produced, resulting in altered body designs.

(ii) Pollination is the transfer of pollen from the male anther to the female stigma of a flower. This process is essential for fertilisation because it allows the male gametes (sperm cells) contained within the pollen to reach the female ovules (egg cells). Without pollination, the male and female gametes cannot come into contact, preventing the fusion of their nuclei and thus fertilisation cannot occur.

(iii) Fragmentation and regeneration are specific forms of asexual reproduction that are feasible

in certain simple multicellular organisms, such as some invertebrates and lower plants. However, most multicellular organisms, especially more complex ones like mammals, birds, and many plants, do not have the capability to reproduce or regenerate complete individuals from fragments due to their specialised and differentiated cells and tissues.

(iv) Vegetative propagation is particularly effective for plants that can reproduce through their vegetative parts like stems, roots, or leaves. It is commonly used to grow plants that do not produce viable seeds, have slow germination, or where maintaining the genetic consistency of the offspring is desired. Examples include banana, orange, rose, jasmine etc.

(v) During sexual reproduction, gametes (sperm and egg cells) are produced through meiosis, which halves the chromosome number (i.e, 23). When fertilisation occurs, the fusion of these haploid gametes restores the diploid chromosome number (i.e, 46) in the offspring. This ensures that the offspring have the same chromosome number as their parents, maintaining the offsprings chromosomal integrity across generations.

8 CHAPTER

Heredity and Evolution

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (D) is correct.
Explanation: In snails, sex is not strictly genetically determined; rather, it can change based on environmental factors. This phenomenon is known as sequential hermaphroditism, where individuals can start life as one sex (male) and later change to the other sex (female) depending on external conditions like size, age, or population dynamics.

2. Option (D) is correct.
Explanation: Changes in proteins can impact the function and structure of cells, tissues, and organs, which in turn can affect an organism's traits or features. Since proteins are crucial in determining the phenotype, any alteration in a protein could lead to changes in how traits are expressed, regardless of whether the genetic information remains the same. Thus, statement (D) is not correct.

3. Option (C) is correct
Explanation: Chromosomes are thread-like structures located in the nucleus of animal cells that carry genetic information from parents to offspring. They play a vital role in inheritance and cell division, ensuring the precise distribution of genetic material during cell division, which enables the transmission of genetic information across generations. Statement (iii) is incorrect because human reproductive cells (gametes) are haploid and do not exist in pairs.

4. Option (C) is correct
Explanation: T represents the dominant gene for tallness. t represents the recessive gene for shortness. A plant will only be short if it has two recessive genes (tt). The cross must involve heterozygous tall parent (Tt) and one homozygous short parent (tt). Option (c), Tt and tt is the only option that gives 50% tall and 50% short plants.

5. Option (C) is correct
Explanation: If two traits (such as seed shape and colour) are inherited independently, and both are governed by dominant and recessive alleles (for example, R for round shape vs. r for wrinkled, and Y for yellow colour vs. y for green), the F_2 progeny would result in four different combinations of seeds. They will be wrinkled-yellow, round-yellow, wrinkled-green seeds and round-green in the phenotypic ratio of 9:3:3:1.

6. Option (A) is correct
Explanation: For dwarf plants (tt) to appear, both parents must carry the recessive t allele. A cross between two Tt (heterozygous tall) plants will produce TT, Tt, and tt offspring, with 25% of them being dwarf (tt).

7. Option (C) is correct
Explanation: A human zygote is formed by the fusion of a male gamete (sperm, 23 chromosomes) and a female gamete (egg, 23 chromosomes). Together, they result in a zygote with 46 chromosomes (23 pairs).

8. Option (A) is correct
Explanation: When pure tall plants (TT) are crossed with pure dwarf plants (tt), all offspring in the F_1 generation will have the genotype Tt (heterozygous), and they will all be tall since the tall trait (T) is dominant over the dwarf trait (t). When the F_1 generation (Tt) is self-crossed, the possible genotypes of the offspring will be:

	T	t
T	TT	Tt
t	Tt	tt

The results from the Punnett square show the following genotypes:
1 TT (homozygous tall)
2 Tt (heterozygous tall)
1 tt (homozygous dwarf)
So, the ratio of the genotypes in the F_2 generation is 1 TT: 2 Tt: 1 tt

9. Option (A) is correct
Explanation: In individuals of a given species, a specific gene is located on a particular chromosome. This is because genes are segments of DNA that are located on specific locations on chromosomes, and they carry the instructions for making proteins and other molecules that are essential for the functioning of cells.

10. Option (A) is correct
Explanation: When the F_1 plants (Vv) are self-crossed to produce the F_2 generation, the possible genotypes and phenotypes of the offspring can be determined using a Punnett square. In this case, the genotypic ratio would be: 1 VV : 2 Vv : 1 vv
And the phenotypic ratio (ratio of violet flowers to white flowers) would be:
3 Violet: 1 White
So, in the F_2 progeny, the ratio of violet (VV) to white (vv) flowers will be 1:1.

11. Option (C) is correct
Explanation: The trait that expresses itself in the F_1 generation refers to a trait that is visible or dominant when the first filial generation is produced from a cross between two parent organisms. In genetics, this trait is known as the dominant trait.
The trait that keeps on passing from one generation to another refers to traits that are inherited from parents to offspring. In genetics, this is referred to as an inherited trait.

12. Option (B) is correct
Explanation: The cross between a plant with red flowers (Rw) and a plant with white flowers (ww) results in the following Punnett square:

	w	w
R	Rw	Rw
w	ww	ww

Thus, the genotypes of the offspring are:
- 2 Rw (red flowers)
- 2 ww (white flowers)

This gives us a ratio of:
- 2 red (Rw): 2 white (ww)

Simplifying the ratio, we get:
- 1 red: 1 white

Thus, 50% of the offspring will have white flowers (ww).

13. Option (A) is correct
Explanation: Traits are characteristics that an individual possesses. The traits developed in an organism due to the effect of environmental factors are known as acquired traits. These traits are not encoded in the DNA of the organism and therefore cannot be passed on to future generations. Examples of acquired traits include the muscular body of a wrestler, playing a musical instrument, reading, writing, animal behavior, and short hair. On the other hand, tall height, brown eyes, and body mass are examples of inherited traits.

14. Option (D) is correct
Explanation: Attached earlobes in humans is a recessive trait, meaning an individual must inherit two copies of the recessive allele (ee) to express the trait. If both parents have attached earlobes, their genotype must be ee (homozygous recessive), as this is the only way the trait is expressed. When both parents have the genotype ee, they can only pass on the recessive allele (e) to their offspring. As a result, all children will inherit the ee genotype and exhibit the attached earlobes trait. Therefore, the chances of their child having attached earlobes is 100%.

15. Option (A) is correct
Explanation: A monohybrid cross is a cross between two parents that differ in one specific trait with contrasting alleles. In this case, the full pod shape (FF) is a dominant trait, whereas the constricted pod shape (ff) is a recessive trait. When a pea plant with full pods (FF) is crossed with a pea plant with constricted pods (ff), all the F_1 progeny will be heterozygous (Ff). This means they will all display the dominant full pod shape. Therefore, 100% of the F_1 generation will have the full pod shape.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (B) is correct
Explanation: The Assertion (A) states that human females have a perfect pair of sex chromosomes (XX), which is true because their sex chromosomes are homologous. The Reason (R) explains that the sex chromosome contributed by the human male in the zygote determines the sex of the child, which is also true. While both statements are true, reason does not explain assertion. The chromosome pair in females being perfect is unrelated to how the male gamete determines the sex of a child.

2. Option (D) is correct.
Explanation: The Assertion (A) that the sex of the children is determined by what they inherit from their mother is false because the mother's contribution is always an X chromosome, and the sex of the child is determined by the father's contribution (either an X for a female or a Y for a male). The Reason (R) that women have XX sex chromosomes is true, as females possess two homologous X chromosomes. Therefore, A is false, but R is true.

3. Option (C) is correct
Explanation: The Assertion (A) that each human trait is influenced by both paternal and maternal DNA is true, as every child inherits one set of chromosomes from each parent, which together determine their traits. However, the Reason (R) that the mother contributes more genetic material to the child compared to the father is false, as both parents contribute an equal amount of genetic material (23 chromosomes each). While the mother does provide additional cytoplasmic material, such as mitochondrial DNA, it does not increase her nuclear genetic contribution. Therefore, A is true, but R is false.

4. Option (C) is correct
Explanation: The sex of a child is determined by the combination of sex chromosomes inherited from the parents. A child inherits one sex chromosome from each parent: an X chromosome from the mother and

either an X or Y chromosome from the father. If the child inherits an X chromosome from the father, the child will be female (XX). If the child inherits a Y chromosome from the father, the child will be male (XY). Therefore, in a male child, the father provides the Y chromosome that determines the child will be male. Thus, assertion is true but reason is false.

5. Option (D) is correct
Explanation: The Assertion (A) states that in humans, if gene B is responsible for black eyes (dominant) and gene b is responsible for brown eyes (recessive), then progeny with the combinations Bb, bb, or BB will have black eyes. This is false because only individuals with at least one dominant B allele (Bb or BB) will have black eyes, while individuals with bb (homozygous recessive) will have brown eyes. The Reason (R) that black eye color is a dominant trait is true, as it explains why Bb and BB combinations express the black eye phenotype. Thus, assertion is false but reason is true.
6. Option (C) is correct
Explanation: Humans exhibit a wide range of variations in their traits, including physical traits like skin color, eye color, and height, as well as non-physical traits like personality and intelligence. These variations arise due to genetic differences and environmental influences, which contribute to the diversity in human populations. However, not all variations have an equal chance of survival and reproduction. Some variations may provide an advantage, helping individuals adapt better to their environment, survive, and reproduce, while others may be neutral or even harmful. Thus, assertion is true but reason is false.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i) The two observations made by Mendel were:
(1) All F_1 plants were tall, indicating that the tall trait is dominant over the short trait.
(2) No F_1 plants exhibited the short trait, showing that the short trait is recessive and is masked in the presence of the dominant allele.

(ii)

Dominant Trait	Recessive Trait
In a heterozygous individual, the dominant trait overpowers the recessive trait and is always expressed. It is denoted using capital letters (e.g., T for tall plants). For example, in Tt, the tall trait is expressed because the dominant allele T masks the recessive allele.	This trait is only expressed in homozygous individuals (tt) and remains hidden in the presence of a dominant allele. It is represented by lowercase letters (e.g., t for short plants). For instance, in Tt, the short trait remains masked.

(iii) (a) Mendel crossed the F_1 hybrids (RrYy) obtained from the parental cross RRYY × rryy (Round Yellow × Wrinkled Green) through self-pollination to produce the F_2 generation.
Observations in F_2 generation:
- Mendel observed 4 types of combinations: Round Yellow, Round Green, Wrinkled Yellow, and Wrinkled Green in a phenotypic ratio of 9:3:3:1.
- The ratio of parental combinations (Round Yellow and Wrinkled Green) was 9 (Round Yellow):1 (Wrinkled Green).

From this experiment, Mendel concluded the following:
- **Law of Independent Assortment:** Mendel found that genes for various characteristics segregate independently during gamete development. Seed shape (round or wrinkled) and colour (yellow or green) are not inherited.
- **Dihybrid Ratio:** The F_2 generation exhibits a phenotypic ratio of 9:3:3:1, supporting the Law of Independent Assortment. The dihybrid ratio shows the distribution of attributes between two opposing pairs in a genetic cross.

OR

(b) If pea plants with yellow seeds are crossed with plants of green seeds, it is found that in F_1 generation all the plants have yellow seeds. When F_1 generation, plants with yellow seeds and plants with green seeds are obtained. This shows that both the traits are inherited but only one trait is visible in F_1 progeny while the others remains unexpressed.

2. (i) **Flower color:** Purple (dominant) vs. White (recessive)
Height of the plant: Tall Vs. Dwarf.

(ii)

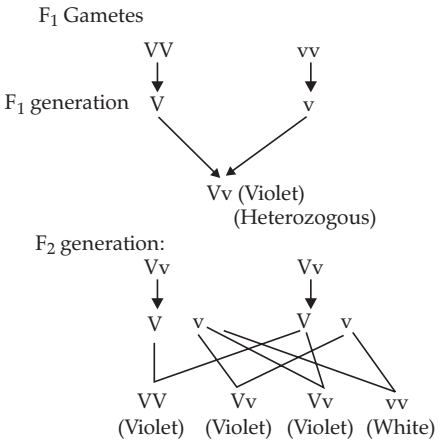
Dominant trait	Recessive trait
The trait which gets expressed in F_1 generation is called dominant trait.	The trait which remains suppressed in F_1 generation, which cannot express itself in presence of dominant trait is called recessive trait.
It gets expressed in both homozygous and heterozygous condition.	It gets expressed only when present in homozygous condition.

(iii) (a) The F_2 generation seeds shows the 9:3:3:1 phenotypic ratio
- Round yellow seeds: 9
- Round green seeds: 3
- Wrinkled yellow seeds: 3
- Wrinkled green seeds: 1

This 9:3:3:1 ratio is a classic Mendelian dihybrid cross result, demonstrating his law of independent assortment. This ratio indicates that Mendel observed nine plants with the dominant phenotype for both traits, three plants with the dominant phenotype for one trait and the recessive phenotype for the other trait, three plants with the recessive phenotype for one trait and the dominant phenotype for the other trait, and one plant with the recessive phenotype for both traits.

OR

(b)



Hence,

F_1 Generation:

- **Genotype:** All plants will be heterozygous (Vv)
- **Phenotype:** All plants will have violet flowers (since violet is dominant)

F_2 Generation (Selfing F_1 plants):

- **Genotypes:**
  - 1 VV (homozygous dominant)
  - 2 Vv (heterozygous)
  - 1 vv (homozygous recessive)
- **Phenotypes:**
  - 3 Violet-flowered plants (VV and Vv)
  - 1 White-flowered plant (vv)

This demonstrates Mendel's principle of dominance and segregation, where the recessive trait reappears in the F_2 generation in a predictable ratio.

3. (i) An offspring of a human is not a true copy of its parents in sexual reproduction because it inherits a unique combination of genes from both parents, resulting in genetic variation.

(ii)

F_1 generation	F_2 generation
(1) In F_1 generation only the dominant traits are expressed.	In F_2 generation, both dominant and recessive triats are expressed.
(2) It refers to the offspring/plants resulting immediately from a cross between the first set of parents.	It refers to the offspring/plants resulting from a cross among the plants of F_1 generation.

(iii) (a) Variations are useful for the survival of a species over time because they provide a genetic diversity that allows populations to adapt to changing environments. Variations can lead to the development of new traits that may offer a survival advantage, such as resistance to diseases, ability to find new food sources, or adaptability to different climates.

OR

(b) The new combinations observed in the F_2 generation are "Round Green" (RRyy) and "Wrinkled Yellow" (rryy). These combinations were not present in the parental generation and result from the independent assortment of alleles during gamete formation.

These new combinations arise due to Mendel's laws of independent assortment and segregation, which contribute to genetic diversity in the offspring.

4. (i) The sex of a newborn baby in humans is determined by the sex chromosome inherited from the father: an X chromosome results in a female (XX), while a Y chromosome results in a male (XY).

(ii) The pair of sex chromosomes in males is called a mismatched pair because they consist of one X chromosome and one Y chromosome, which are different in size and genetic content.

(iii) (a) The original number of chromosomes present in the parents is restored in the progeny through the processes of meiosis and fertilisation. During meiosis, the number of chromosomes in germ cells (sperm and egg) is halved, resulting in haploid cells with 23 chromosomes each in humans. When fertilisation occurs, the haploid sperm and egg combine to form a diploid zygote with 46 chromosomes, restoring the original number of chromosomes.

OR

(b) Temperature-Dependent Sex Determination in Turtles: In many turtle species, the sex of the offspring is determined by the temperature at which the eggs are incubated. For example, eggs incubated at higher temperatures often produce females, while those at lower temperatures produce males.

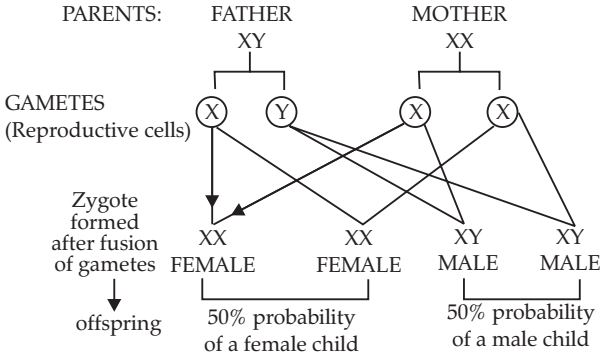
Sequential Hermaphroditism in Clownfish: All clownfish are born male, and the

dominant male can change to female if the current female dies, allowing the next male in the hierarchy to become the new breeding male.

5. (i)
- In a human zygote, there are 46 chromosomes.
- In each human gamete (sperm or egg), there are 23 chromosomes.

(ii) In some reptiles, such as turtles, sex determination is influenced by the incubation temperature of the eggs, with higher temperatures producing females and lower temperatures producing males; this is called temperature-dependent sex determination (TSD).

(iii) (a) The sex of a child is determined by the combination of sex chromosomes from the parents. The mother contributes an X chromosome, while the father can contribute either an X or a Y chromosome. If the father's sperm carries an X chromosome, the child will be female (XX). If the father's sperm carries a Y chromosome, the child will be male (XY). Thus, there is an equal chance of fusion of either X or Y chromosome with the egg. Therefore, we can say that the sex of a newborn child is a matter of chance and none of the parents are responsible for it.



OR

(b) All gametes (eggs) formed in human females have an X chromosome because females have two X chromosomes (XX). During meiosis, the two X chromosomes separate, ensuring that each egg receives one X chromosome. Since, females do not have a Y chromosome, they can only produce gametes with an X chromosome.

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

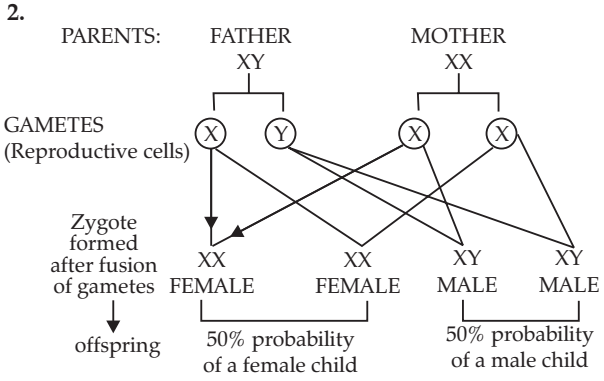
1. Two of the most famous pairs of traits that Mendel studied were:

Seed Shape:
- **Dominant Trait:** Round seeds (Symbolised by "R")
- **Recessive Trait:** Wrinkled seeds (Symbolised by "r")

Flower Color:
- Dominant Trait: Purple flowers (Symbolised by "P")
- Recessive Trait: White flowers (Symbolised by "p")

These contrasting pairs of traits allowed Mendel to observe clear patterns of inheritance and formulate his laws of segregation and independent assortment.

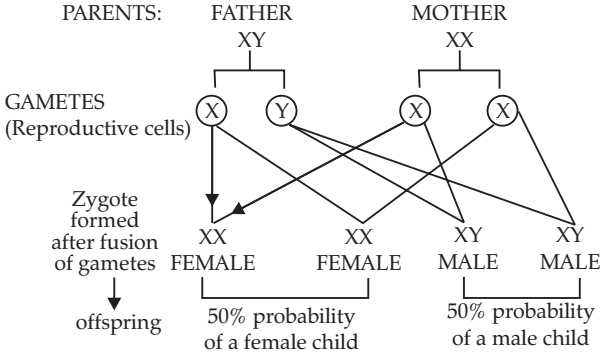
2.



3. The survival of species is promoted through creation of variations because vairations increase the chances of species adapting of changing environments. This principle is central to evolution.

Example: A population of bacteria living in temparate waters that can withstand heat due to the rise in temperature due to global warming will survive better in a heat wave than the non-variant bacteria having no capacity to tolerate heat wave. Thus, suitable variations promote survival.

4. A newborn child who inherits 'X' chromosome from father will be a girl and one who inherits a 'Y' chromosome from the father will be a boy. This can be explained with the help of a flow diagram given below:



5. (i) The gene combination present in the plants of the F_1 generation is Tt. All F_1 plants are heterozygous with one allele for tallness (T) and one allele for shortness (t).

(ii) Only tall plants are observed in the F_1 progeny because the allele for tallness (T) is dominant over the allele for shortness (t). In a heterozygous combination (Tt), the dominant trait (tallness) is

expressed, masking the effect of the recessive trait (shortness). This phenomenon is explained by Mendel's Law of Dominance, which states that "among the different alleles of a specific gene located at the same chromosomal position, some alleles are dominant over others."

(iii) When F_1 plants are self-pollinated:

	T	t
T	TT	Tt
t	Tt	tt

Genotypic ratio: 1 : 2 : 1 (TT = 25% Tt = 50% tt = 25%)

Phenotypic ratio: 3 : 1 (Tall = 75% Short = 25%)

Based on Punnet Square analysis, the F_2 generation will have the following genotype ratio:

- TT (homozygous tall): 1/4
- Tt (heterozygous tall): 2/4
- tt (homozygous short): 1/4

Therefore, the phenotypic ratio of tall to short plants in the F_2 generation will be:

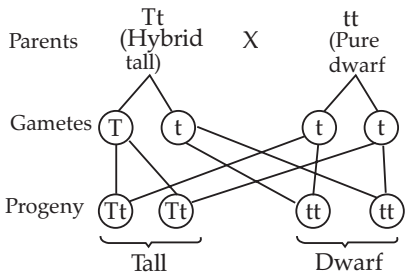
- 3 tall plants (TT and Tt): 1 short plant (tt)

So, the ratio of tall to short plants in the F_2 generation is 3:1.

6. In sexually reproducing organisms, the number of chromosomes in the progeny is re-established through meiosis and fertilisation. The process of meiosis reduces the chromosome number by half, producing haploid gametes (sperm and egg), each containing one set of chromosomes (n). During fertilisation, a haploid sperm cell fuses with a haploid egg cell, combining their genetic material to form a diploid zygote with two sets of chromosomes (2n). This restores the original chromosome number in the progeny.

7. Humans have 23 pairs of chromosomes, with one pair being sex chromosomes. Females have identical sex chromosomes (XX), while males have non-identical sex chromosomes (XY). During gametogenesis, the chromosome number is halved, resulting in male sperm containing either an X or a Y chromosome in equal proportions. During ejaculation, millions of sperm are released, and the sperm that fertilises the egg determines the sex of the zygote. If an X-bearing sperm fertilises the egg, the zygote will be XX (female). If a Y-bearing sperm fertilises the egg, the zygote will be XY (male). Since the ratio of X to Y chromosomes in male sperm is 50:50, the probability of having a male or female child is also 50:50. Thus, the statistical probability of conceiving either a male or female child is equal.

8. This can be shown as



9. Variation refers to the differences in the genetic makeup and physical traits among individuals within a population. The two main reasons that may lead to variation in a population are:

(i) Mutations: Mutations are changes in the DNA sequence that can occur spontaneously or due to environmental factors. These changes can introduce new traits into a population, increasing genetic diversity.

(ii) Sexual Reproduction: During sexual reproduction, the combination of genes from two parents leads to offspring with a unique set of genetic information. This recombination of genes during the formation of gametes (meiosis) and fertilisation results in variation among offspring.

10. (i) All F_1 progeny will have violet flowers (Vv) because the violet flower trait is dominant over the white flower trait.

(ii) The F_2 progeny will show a phenotypic ratio of 3:1, where 75% of the plants will have violet flowers and 25% will have white flowers. This is because the F_1 progeny (heterozygous for the flower colour trait) will produce a mix of homozygous dominant, heterozygous, and homozygous recessive offspring.

(iii) Since the recessive trait appears in 25% of the F_2 progeny:

Number of plants with recessive trait = 0.25 x 100 = 25

So, 25 plants will show the white flower (recessive) trait.

11. Mendel observed that crossing two pea plants with contrasting traits (such as tall and short) resulted in F_1 progeny showing only one parental trait (e.g., all tall or all short). This is explained by the principle of dominance:

- Each trait is controlled by a pair of alleles (one from each parent).
- One allele is dominant, and the other is recessive.
- The dominant allele masks the expression of the recessive allele in heterozygous individuals.

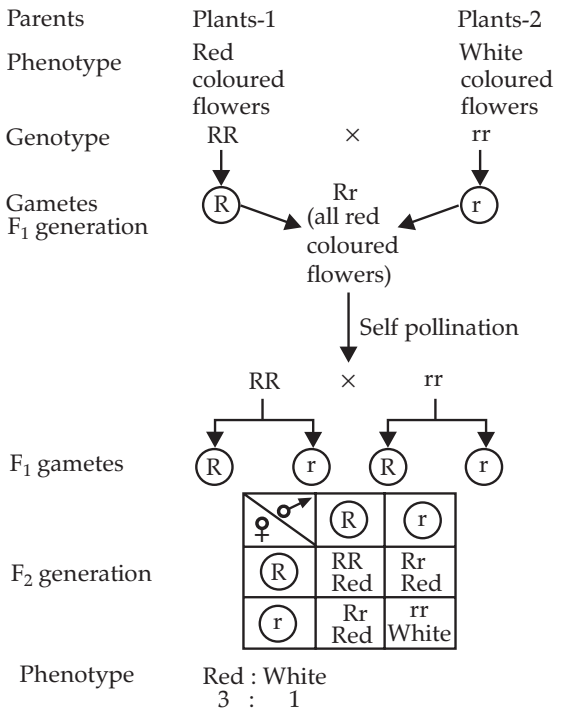
For example, if tallness (T) is dominant over shortness (t), crossing homozygous tall (TT) with homozygous short (tt) results in F_1 progeny that are all heterozygous (Tt) and display the tall phenotype. Thus, no intermediate characteristics appear in the F_1 generation.

12. Humans have two types of sex chromosomes, X and Y, which determine the sex of an individual. Females

have two X chromosomes (XX). Males have one X and one Y chromosome (XY). During reproduction, the mother contributes one X chromosome whereas a father can contribute either an X or a Y chromosome to the offspring. If the child inherits an X chromosome from the father, the resulting combination will be XX, which means the child will be female. If the child inherits a Y chromosome from the father, the resulting combination will be XY, which means the child will be male. Therefore, sex of the children will be determined by what they inherit from their father.

13. Genes control the characteristics or traits in an organism by encoding instructions for the synthesis of specific proteins. For example, in plants, the gene responsible for tallness codes for proteins that help promote the growth of the plant by enabling efficient cell division and elongation. This results in the production of more plant tissues, leading to greater height. In contrast, the gene for shortness (dwarfness) codes for proteins that limit the plant's growth, either by reducing the efficiency of cell growth or by influencing the plant's overall growth process. Therefore, the gene determines the type of protein produced, which in turn controls the plant's height, showing how genes regulate the traits of an organism.

14. The following flow chart and explanation illustrate the inheritance pattern and the ratio of red to white flowers in the F_2 generation.



The phenotypic ratio of the F_2 generation is 3:1, with 75% of the plants having red flowers and 25% having white flowers. This result confirms Mendelian inheritance principles, where a dominant trait (red flowers) masks the presence of a recessive trait (white flowers) in the heterozygous condition (Rr).

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. Difference between Dominant trait and Recessive trait

Dominant Trait	Recessive Trait
It is a trait or characteristic, which is able to express itself over another contrasting trait.	It is a trait which is unable to express its effect in the presence of the dominant trait.
It can express in both heterozygous and homozygous conditions.	It can express only in homozygous condition.

Mendel crossed pea plants with yellow seeds (YY) and green seeds (yy). In the F_1 generation, all offspring were Yy, displaying the yellow seed color (since Y is dominant). When F_1 plants (Yy) were self-crossed to produce the F_2 generation, the genotypic and phenotypic ratio were:

Genotypic Ratio:

- YY (homozygous dominant): 1/4
- Yy (heterozygous dominant): 2/4
- yy (homozygous recessive): 1/4

Phenotypic Ratio:

- Yellow seeds (YY or Yy): 3/4
- Green seeds (yy): 1/4

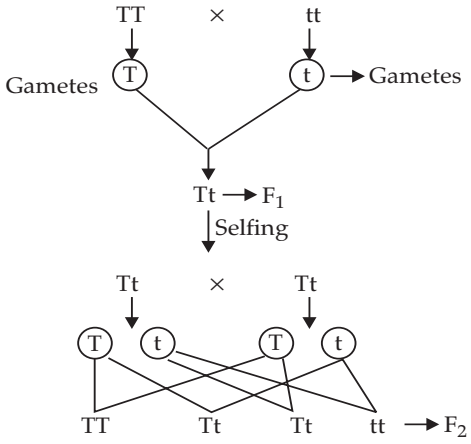
Therefore, 75% of the pea plants in the F_2 generation had yellow seeds.

2. (i) The F_1 progeny from a cross between pure tall (TT) and pure short (tt) pea plants would all be tall. This is because the tall allele (T) is dominant over the short allele (t).

Since, the TT parent contributes a T allele and the tt parent contributes a t allele, all the F_1 plants will have the genotype Tt. So, the F_1 plants were tall, with the genotype Tt.

(ii) In a heterozygous state (Tt), the dominant allele T "masks" the effect of the recessive allele t. As a result, even though the F_1 plants carry the shortness allele (t), they appear tall because the dominant tall allele (T) determines their phenotype.

(iii) When the F_1 plants (Tt) are self-pollinated, the phentoypic and genotypic ratio obtained in F_2 progeny are:



The possible genotypes in the F_2 progeny are:

- TT (homozygous tall)
- Tt (heterozygous tall)
- tt (homozygous short)

Thus, the genotypic ratio in F_2 would be:

- 1 TT: 2 Tt: 1 tt

The phenotypic ratio in terms of height (tall or short) would be:

- 3 tall: 1 short

The experiment shows that the inheritance of the trait for height in pea plants follows Mendel's laws of inheritance, specifically the law of segregation. The tallness allele is dominant over the shortness allele. The 3:1 ratio in the F_2 progeny is consistent with the segregation of a single gene with two alleles (dominant and recessive), confirming Mendel's theory of heredity.

3. (i) The term used for the trait observed in the F_1 generation is "dominance."

When the blue-flowered plant (BB) is crossed with the white-flowered plant (bb), all the plants in the F_1 generation will have the genotype Bb. Since B is dominant, all F_1 plants will have blue flowers, despite carrying the recessive b allele. Thus, the F_1 generation will have blue flowers with the gene combination Bb.

(ii) When the F_1 plants (Bb) are self-pollinated,

Blue Colour Flower → BB
White Colour Flower → bb

Parent BB × bb
Gametes B b
F_1 generation Bb × Bb (selfing)
F_2 generation

	B	b
B	BB	Bb
b	Bb	bb

(1) Percentages of Plants with blue flowers in F_2 Generation: The plants with blue flowers have either the BB or Bb genotype. From the above diagram, it is clear that there are 3 out of 4 plants (1 BB + 2 Bb) with blue flowers. Thus, there are 75% of blue-flowered plants.

(2) Plants with white flowers in F_2 Generation: The plants with white flowers have the bb genotype. There is 1 out of 4 plants (1 bb) with white flowers. Thus, there are 25% of white-flowered plants.

The reappearance of white flowers in the F_2 generation indicates that the white flower color trait (bb) is recessive and can only be expressed when both alleles are bb. The presence of white flowers in the F_2 generation shows that the recessive allele b has been inherited from both parents (F_1 plants) and is now expressed when no dominant B allele is present. This result confirms Mendel's law of segregation, where alleles for a trait separate during gamete formation, and offspring inherit one allele from each parent.

4. (i) Men produce two types of gametes:

- Sperm carrying the X chromosome.
- Sperm carrying the Y chromosome.

(ii) No, a male child does not inherit the X chromosome from his father. A male child inherits his X chromosome from his mother and his Y chromosome from his father. This is because the mother contributes one of her X chromosomes, whereas, the father contributes either an X or a Y chromosome to the offspring.

(iii) A human female produces one type of gamete, i.e., eggs (ova), all carrying the X chromosome.

5. Mendel's experiments demonstrated the independent inheritance of traits through his dihybrid cross experiments, which led to the formulation of the Law of Independent Assortment. Mendel crossed pea plants that had two different traits, such as seed shape (round or wrinkled) and seed color (yellow or green). He started with plants that were homozygous for both traits (RRYY and rryy). The F_1 progeny from this cross were all heterozygous for both traits (RrYy) and displayed the dominant traits (round and yellow). Mendel then allowed the F_1 plants (RrYy) to self- pollinate. He observed the F_2 generation and found a phenotypic ratio of 9:3:3:1.

- 9 plants had round yellow seeds (both dominant traits).
- 3 plants had round green seeds (one dominant and one recessive trait).
- 3 plants had wrinkled yellow seeds (one dominant and one recessive trait).
- 1 plant had wrinkled green seeds (both recessive traits).

The appearance of all possible combinations of traits in the F_2 generation, in specific ratios, indicated that the alleles for seed shape and seed color assorted independently of each other during gamete formation. This independent assortment occurs because the

genes for different traits are located on different chromosomes, or far apart on the same chromosome, allowing them to segregate independently during meiosis.

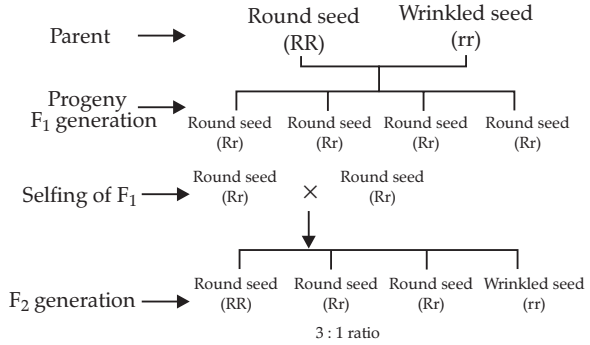
LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) Law of Dominance of Traits: The law of dominance is one of the principles established by Gregor Mendel through his work on pea plants. According to this law, when parents having pure contrasting characters are crossed then only one character expresses itself in the F_1 generation. The character that masks the other is called the dominant character, and the one that is masked is called the recessive character.

For example, When pea plants with round seeds (RR) are crossed with plants with wrinkled seeds (rr), all seeds in F_1 generation were found to be round (Rr).

When these round seeds were self fertilised, both the round and wrinkled seeds appeared in F_2 generation in 3: 1 ratio.

Hence, in F_1 generation, the dominant character (round seeds) appeared and the recessive character (wrinkled seeds) got suppressed, which reappeared in F_2 generation. This shows that in the F_1 generation, the dominant trait (round seeds) is expressed, while the recessive trait (wrinkled seeds) is suppressed. However, the recessive trait reappears in the F_2 generation.



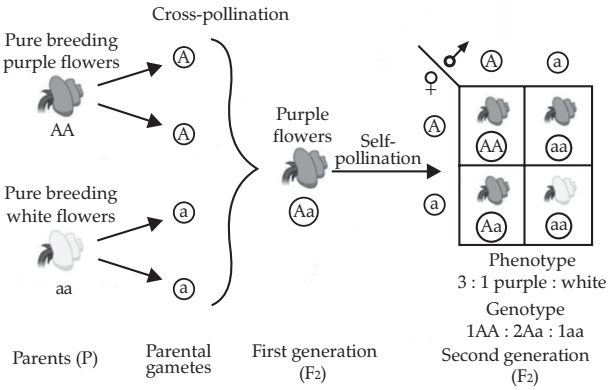
(ii) Traits acquired during an individual's lifetime are known as acquired traits. These traits are not encoded in an individual's DNA but are a result of environmental influences, lifestyle choices, or experiences. Since they do not alter the genetic code, they cannot be passed on to offspring. Inheritance only involves traits that are encoded in the genetic material (DNA) and can be transmitted from parents to their children through genes. For example, if a person builds muscle through exercise, this physical change is an acquired trait and will not be inherited by their children. Thus, the traits acquired during the life time of an individual not inherited.

2. (i) The two visible traits of a garden pea that Mendel considered in his experiments are:

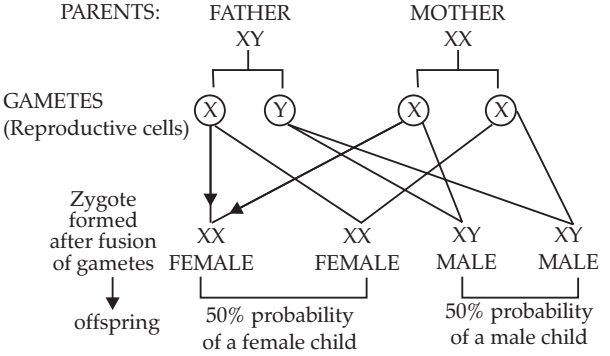
Flower color: Purple (dominant) vs. White (recessive)

Seed shape: Round (dominant) vs. Wrinkled (recessive)

Explanation: Mendel's experiments demonstrated that traits could be dominant or recessive through his method of cross-breeding pea plants. When he crossed pure- breeding plants with different traits (e.g., purple flowers and white flowers), all the F_1 offspring exhibited the dominant trait (e.g., purple flowers). Upon self-fertilisation of the F_1 generation, the F_2 generation showed both the dominant and recessive traits in a 3:1 ratio, respectively. This showed that the dominant trait masked the recessive trait in the F_1 generation, but the recessive trait reappeared in the F_2 generation.



(ii) The sperm carries either an X or a Y chromosome, while the egg carries only an X chromosome. If a sperm carrying a Y chromosome fertilises the egg, the resulting combination (XY) produces a male child. Conversely, if a sperm carrying an X chromosome fertilizes the egg, the resulting combination (XX) produces a female child.



Therefore, there is an equal chance of either an X-bearing sperm or a Y-bearing sperm fertilising the egg. This means that the sex of a newborn is determined purely by chance, and neither parent is responsible for the sex of the child.

3. (i) For the offspring to have the dwarf phenotype (tt), both parents must provide a t allele. This

means that at least one t allele must come from each parent.

- tt × tt → 100% tt offspring (dwarf)
- Tt × Tt → 25% tt offspring (dwarf), 50% Tt offspring (tall), 25% TT offspring (tall)
- Tt × tt → 50% Tt offspring (tall), 50% tt offspring (dwarf)
- tt × Tt → 50% Tt offspring (tall), 50% tt offspring (dwarf)

So, the following parent pairs can produce dwarf offspring (tt):

1. tt × tt
2. Tt × Tt
3. Tt × tt
4. tt × Tt

(ii) Let's choose one of the pairs from part (A) and perform a cross.

Example Cross: Tt × tt

The genotypes of the parents are:

- Tt (heterozygous tall) × tt (homozygous dwarf)

To determine the offspring, we can set up a Punnett square,

	T	t
t	Tt (tall)	tt (dwarf)
t	Tt (tall)	tt (dwarf)

Offspring Genotypes: Tt (tall) - 50% and tt (dwarf) - 50%

Phenotypes of Offspring: Tall (Tt) - 50% and Dwarf (tt) - 50%

So, the cross Tt × tt produces offspring with a 50% chance of being dwarf (tt) and a 50% chance of being tall (Tt).

9 CHAPTER

Light : Reflection & Refraction

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (B) is correct

Explanation: When a ray passes through the centre of curvature of a concave mirror, it strikes the mirror perpendicularly (normally) to the surface. The normal to the mirror at the point of incidence is along the same line as the ray itself, meaning the angle of incidence is zero. Since the ray is incident along the radius (normal), it reflects back along the same path.

Thus, for a ray passing through the centre of curvature, the angle of incidence is zero.

2. Option (C) is correct

Explanation: Consider using a magnifying glass to project an image onto a screen. To ensure the image on the screen is the same size as the real object, position it at the appropriate distance from the lens. The item must be twice the distance from the lens's focus point to use a magnifying glass with a curved lens. This ensures that the image remains consistent with the original size.

3. Option (A) is correct

Explanation: Absolute refractive index of glass and water is $\frac{3}{2}$ and $\frac{4}{3}$ respectively.

As we know that,

Speed of light in medium (v)

$$= \frac{\text{Speed of light in vacuum (c)}}{\text{refractive index } (\mu)}$$

As speed of light is constant.

$\therefore$ Speed of light in medium (v) $\times$ refractive index (m) = constant

$$v_g \times \mu_g = v_w \times \mu_w$$

$$v_w = \frac{v_g \times \mu_g}{\mu_w} = \frac{2 \times 10^8 \times \frac{3}{2}}{\frac{4}{3}}$$

$$v_w = \frac{9}{4} \times 10^8 \text{ m/s}$$

4. Option (A) is correct

Explanation: Refractive index of glass is maximum for violet colour and minimum for red colour as refractive index of a medium is inversely proportional to the wavelength of light passing through it.

5. Option (D) is correct

Explanation: Focal length, $f = -50$ ($\because$ it is a concave mirror)

Magnification = –1

Since,

$$M = \frac{-v}{u}$$

$$\Rightarrow \quad -1 = \frac{-v}{u}$$

$$\Rightarrow \quad -u = -v \Rightarrow u = v$$

Using mirror formula

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

$$\frac{1}{-50} = \frac{1}{u} + \frac{1}{u} \qquad (\because v = u)$$

$$\frac{1}{-50} = \frac{2}{u}$$

$$u = -100 \text{ cm}$$

Distance between object and image = $v - u$

$$\Rightarrow \quad -100 - (-100) = 0 \text{ cm}$$

6. Option (D) is correct

Explanation: When an object is placed at infinity in front of a convex mirror, the rays coming from the object will be parallel to the principal axis after reflection. In this scenario:

1. For a convex mirror, the focal point lies behind the mirror. According to the New Cartesian sign convention, distances measured behind the mirror are positive. Thus, the focal length (f) of a convex mirror is positive (+).
2. When an object is placed at infinity, the image formed by a convex mirror is virtual, erect and

highly diminished. It is formed at the focus, which is behind the mirror. According to the New Cartesian sign convention, distances behind the mirror, where virtual images are formed are positive. Therefore, the image distance is also positive (+).

7. Option (A) is correct

Explanation: To form an erect image, the object should be placed inside the focal point of the concave mirror, which means object distance u must be less than the focal length f.

For $f = 10$ cm, the object should be placed at a distance less than 10 cm from the mirror.

8. Option (B) is correct

Explanation: A concave mirror forms a virtual, enlarged image when the object is placed between the pole (P) and the principal focus (F). In this case, the image will appear on the same side as the object, and it will be virtual, upright, and magnified.

If the object is placed between the pole and the principal focus (closer to the mirror), the image formed will be virtual, upright, and enlarged.

At other positions like at the focus or beyond it, the nature of the image changes (real and inverted, or smaller in size).

9. Option (B) is correct

Explanation: Refractive index of a medium,

$$n_m = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in the medium}}$$

Speed of light in vacuum, $c = 3 \times 10^8 \text{ms}^{-1}$

Speed of light in the glass,

$$v = \frac{\text{Speed of light in vacuum}}{\text{Refraction index of glass}}$$

$$v = \frac{c}{n_g}$$

$$v = \frac{3 \times 10^8}{1.50} = 2 \times 10^8 \text{ ms}^{-1}$$

Therefore, speed of light in the glass, $v = 2 \times 10^8$ m/s

10. Option (D) is correct

Explanation: A convex mirror always forms a virtual, erect and diminished image. The focal length (f) of a convex mirror is positive because the focus is behind the mirror. The image distance (v) is also positive because the virtual image is formed behind the mirror. The height of the image (h_i) is positive because the image is erect. The correct representation according to the New Cartesian sign convention is:

$v = +5$ cm; $f = +10$ cm; $h_i = +7.5$ cm

11. Option (B) is correct

Explanation: The characteristic of a spherical mirror that is given by the ratio of the size of the image to the size of the object is magnification.

Magnification (M) is defined as the ratio of the height (or size) of the image to the height (or size) of the object. It is given by the formula:

$$M = \frac{\text{Height of Image } (h_i)}{\text{Height of Object } (h_o)}$$

12. Option (A) is correct

Explanation: The power of a lens (P) is related to its focal length (f) by the formula:

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

where:

P is the power of the lens (in diopters, D),

f is the focal length of the lens (in meters).

A negative power indicates a concave lens (diverging lens), where the focus is on the same side of the lens as the object.

13. Option (B) is correct

Explanation: A lens with a positive power (e.g., 4D) is a converging lens and can form a real image. A lens with a negative power (e.g., –3D) is a diverging lens and cannot form a real image; it forms only virtual images.

14. Option (C) is correct

Explanation: The speed of light in a vacuum is approximately 3.00×10^8 m/s. The absolute refractive index of a medium can be calculated using the formula:

$$n = \frac{c}{v}$$

In this case, the speed of light in the medium is given as 2.25×10^8 m/s.

Substituting the values:

$$n = \frac{3.00 \times 10^8 \text{ m/s}}{2.25 \times 10^8 \text{ m/s}}$$

This simplifies to $\frac{4}{3}$

15. Option (A) is correct

Explanation: When an object is set beyond the centre of curvature, then a parallel light ray to the principal axis, moves through the focus F. Simultaneously, the other ray passes through the optical centre C and goes undeviating. In this way, a diminished, real and inverted image is formed on the other side of the lens between the focus F and centre of curvature 2F.

Assertion-Reason Questions (1 Mark)

1. Option (B) is correct.

Explanation: A convex mirror always forms a virtual, erect, and diminished image behind the mirror, regardless of the position of the object. This happens because the reflected rays diverge, and the image appears to form at a point where the extensions of these diverging rays meet behind the mirror. The reason is also true as according to the sign convention, the focal length of a convex mirror is considered positive. Thus, both assertion and reason are true but reason is not the correct explanation of assertion.

2. Option (A) is correct.

Explanation: The centre of a circle which passes through a curve at a given point and has the same tangent and curvature at that point is called the centre of curvature of a mirror. It is the same as the centre of the sphere that constitutes the reflecting surface of the spherical mirror.

3. Option (A) is correct

Explanation: When a light ray passes through the centre of curvature of a concave mirror, it strikes the mirror along the normal of the mirror, i.e., when the incident ray strikes normal to the surface of mirror then angle of incidence = 0°. So, according to the law of reflection: angle of incidence = angle of reflection = 0°. Thus, the ray of light retraces its path.

4. Option (A) is correct.

Explanation: The incident ray will refract while entering the second medium. While leaving the second medium, it again enters the first medium. Here also, the ray will suffer refraction. The angle of refraction depends upon the refractive indices of the media. And since the medium will remain the same, the angle of incidence will be equal to the angle of emergence. Hence, the emergent ray will be parallel to the incident ray.

As mentioned, the extent of bending depends upon the refractive index of the medium. As the medium is the same, the bending of the ray of light will be equal. The light ray bends towards normal when it enters a denser medium. If the incident ray is entering from rarer to a denser medium, then the emergent ray will be entering denser to rare medium. Hence, the bending will be the opposite. This is the reason why the emergent ray is parallel to the direction of the incident ray.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i) Real Image (the final image is formed due to the lens at the eye-piece)

(ii) Concave Mirror

(iii)(a) A converging lens is used at the eyepiece to collect the rays from the plane mirror and help the viewer to see a real erect image of the star.

OR

(b) The plane mirror laterally inverts the image formed by the curved mirror and its position helps to direct the rays towards the eye-piece.

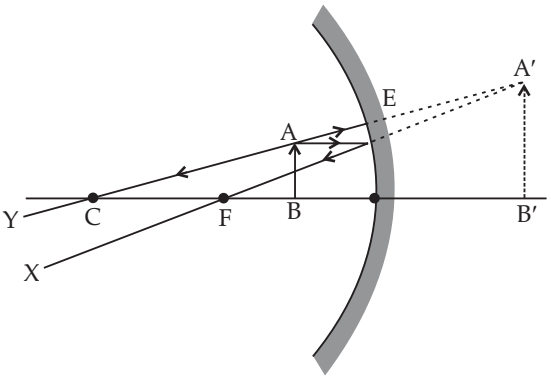
2. (i) In Case 1, where mirror A has a focal length of 20 cm and an object distance of 45 cm, the mirror will form a diminished image of the object. This is because the object distance (u) is greater than twice the focal length ($2f$). According to the formula $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$, when $u > 2f$, the image formed is diminished.

(ii) The image in Case 2 (Mirror B with a focal length of 15 cm and an object distance of 30 cm) shows two properties:

1. The image is formed beyond $2f$ (twice the focal length).
2. The image is real.

(iii) (a) Nature of the Image: The image formed will be virtual and erect.

Size of the Image: The image formed by mirror C will be magnified.



OR

(b) To determine the position of the image created by a concave mirror, use the mirror formula:

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

- Given, f = –12 cm (negative because it's a concave mirror), u = –18 cm (negative because the object is placed in front of the mirror).

Substitute the values into the formula:

$$\frac{1}{-12} = \frac{1}{v} + \frac{1}{-18}$$

$$\Rightarrow \quad \frac{1}{v} = \frac{1}{-12} - \frac{1}{-18}$$

$$\Rightarrow \quad -\frac{3}{36} + \frac{2}{36} = \frac{-1}{36}$$

$$v = -36$$

The image is formed in front of the mirror at a distance of 36 cm from the pole of the mirror.

3. (i) The principal axis of a concave mirror is the straight line that passes through the center of curvature (C) and the pole (P) of a concave mirror. It is perpendicular to the mirror's surface at the pole.

(ii) A ray of light incident parallel to the principal axis on a concave mirror will pass through the focus after reflection. According to the question, this reflected ray passes through a point on the principal axis, 10 cm from the pole. Hence, the focal length (f) of the concave mirror is 10 cm.

The radius of curvature (R) is related to the focal length by the formula:

$$R = 2f$$

Substituting the value of

$$R = 2 \times 10 = 20 \text{ cm}$$

Thus, the radius of curvature of the mirror is 20 cm.

(iii)(a) For a convex mirror, the mirror formula is:

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

where:

f = focal length = 15 cm (positive for convex mirror)

u = object distance = –10 cm (negative as the object is on the left side of the mirror)

v = image distance (to be found)

Substituting the known values into the formula:

$$\frac{1}{15} = \frac{1}{v} + \frac{1}{-10}$$

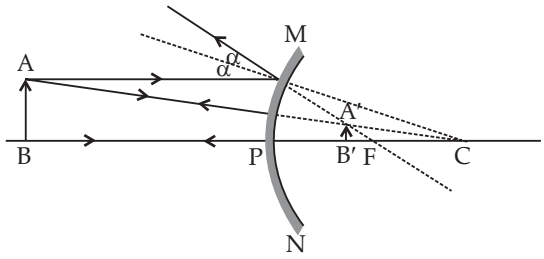
$$\frac{1}{v} = \frac{1}{15} + \frac{1}{10} = \frac{2}{30} + \frac{3}{30} = \frac{5}{30}$$

$$v = \frac{30}{5} = 6 \text{ cm}$$

Thus, the position of the image is 6 cm behind the convex mirror.

OR

(b) The mirror that forms a virtual, erect, and diminished image is a convex mirror. This type of image is always formed irrespective of the position of the object in front of the convex mirror.

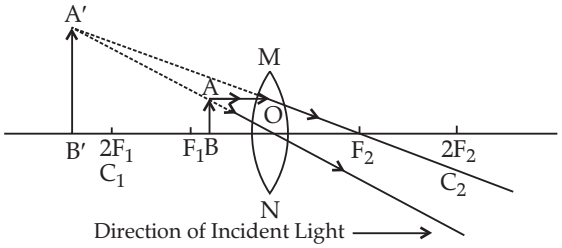


4. (i) For a real, inverted, and magnified image formed by a convex lens, the object distance (u) must be greater than the focal length (f) but less than twice the focal length ($2f$).

Therefore, $f < u < 2f$. Given $f = 2$ cm, the range of object is more than 2 cm and less than 4 cm from the optical centre.

(ii) For a virtual, erect, and magnified image formed by a convex lens, the object distance (u) must be less than the focal length (f). Therefore, $u < f$. Given $f = 6$ cm, the range of object is less than 6 cm from the optical centre.

(iii)(a)



OB = 12 cm

OF = 18 cm

A′B′ : Image

OR

(b) To determine the focal length of the convex lens, we can use the lens formula:

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

Where:

f is the focal length of the lens,
v is the image distance (distance from the lens to the image),
u is the object distance (distance from the lens to the object).
Since the image is the same size, the object distance (u) equals the image distance (v). Therefore,

$$u = v = 60 \text{ cm}/2 = 30 \text{ cm}.$$

Substituting the values:

$$\frac{1}{f} = \frac{1}{30}+\frac{1}{30}=\frac{2}{30}=\frac{1}{15}$$

$$f = 15 \text{ cm}$$

5. (i) (1) Vehicle Headlights

(2) Shaving mirrors

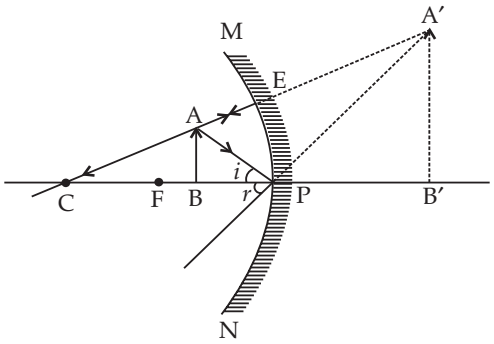
(ii) The radius of curvature (R) of a mirror is related to the focal length (f) by the formula:

$$R = 2f$$

Given, $f = 15$ cm

$$R = 2 \times 15 = 30 \text{ cm}$$

(iii)(a)



OR

(b) (1) Given,

Object distance (u) = –100 cm

Image distance (v) = –100 cm

Focal length (f) = ?

[f in case of a concave mirror is negative.]

Using formula,

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

We get,

$$\frac{1}{f} = \frac{1}{-100}+\frac{1}{-100}$$

$$\frac{1}{f} = \frac{2}{-100}=\frac{1}{-50}$$

So, f = –50 cm

Hence, focal length = –50 cm.

(2) Size of object (h_o) = 10 cm

magnification = ?

From formula,

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

Substituting we get,

$$m = -\frac{-100}{-100} = -1$$

Hence, magnification of the object = –1 i.e., inverted image is formed of same size as object.

6. (i) Refractive index of diamond,

$$n = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in diamond}}$$

$$n = \frac{c}{v}$$

$$2.42 = \frac{3\times10^8}{\text{Speed of light in diamond}}$$

$$\text{Speed of light in diamond} = \frac{3\times10^8}{2.42}$$

$$= 1.23 \times 10^8 \text{ m/s}$$

(ii) $\angle r_{\text{carbon disulphide}} < \angle r_{\text{glass}} < \angle r_{\text{water}}$

(iii) (a) (1) Since the speed of light is lesser in glass than the speed of light in water, glass is optically denser than water. This demonstrates that glass presents a greater barrier to light transmission than water.

(2) Light will enter from water to glass without bending i.e. undeviated because in this case

$\angle i = 0; \angle r = 0$

OR

(b) $\eta_{\text{glass}} = \frac{3}{2}$

$\eta_{\text{water}} = \frac{4}{3}$

$V_{\text{glass}} = 2 \times 10^8$ m/s

(1) Speed of light in vacuum

$$\therefore \quad \eta_g = \frac{\text{Speed of light in vacuum } (c)}{\text{Speed of light in glass } (V_g)}$$

$$c = \eta_g \times V_g$$

$$= \frac{3}{2}\times2\times10^8 \text{ m/s}$$

$$= 3 \times 10^8 \text{ m/s}$$

(2) Speed of light in water

$$V_w = \frac{c}{\eta_w}$$

$$= \frac{3\times10^8}{\frac{4}{3}}$$

$$= \frac{9}{4}\times10^8$$

$$= 2.25 \times 10^8 \text{ m/s}$$

7. (i) The absolute refractive index is defined as the ratio of the speed of light in a vacuum to the speed of light in the given medium. It is always greater than 1.

Absolute refractive index of a medium

$$= \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}}$$

(ii) (1) The speed of light is more in water.

(2) The ray of light will bend away from the normal when entering water from glass.

(iii) (a) Given,

Refractive index of glass, $\eta_g = \frac{3}{2}$

Refractive index of water, $\eta_w = \frac{4}{3}$

Speed of light in glass, $V_g = 2 \times 10^8$ m/s.

Refractive index of medium

$$= \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}}$$

$$\frac{3}{2} = \frac{c}{2\times10^8}$$

$$c = 3 \times 10^8 \text{ m/s}$$

(1) Speed of light in water

$$\frac{4}{3} = \frac{3\times10^8}{V_w}$$

$$= \frac{3}{4}\times3\times10^8 \text{ m/s}$$

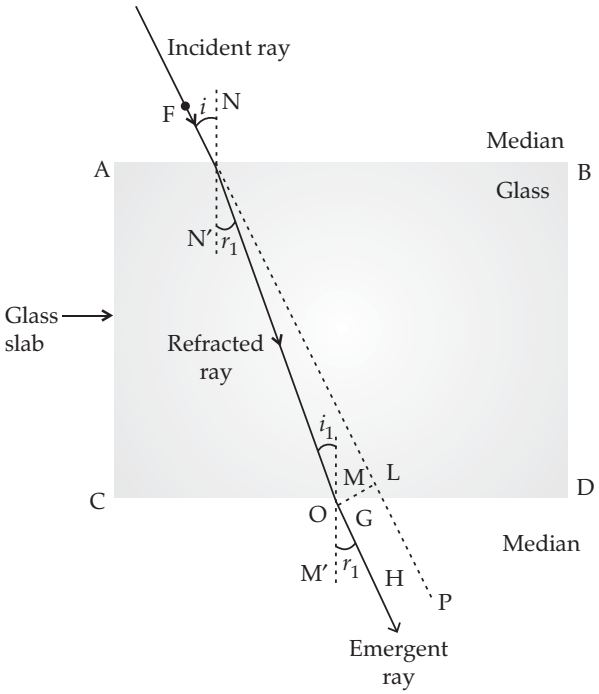
$$= \frac{9}{4}\times10^8 \text{ m/s}$$

$$= 2.25 \times 10^8 \text{ m/s}$$

(2) Speed of light in vacuum $= 3 \times 10^8$ m/s

OR

(b)



EF is the incident ray and GH is the emergent ray which is parallel to the incident ray.

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. (i) The lens is a convex lens.

(ii) The image is virtual.

(iii) Magnification for lens $= \frac{v}{u} = \frac{h_i}{h_o} = 2$

$$\frac{-30 \text{ cm}}{u} = 2$$

Hence $u = -15$ cm.

2. According to the mirror formula.

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

The focal length of a convex mirror, $f = 15$ cm.

Object distance, $u = -10$ cm

Image distance (v) = ?

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

$$\frac{1}{v} = \frac{1}{15} - \frac{1}{-10}$$

$$\frac{1}{v} = \frac{1}{15} + \frac{1}{10}$$

$$\frac{1}{v} = \frac{2+3}{30}$$

$$\frac{1}{v} = \frac{5}{30}$$

$$v = \frac{30}{5}$$

$$v = 6 \text{ cm}$$

Image is formed behind the mirror.

3. (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 the sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given colour and for the given pair of medium.

$$\frac{\sin i}{\sin r} = \text{constant}$$

4. Absolute refractive index of a medium is the ratio of speed of light in air/vacuum to the speed of light in the given in medium.

Given:

$c = 3 \times 10^8$ m/s; $n_m = 1.5$; $v_m = ?$

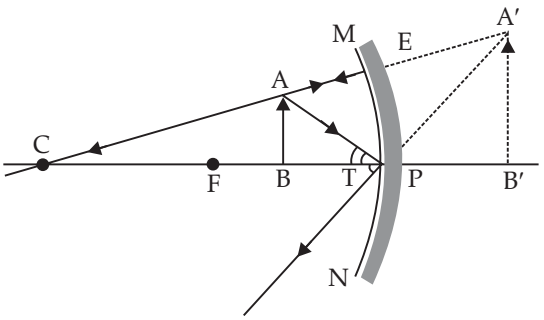
Absolute refractive index of a medium

$$n_m = \frac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$$

$$1.5 = \frac{3\times10^8}{v_m}$$

$$= 2 \times 10^8 \text{ m/s}$$

5.



P : Pole; F : Principal focus; AB : Object; A′B′ : Image

6. (i) Clearly, the ray in medium B is moving towards normal when it enters from medium A. Hence, medium B is optically denser than medium A. This means that the refractive index of medium B with respect to refractive index of medium A will be greater than 1.

(ii) The refractive index (n) of medium B with respect to medium A can be calculated using the formula:

$$n = \frac{V_a}{V_b}$$

where, V_a is the speed of light in medium A and V_b is the speed of light in medium B.

So, if the speed of light in medium A is V_a and in medium B is V_b, the refractive index of medium B with respect to medium A can be calculated as:

$$n = \frac{V_a}{V_b}$$

7. Given : $u = -20$cm $f = 15$cm (Convex Mirror because f is positive)

According to mirror formula,

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

$$\frac{1}{v}-\frac{1}{20} = \frac{1}{15}$$

$$\frac{1}{v} = -\frac{1}{15}+\frac{1}{20}$$

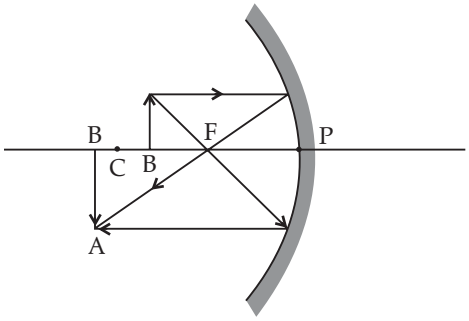
$$\frac{1}{v} = \frac{-4+3}{60} = -\frac{1}{60}$$

$$v = -60 \text{ cm}$$

Now, magnification $m = -\frac{v}{u}$

$$m = -\frac{-60}{-20} = -3$$

8.



9. (i) $n_P = \dfrac{\text{Speed of light in vacuum}}{\text{Speed of light in medium P}}$

$$n_q = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium Q}}$$

$$\frac{n_P}{n_Q} = \frac{v_Q}{v_P}$$

$$= \frac{1.33}{2.52} = \frac{v_Q}{2\times10^8}$$

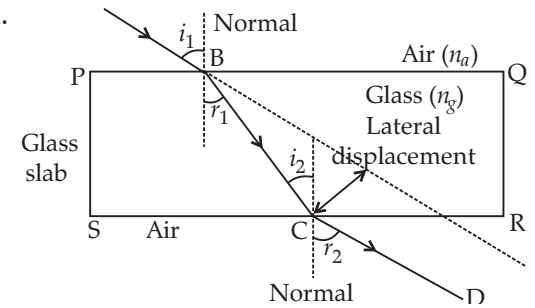
$$v_Q = \frac{1.33\times2\times10^8}{2.52}$$

$$= 1.056 \times 10^8 \text{ m/s}$$

(ii) The ray will travel undeviated through the medium Q.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1.



2. To determine the position of the image formed by a concave mirror, we use the mirror formula:

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

Where:

f is the focal length of the mirror $f = -12$ cm (negative for concave mirrors),

u is the object distance, $u = -8$cm (negative as the object is on the same side as the incoming light),

v is the image distance.

Substitute the known values into the mirror formula

$$\frac{1}{-12} = \frac{1}{-8}+\frac{1}{v}$$

$$\frac{1}{v} = \frac{1}{-12} - \frac{1}{-8}$$

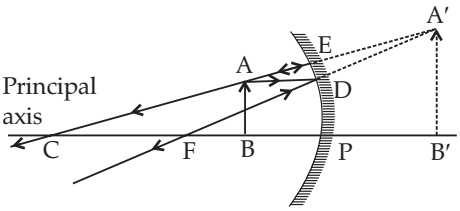
$$\frac{1}{v} = \frac{-1}{12} + \frac{1}{8}$$

$$\frac{1}{v} = \frac{-2}{24} + \frac{3}{24}$$

$$\frac{1}{v} = \frac{1}{24}$$

$$v = 24\,\text{cm}$$

The image is formed at 24 cm behind the mirror.



3. (i) Image of an object formed by a mirror is real, inverted indicates that the mirror is a concave mirror and that the image is formed on the same side as the object.

So, using magnification formula to find object distance

If an object

$m = -1, v = -30$ cm

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

$$-1 = -\left(\frac{-30}{u}\right),$$

$u = -30$ cm is the object distance.

The object is placed at 30 cm from the mirror.

(ii) If an object is moved 15 cm toward the mirror, the new object distance (u_{new}) is 15 cm less than original distance (u)

$$u_{new} = u - 15\,\text{cm}$$

$$u_{new} = 30 - 15\,\text{cm}$$

$$u_{new} = 15\,\text{cm}$$

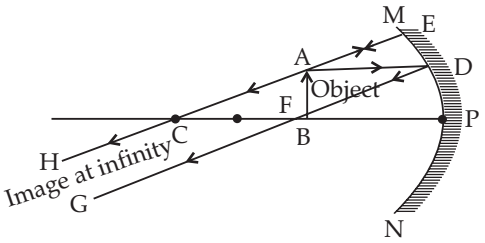
Now using mirror formula, new imaged distance will be:

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{-15}$$

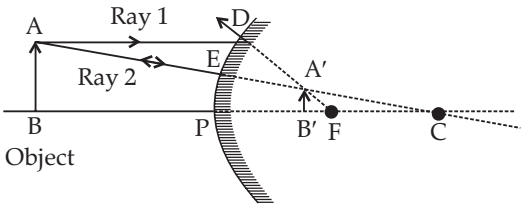
$$\frac{1}{f} = \frac{1}{-15} + \frac{1}{15}$$

$$v = \infty$$

The image is formed at infinity.



4. (i)



A′B′ is the image formed.

(ii) The image of object obtained in the convex mirror is erect and diminished. This is because a convex mirror always forms a virtual, erect and diminished image of an object.

The position of the image is behind the mirror, between P and F.

(iii) The image distance is positive. This is because the image formed is behind the mirror.

5. (i) Height of object, $h = 3$ cm

Distance of object from mirror, $u = -18$ cm (negative sign indicates that the object is placed on the left side of the mirror)

Focal length of mirror, $f = -12$ cm (negative sign indicates that the mirror is concave)

We can use the mirror formula to find the distance of the image from the mirror:

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

where v is the distance of the image from the mirror.

Substituting the values of u and f, we get:

$$\frac{1}{-12} = \frac{1}{-18} + \frac{1}{v}$$

$$v = -36\,\text{cm}$$

(negative sign indicates that the image is formed on the left side of the mirror)

Therefore, the distance of the image from the mirror is 36 cm.

(ii) To find the height of the image, we can use the magnification formula:

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

where m is the magnification of the image.

Substituting the values of v and u, we get:

$$m = -\frac{-36}{-18} = -2$$

Since the magnification is negative, the image is inverted and enlarged.

The height of the image can be found using the formula:

$$h' = m \times h$$

where h' is the height of the image and h is the height of the object.

Substituting the values of m and h, we get:

$$h' = -2 \times 3 = -6 \text{ cm}$$

Therefore, the height of the image is 6 cm.

6. The power of a lens is defined as the reciprocal of its focal length. Mathematically, it can be expressed as

$$\text{the Power of lens} = \frac{1}{\text{focal length}}$$

where the focal length is measured in meters and the power of the lens is measured in diopters (D).

In this case, the given focal length of the lens is –10 cm. We need to convert this to meters to calculate the power of the lens. So, we have:

Focal length = –10 cm = –0.1 m

The negative sign indicates that the lens is a concave lens, also known as a diverging lens.

The power of the lens is:

$$\text{Power of lens} = \frac{1}{-0.1 \text{ m}} = -10\text{D}$$

The negative sign indicates that the lens has a negative power, which means it is a diverging lens.

The magnification (m) is given by:

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

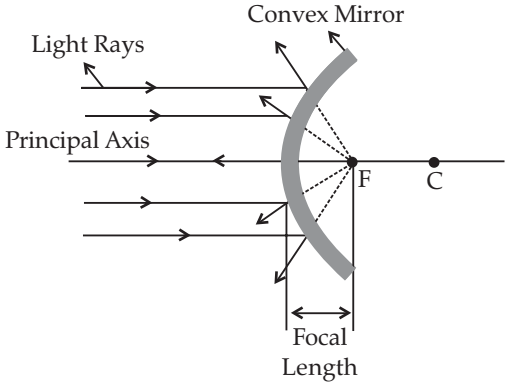
Here $u = -20$ cm

(negative as per New Cartesian convention)

Hence, the magnification will be positive.

7. (i) Principal focus: The principal focus of the diverging mirror is the point on the principal axis from where the rays parallel to principal axis appear to diverge after reflection.

(ii) Focal length: The distance between the pole and the principal focus of a spherical mirror is called the focal length.



8. Object height, O = +10 cm

Focal length, f = +15 cm

Object distance, u = –25 cm

Image distance, v = ?

Image height, I = ?

Using lens formula,

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

$$\frac{1}{15} = \frac{1}{v} - \frac{1}{(-25)}$$

Or, $$\frac{1}{v} = \frac{1}{15} - \frac{1}{25}$$

$$\frac{1}{v} = \frac{2}{75}$$

$$v = \frac{75}{2} = 37.5 \text{ cm}$$

The image distance is 37.5 cm.

Also, $$\frac{v}{u} = \frac{I}{O}$$

Hence, $$\frac{\frac{75}{2}}{-25} = \frac{1}{10}$$

$$I = (-1.5) \times 10 = -15 \text{ cm}$$

Height of image is 15 cm, inverted.

9. (i) Height of the object = 5 cm

Object distance (u) = –20 cm

Focal length (f) = –18 cm

Using the lens formula, we can find the image distance (v) for the given object distance (u) and focal length (f):

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

$$= \frac{1}{-20} + \frac{1}{-18}$$

$$= -\left(\frac{18+20}{360}\right)$$

$$= \frac{-38}{360}$$

$$\Rightarrow \quad v = \frac{-360}{38} = -9.47 \text{ cm}$$

To find the magnification (m), we can use the formula:

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

Substituting the values, we get:

$$m = -\frac{-9.47}{20} = 0.47$$

(ii) When a concave lens forms a virtual image, the magnification is always less than 1 (i.e., the image is smaller than the object). This is because a concave lens always forms a virtual, erect, and diminished image of a real object.

On the other hand, when a convex lens forms a virtual image, the magnification can be greater

than or less than 1, depending on the position of the object relative to the lens. If the object is closer to the lens than its focal length, the magnification is greater than 1 (i.e., the image is larger than the object). If the object is farther from the lens than its focal length, the magnification is less than 1 (i.e., the image is smaller than the object).

Thus, the magnification of the concave lens is always less than 1 and the magnification of the convex lens is greater than or less than 1, depending on the position of the object.

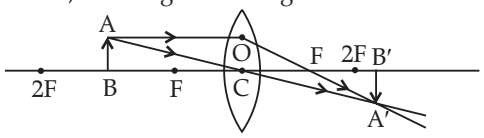
10. (i) For a real and inverted image to be magnified, the object must be placed between the focal point and twice the focal length (i.e., between f and $2f$).

Focal Length: $f = 10$ cm

Range of Object Distance:

The object distance u must be less than 20 cm (which is $2f$) and greater than 10 cm (which is f).

Therefore, the range of object distance for a real, inverted, and magnified image is:



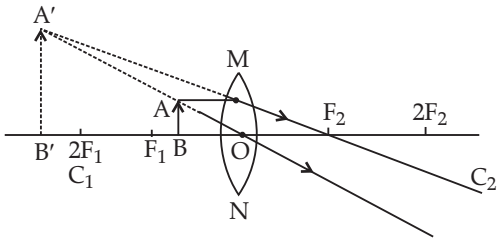
$$20 \text{ cm} > u > 10 \text{ cm}$$

(ii) For a virtual and erect image to be formed, the object must be placed within the focal length of the lens (i.e., less than f).

Range of Object Distance:

The object distance u must be less than 10 cm (which is f).

Therefore, the range of object distance for a virtual, erect, and magnified image is:



$$10 \text{ cm} > u > 0$$

11. (i) Object distance (u) = –18 cm (negative because the object is on the same side as the incoming light)

Image distance (v) = +36 cm (positive because the image is formed on the opposite side of the lens)

The magnification (m) of a lens is given by the formula:

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

Substituting the values:

$$m = -\frac{-36}{18} = -2$$

This means the image is inverted and twice the size of the object.

(ii) The Lens Formula is given by:

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

$$\frac{1}{f} = \frac{1}{36} - \frac{1}{-18}$$

$$\frac{1}{f} = \frac{1}{36} + \frac{1}{18} = \frac{3}{36} = \frac{1}{12}$$

$$f = 12 \text{ cm}$$

12. (i) Given that, an object is placed at a distance of 60 cm from a concave lens of focal length 30 cm.

So, we have

Distance of the object from concave lens, $u = -60$ cm

Focal length of a concave lens, $f = -30$ cm

We know, the distance of the object, distance of the image and focal length of concave lens are connected by the relationship

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

On substituting the values, we get

$$\frac{1}{-30} = \frac{1}{v} - \frac{1}{-60}$$

$$\frac{1}{-30} = \frac{1}{v} + \frac{1}{60}$$

$$\frac{1}{-30} - \frac{1}{60} = \frac{1}{v}$$

$$\frac{-2-1}{60} = \frac{1}{v}$$

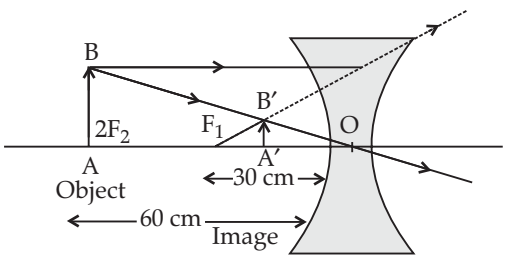
$$\frac{-3}{60} = \frac{1}{v}$$

$$\frac{-1}{20} = \frac{1}{v}$$

$$\Rightarrow \quad v = -20 \text{ cm}$$

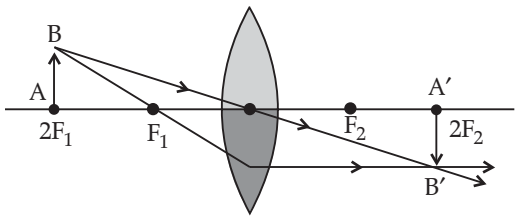
This means, the distance of the image from concave lens is 20 cm on the same side of lens.

(ii)



LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i)



The image formed will be real, inverted and located at 2F2 on the opposite side of the lens.

When the lens is uncovered:

The image position and size will remain the same.

However, the image will appear brighter because more light rays will pass through the lens.

When the lens is half covered:

The image position and size will remain the same.

Fewer rays are involved in forming the image, resulting in reduced brightness.

(ii) Object distance, $u = -15$ cm, $v = ?$

Focal length, $f = -15$ cm

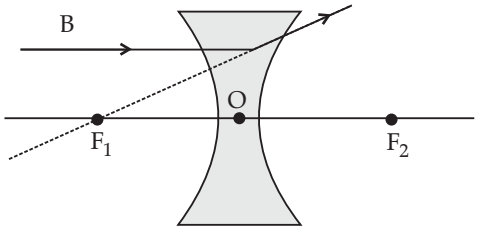
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

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

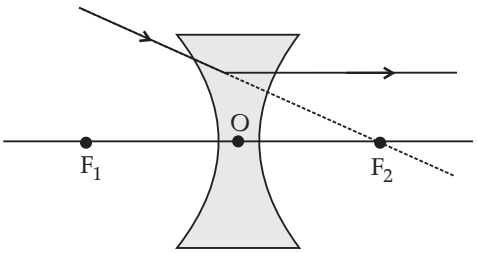
$$\frac{1}{-15} + \frac{1}{-30} = \frac{-3}{30} = \frac{-1}{10}$$

$$v = -10 \text{ cm}$$

2. (i) (1)



(2)



(ii) Given, $u = -16$ cm, $f = +24$ cm, $h = 4$ cm

Formula used $\quad \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\therefore \quad \frac{1}{v} - \frac{1}{(-16)} = \frac{1}{+24}$$

$$\frac{1}{v} = \frac{1}{24} - \frac{1}{16}$$

$$\frac{1}{v} = \frac{-1}{48}$$

$$v = -48 \text{ cm}$$

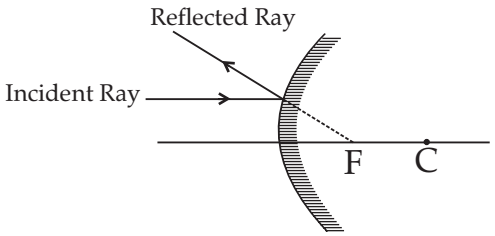
Image is formed on the same side as the object

$$m = \frac{h'}{h} = \frac{v}{u}$$

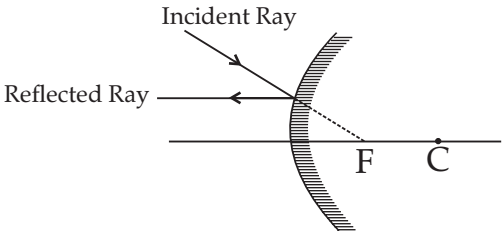
$$\frac{h'}{4} = \frac{-48}{-16}$$

$$h = 12 \text{ cm}$$

3. (i) (1)



(2)



(ii) Here $f = -12$ cm, $u = -18$ cm, $v = ?$, $h = 1.5$ cm, $h' = ?$

Mirror formula $\quad \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\therefore \quad \frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$= \frac{1}{-12 \text{ cm}} - \frac{1}{-18 \text{ cm}}$$

$$= \frac{-1}{36}$$

$$\therefore \quad v = -36 \text{ cm}$$

$$m = \frac{h'}{h} = -\frac{v}{u}$$

$$\frac{h'}{1.5} = -\frac{(-36)}{(-18)}$$

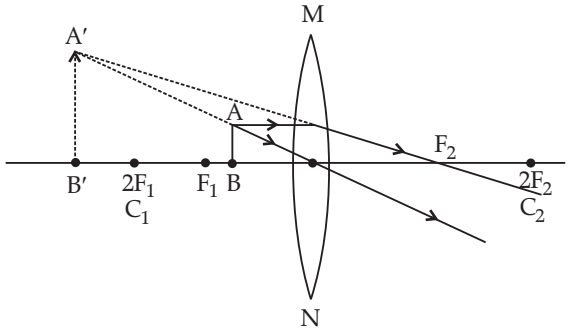
$$h' = -3.0 \text{ cm}$$

4. (i) At S. No. 3, $2f = 50$cm; $f = 25$ cm

Object distance (u) and image distance (v) are same. So it implies that object is placed at 2F.

(ii) S. No. 6 is not correct.

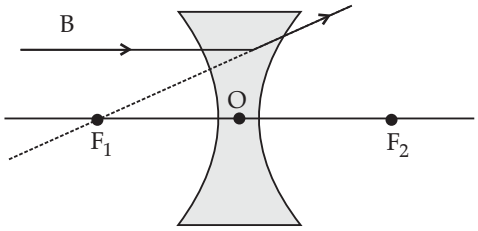
Reason: For $u = -15$ cm, sign of v must be negative. (as the image is formed on the same side of the lens as the object.



(iii) Magnification: $m = \frac{v}{u}$

$$= \frac{+150 \text{ cm}}{-30 \text{ cm}} = -5$$

5. (i) Principal axis: It is an imaginary line passing through the two centres of curvatures of a lens.



(ii) $f = -20$ cm; $h = 5$ cm; $v = -15$ cm

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

or $$\frac{1}{u} = \frac{1}{v} - \frac{1}{f}$$

$$= \frac{1}{(-15)} - \frac{1}{(-20)}$$

$$= \frac{-1}{60 \text{ cm}}$$

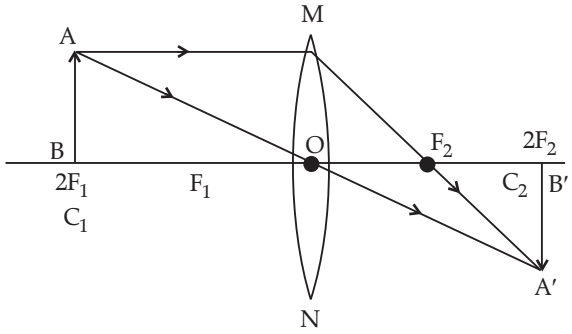
or $u = -60$ cm

The object is at a distance of 60 cm from the lens.

Size of the image (magnification): $m = \frac{h'}{h} = \frac{v}{u}$

$$h' = \frac{v}{u} \times h = \frac{(-15)}{(-60)} \times 5 = 1.25 \text{ m}$$

6. (i)



Magnification will be –1

(ii) (1) We use the lens formula:

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

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

$$\Rightarrow \quad \frac{1}{v} = \frac{1}{-16} + \frac{1}{12}$$

$$= \frac{1}{48}$$

$$v = +48 \text{ cm}$$

(2) $$h_i = \frac{v}{u} \times h_0$$

$$= \frac{+48}{-16} \times 2 = -6 \text{ cm}$$

$\therefore$ Length of the image is 6 cm.

10 CHAPTER

The Human Eye and The Colourful World

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (C) is correct

   Explanation: In the given diagram, white light is passing through a glass prism and undergoing dispersion, which splits the white light into its constituent colours. The different colours of light are refracted at different angles due to their varying wavelengths.

   - Ray A is refracted the least and is red, as red light has the longest wavelength and bends the least.
   - Ray B is refracted the most and is violet, as violet light has the shortest wavelength and bends the most.

2. Option (D) is correct

   Explanation: The lens system of the human eye forms an image on a light sensitive screen called the retina. The retina captures the light and sends the visual information to the brain, through the optic nerves, allowing us to see.

3. Option (A) is correct

   Explanation: The correct statements about human eye are (a) and (b). The diameter of the eyeball is indeed about 2.3 cm, and the iris is the dark muscular part that controls the size of the pupil, regulating the amount of light entering the eye. While (c) and (d) are not entirely accurate: most light refraction occurs at the cornea, not primarily at the crystalline lens, and the ciliary muscles adjust the shape of the lens rather than the distance between the lens and the retina.

4. Option (D) is correct

   Explanation: A rainbow is a natural spectrum of seven colours appearing in the sky after a rain shower. It is caused by dispersion of sunlight by tiny water droplets, present in the atmosphere. The water droplets act like small prisms. They refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop.

5. Option (C) is correct.

   Explanation: When a beam of white light passes through an area with fine dust particles, the colour of light that gets scattered the most is blue. This happens because shorter wavelengths of light, like blue, scatter more easily than longer wavelengths of light, like red or orange. Therefore, blue light is not visible in these conditions.

6. Option (B) is correct

   Explanation: Dispersion of white light is the separation of white light into its constituent colors. This can be achieved by passing white light through a prism. The different colors of the spectrum refract by different amounts when passing through the prism, resulting in the separation of the colors. When white light enters the prism, it undergoes refraction and gets dispersed into its constituent colors. The amount of refraction depends on the wavelength of the light. Violet light has the shortest wavelength and hence undergoes the maximum refraction (P). Red light has the longest wavelength and undergoes the least refraction (Q). Therefore, the colors are arranged in the following order from maximum to minimum refraction: Violet, Indigo, Blue, Green, Yellow, Orange, Red.

7. Option (D) is correct

   Explanation: The Cornea is the transparent, outermost layer of the eye that allows light to enter. It plays a key role in focusing light onto the retina. While the pupil regulates the amount of light entering the eye the cornea is the initial structure that lets light in.

8. Option (D) is correct

   Explanation: The splitting of beam of white light into its seven constituent colours, when it passes through a glass prism, is called dispersion of light.

9. Option (C) is correct.

   Explanation: The far side of the Moon, also called the "dark side", experiences day and night cycles just like the near side. The only reason the far side is not visible from Earth is due to the Moon's synchronous rotation as the same side always faces Earth. The far side still receives sunlight, but there is no scattering effect from an atmosphere, so the sky remains black.

10. Option (A) is correct

Explanation: Myopia or short sightedness is the defect of vision due to which a person cannot see the distant objects clearly. It is corrected by using spectacles containing concave lens.

11. Option (D) is correct

Explanation: The upper part of a bifocal lens has a concave lens (diverging lens) so that a person can see distant objects from the upper part and the lower part has a convex lens (converging lens) so that the person can look through it to see near objects, i.e., for reading. The lenses are placed in this order for the convenience of the users.

Assertion-Reason Questions (1 Mark)

1. Option (C) is correct

Explanation: Assertion is true because a rainbow occurs when sunlight interacts with water droplets, splitting into its constituent colours, forming a natural spectrum.

Reason is false because a rainbow is typically observed when the sun is low in the sky and not overhead.

2. Option (C) is correct.

Explanation: Assertion states that a myopic eye cannot see the distant objects clearly is true. However, reason (R) claims that converging lenses are used to correct myopia is false. Instead, diverging lens are used to correct myopia.

3. Option (C) is correct.

Explanation: Assertion (A) is true because red light signals are indeed used to indicate that vehicles should stop. However, reason (R) is false as red light is least scattered, which is why it can be seen from a long distance.

4. Option (C) is correct.

Explanation: Myopia, commonly known as near-sightedness, is a refractive error of the eye that makes it difficult to see distant objects clearly. This occurs because the eyeball is too long or the cornea is too curved, which causes light rays to focus in front of the retina instead of on it. To correct myopia, a diverging (concave) lens is used. A concave lens diverges the incoming light rays so that they focus correctly on the retina.

5. Option (D) is correct.

Explanation: Assertion is false as rainbow is a natural spectrum and not an artificial spectrum. When sunlight enters a water droplet, it undergoes both refraction and internal reflection. The tiny water droplets act like small prism. This causes the light to be dispersed into its component colors due to the different wavelengths being refracted by varying amounts.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i) Given: $P_1 = 4$ D, $P_2 = -2$D

$P = P_1 + P_2 = 4D - 2D = 2D$

So, power of lens is positive. Hence, the lens is convergent in nature.

(ii) $P = -2.5$ D

$$P = \frac{100}{f(\text{cm})}$$

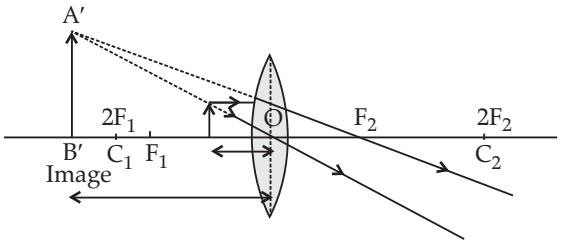
$$\Rightarrow \quad -2.5 = \frac{100}{f(\text{cm})}$$

$$\Rightarrow \quad f = -40 \text{ cm}$$

(iii)(a) $P = 0.1$ D, $u = -20$ cm

$$f = \frac{1}{P} = \frac{1}{0.1} = 10 \text{ cm}$$

$$\Rightarrow \quad f = 10 \text{ cm}$$



OR

(iii) (b) A virtual image formed by a convex lens is always erect and magnified whereas a virtual image formed by concave lens is erect and diminished.

A convex lens forms a virtual image when the object is placed between the focal point (F) and optical center, i.e. D and F. A concave lens always forms a virtual image when the object is placed anywhere between optical centre and infinity.

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. When a person cannot see nearby objects distinctly but can see far objects clearly, he is said to be suffering from hypermetropia.

Causes: (1) Focal length of the eye ball is too long.

(2) Eyeball becomes too small.

Convex or converging lens are used to correct this defect.

2. Presbyopia is a condition that typically occurs with age and affects a person's ability to focus on close objects. Bifocal lenses are designed to correct both near and distant vision in individuals with presbyopia. In bifocal lenses, the upper part of the lens corrects distant vision, while the lower part corrects near vision. The upper part of the lens typically has a negative power (for distance vision), and the lower part has a positive power (for near vision).

In this case, the lens with a power of -4.0 dioptre is for the correction of distant vision. The focal length of a lens can be calculated using the formula:

$$\text{Focal Length } (f) = \frac{1}{\text{power (diaoptre)}}$$

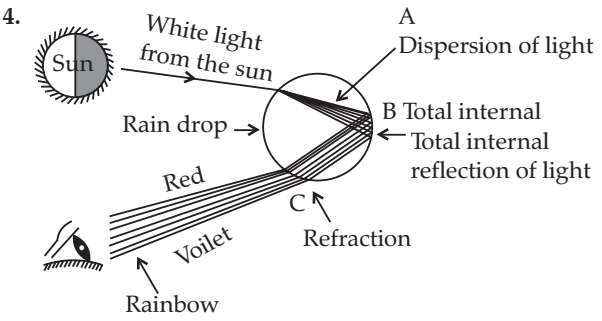
$$\text{Focal Length} = \frac{1}{-4D} = -0.25 \text{ m or } -25 \text{ cm}$$

Since the focal length is negative, it indicates that the lens is a diverging lens, which is suitable for correcting distant vision.

3. (i) When sun rays fall on the convex lens they get converged to a point. Thus, all the rays come together in the focus. These rays surely have heat energy and they get accumulated in that point. When the amount of rays have accumulated enough so as to reach the ignition temperature of paper, the paper catches fire.

(ii) Principal Focus: When sunlight is focused by a convex lens, it converges the parallel rays to a single point on the paper. This point, where the sunlight is concentrated and the paper begins to burn, is known as the principal focus. The bright spot on the paper represents the real image of the sun.

4.



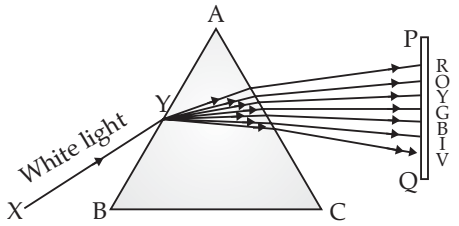
5. The muscles in the human eye that enable it to focus on objects at varied distances are ciliary muscles.

When looking at a distant object, the ciliary muscles relax, causing the lens to flatten and increase its focal length. This allows distant objects to be focused on the retina.

When looking at a near object, the ciliary muscles contract, causing the lens to become thicker and decrease its focal length. This allows near objects to be focused on the retina.

This process is called accommodation.

6.



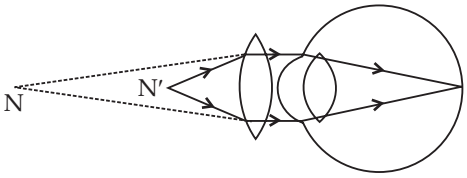
The phenomenon is dispersion of light

Cause: The dispersion of white light occurs because colors of white light travel at different speeds through glass prism. Different colours undergo different deviations on passing through prism.

7. (i) The power of an eye to see nearby objects as well as far off objects diminishes with age because the power of accommodation of the eye usually decreases with ageing due to weakening of ciliary muscles and decrease in flexibility of eye lens.

(ii) The defect that is likely to arise in the eyes in such a condition is Presbyopia. For most people, the near point gradually recedes away. They find it difficult to see nearby objects comfortably and distinctly without corrective eye-glasses.

(iii) The type of corrective lens used for restoring the vision of such an eye is bifocal lens. It consists of two distinct optical powers: one for near vision and the other for distant vision.



8. (i) The defect of vision shown is Myopia.

(ii) The causes for Myopia are:

(1) Excessive curvature of the eye lens.

(2) Elongation of the eye ball.

(iii) This defect can be corrected by using concave lens of suitable power.

9. The molecules of air and other find particles in the atmosphere have size smaller than the wavelength of visible light. These are more effective in scattering light of shorter wavelenghts at the blue end than light of longer wavelengths at the red end. The red light has a wavelength about 1.8 times greater than blue light. Thus, when sunlight passes through the

atmosphere, the fine particles in air scatter the blue colour (shorter wavelenghts) more strongly than red. The scattered blue light enters our eyes. Since there is no atmosphere in space, there is no scattering of light due to absence of particles. As such the sky appears black from the space.

10. (i) Because red colour light has the highest wavelength and is least scattered.

(ii) Because the optical density of atmospheric layers is more so the light travelling from space to the atmosphere bends towards the normal and thus its position appears slightly raised.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. (i) Hypermetropia is a defect that causes difficulty in focusing on near objects, with clearer vision observed for distant objects. In Myopia, distant objects appear blurry while near objects are seen clearly.

(ii) (A) The image shows a case of hypermetropia.

(B) Shortening of the eyeball or focal length of the eye lens becomes too long.

(C) No, the concave lens would diverge the rays coming to the eyeball and will push the image even further, but a convex lens should be used which will help to converge the rays and create the image at the exact place on the retina.

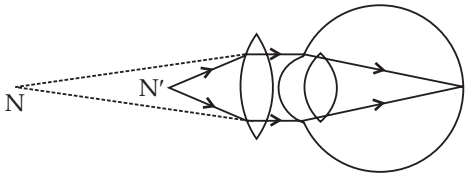
2. (i) Hypermetropia or Far-sightedness.

Reason: Image is formed behind the retina. Near point for the person is farther away from the normal near point (25 cm)

(ii) • Focal length of the eye lens is too long.

• The eyeball has become too small.

(iii)



N = Near point of a hypermetropic eye

N′ = Near point of a normal eye

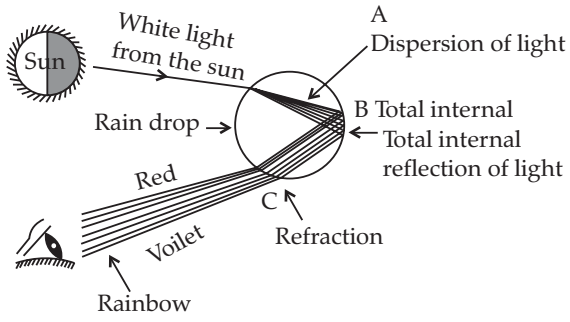
3. Accommodation of human eye is the ability of the eye lens to adjust its focal length.

Ciliary muscles plays a major role in the accommodation of eye.

(i) While focussing on nearby objects ciliary muscles contract, eye lens become thick and its focal length decreases.

(ii) While focussing on distant objects, ciliary muscles relax, eye lens become thin and focal length increases.

4.



Two necessary conditions to observe a rainbow are:

Water droplets: There must be water droplets in the atmosphere, such as from rain, mist, or spray.

Sun position: The sun must be behind the viewer, low in the sky, and at an angle of less than 42° above the horizon.

5. Accommodation of human eye is the ability of the eye lens to adjust its focal length.

When we increase the distance of an object from the eye the image distance remains unchanged.

Ciliary muscles: While focussing on a distant object, ciliary muscles relax, eye lens become thin and its focal length increases.

6. (i) • Hypermetropia

• Ciliary muscles/eye lens

(ii) • Focal length of the eye lens is too long.

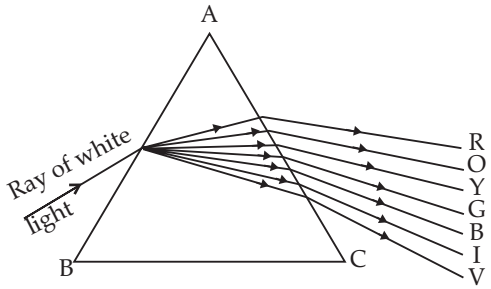
• Eyeball becomes too small.

(iii) Converging lenses/convex lens. They provide the additional focussing power required for forming the image on the retina.

Helps to decrease the focal length of the eye lens.

7. The splitting of white light into constituent colour is called dispersion of white light.

Cause: The cause of dispersion is that different colors of light have different speeds in the refracting medium, so they bend through different angles inside the prism



8. (i) Myopia or Short-sightedness is the inability of an eye in viewing long distance objects. The image in this case falls before the retina. For every myopic eye, there exists a far point beyond which clear image cannot be seen. Short-sightedness is caused due to (1) excessive curvature in cornea. (2) elongation of eyeball.

The short-sightedness is corrected by using a concave lens which diverges and shifts the image to the retina.

(ii) Presbyopia is a vision defect that occurs with age, typically around 40 years and above, where the eye's ability to focus on nearby objects decreases due to the loss of flexibility of the eye's lens. This happens because the ciliary muscles weaken over time, and the lens becomes less able to change shape for near vision.

The correction for presbyopia is made using bifocal lenses or multifocal lenses.

Upper part of the lens: The upper part of the lens is designed for distance vision and contains convex lenses (converging lenses).

Lower part of the lens: The lower part is for near vision and may contain convex lenses as well.

This allows the person to see clearly both at a distance and up close.

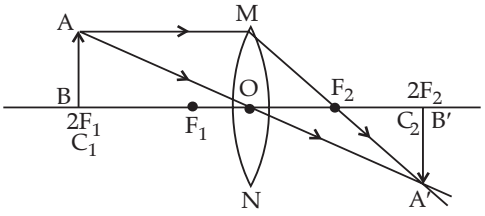
The upper part of bifocal lenses used to correct presbyopia is typically converging (convex lenses), as it is designed to correct distance vision.

9. (i) Red colour has the longest wavelength and it deviates the least, hence, danger signals installed at airports and at the top of tall buildings are of red colour so that they can be easily seen from a distance.

(ii) Scattering of light takes place because of the particles present in the atmosphere. At high altitude, the atmospheric medium is rarer so the scattering of light taking place is very low. Hence, the sky appears dark to passengers flying at high altitudes.

(iii) The path of a beam of light passing through a colloidal solution is visible due to scattering of light by colloidal particles and this is known as Tyndall effect.

10. Focal length $= \frac{1}{P} = \frac{1}{4} = 0.25$ m or 25 cm. It is a convex lens as power and focal length are positive.



Focal length, $f = +25$ cm
Object distance, $u = -50$ cm
Image distance, $v = ?$
Image height, I = ?
Using lens formula,

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

$$\frac{1}{25} = \frac{1}{v} - \frac{1}{(-50)}$$

$$v = +50 \text{ cm}$$

Also, magnification, $m = -\frac{v}{u}$

Hence, $m = \frac{(50)}{-(50)} = -1$

Image formation occurs thus 50 cm in front of the lens. Due to a magnification of 1, the image is the same size as the object. The image is inverted as evidenced by the negative magnification.

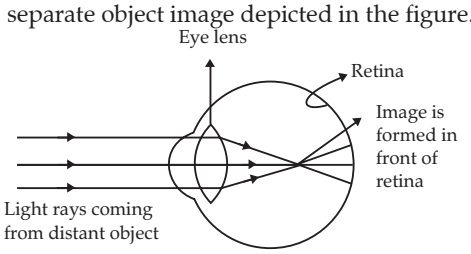
11. Myopia is a visual impairment in which a person can see all around objects clearly, but finds it difficult to comfortably focus on a single object. The eye is referred to as the myopia eye.

Myopia can be caused by:

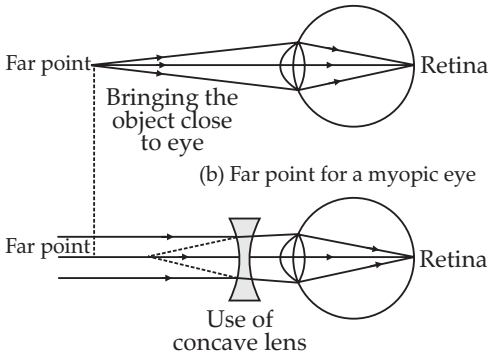
(1) increase in curvature of the lens.

(2) increase in the length of the eye ball.

(i) A myopic eye's far point is close to that infinite distance. In front of the retina, it creates the separate object image depicted in the figure.



(ii) Concave lens has an ability to diverge incoming rays, it is used to correct this defect of vision. The image is allowed to form at the retina by using a concave lens of suitable power as shown in the figure.



12. (i) The defect of vision the student is suffering from is hypermetropia or farsightedness.

Causes of Hypermetropia:

(1) Shortened eyeball length: The eyeball is shorter than normal, causing light rays to focus behind the retina instead of on it.

(2) Decreased curvature of the lens: The lens is less curved than normal, reducing its ability to converge light onto the retina.

To correct hypermetropia, convex lenses (converging lenses) are used. These lenses help to converge light rays before they enter the eye, ensuring the image focuses on the retina.

(ii) This defect of vision the person is suffering from is Myopia or Short-sightedness.

Causes of Myopia:

(1) Long eyeball: The eye is too long, causing light rays to focus in front of the retina instead of on it.

(2) Excessive curvature of the cornea or lens: The cornea or lens may be too curved, causing the light to focus before it reaches the retina.

Correction of Myopia:

The appropriate corrective lenses for this defect are concave lenses (negative lenses), which diverge the incoming light rays before they enter the eye, allowing the light to focus correctly on the retina.

13. When sunlight passes through colloidal solution, the minute particles absorb and emit the sunlight that struck the air particles. Hence, this causes a visible defined propagation of light. This phenomenon is called Tyndall effect.

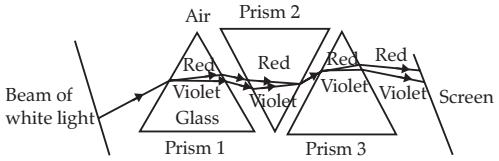
Examples:

(1) Sunlight through forest trees

(2) Passing of laser through colloidal sulfide solution.

14. (i) VIBGYOR – violet, indigo, blue, green, yellow, orange, red.

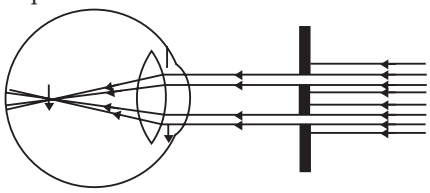
(ii)



(iii) Dispersion and refraction

15. (i) 2 spots

(ii)



(iii) (1) elongation of the eyeball.

(2) excessive curvature of the eye lens

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) Hypermetropia or long sightedness.

(ii) Two possible causes: (1) Curvature of eye lens decreases.

(2) Shortening of eye ball.

(iii) Given, $u = -25$ cm, $v = -75$ cm, $f = ?$

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

$$\Rightarrow \quad \frac{1}{f} = \frac{1}{-75} - \frac{1}{-25} = \frac{2}{75}$$

$$f = 37.5$$

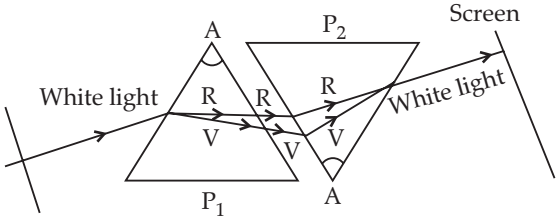
$$P = \frac{100}{f} = \frac{100}{37.5} = +2.67\text{D}$$

2. (i) In a normal eye, ciliary muscles flex and expand in order to modify the focal length of the eye lens, allowing it to see objects at different distances.

When objects are closer than the point of 25cm, too much contraction puts a lot of strain on the eye muscles, and the eye is unable to concentrate its image on the retina.

Therefore, a typical eye cannot easily see objects closer than 25 cm.

(ii)



(iii) Two essential conditions for observing a rainbow are:

(1) Sun position: The sun must be behind you and low in the sky, at an angle of less than 42° above the horizon. The lower the sun is in the sky, the more of the rainbow you'll see.

(2) Water droplets: There must be water droplets in the air. The sun's rays must hit the raindrops to create the rainbow.

3. (i) In front of the retina

(ii) Concave lens

(iii) The person would not have the power of accommodation.

(iv) (A) R (B) Q (C) P (D) S

11 CHAPTER

Electricity

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (A) is correct

Explanation: Maximum resistance is obtained when resistors are connected in series.

$$R_{max} = \frac{1}{5}+\frac{1}{5}+\frac{1}{5}+\frac{1}{5}+\frac{1}{5} = 1\,\Omega$$

2. Option (C) is correct

Explanation: Slope for I-V graph: 1/R is least for R_3.

Hence, R_3 has the greatest resistance value.

3. Option (D) is correct

Explanation: The resistance of a wire is inversely proportional to its cross-sectional area and directly proportional to its length. Therefore, to minimize the resistance of the wire, you would want to maximize the cross-sectional area and minimize the length.

Among the given options:

(A) $\frac{D}{2}$ and $\frac{L}{4}$ → Cross-sectional area: $\left(\frac{D}{2}\right)^2 = \frac{D^2}{4}$, Length: $\frac{L}{4}$

(B) D/4 and 4L → Cross-sectional area: $(D/4)^2 = D^2/16$, Length: 4L

(C) 2D and L → Cross-sectional area: $(2D)^2 = 4D^2$, Length: L

(D) 4D and 2L → Cross-sectional area: $(4D)^2 = 16D^2$, Length: 2L

The option (D) maximizes the cross-sectional area 16 times and increase the length only moderately.

4. Option (C) is correct

Explanation: Combination I: Two resistors of 2Ω each in parallel. Equivalent resistance,

$$\frac{1}{R_{eq}} = \frac{1}{2\Omega}+\frac{1}{2\Omega}$$

$$\Rightarrow \quad R_{eq} = \frac{2\Omega}{2} = 1\Omega$$

Combination II: Three resistors of 3Ω each in parallel. Equivalent resistance,

$$\frac{1}{R_{eq}} = \frac{1}{3\Omega}+\frac{1}{3\Omega}+\frac{1}{3\Omega}$$

$$R_{eq} = \frac{3\Omega}{3}$$

$$\Rightarrow \quad R_{eq} = 1\Omega.$$

Combination III: Two resistor of 4Ω, 2Ω are in series so, resistance of branch R′ = 4+2 ⇒ 8 Ω There are two such branches in parallel. Hence,

$$\frac{1}{R_{eq}} = \frac{1}{8}+\frac{1}{8}$$

$$\Rightarrow \quad R_{eq} = \frac{8\Omega}{2} = 4\Omega$$

Combination IV: Two resistors of 0.5Ω each in parallel. Equivalent resistance,

$$\frac{1}{R_{eq}} = \frac{1}{0.5\Omega}+\frac{1}{0.5\Omega}$$

$$\Rightarrow \quad R_{eq} = \frac{0.5\Omega}{2} = 0.25\Omega$$

Hence Combination I and II have 1 Ω resistance only

5. Option (A) is correct

Explanation: $H = I^2Rt$

I = 5 A, R = 20 Ω, t = 30 s

$H = (5)^2 \times 20 \times 30 = 15000$ J

6. Option (C) is correct

Explanation: When too many electrical appliances are connected to a single socket, the total resistance of the circuit decreases because the appliances are typically connected in parallel. According to Ohm's Law, I = V/R, if the resistance decreases while the voltage remains constant, the current drawn from the source increases. If the current exceeds the rated value of the circuit, it can cause overheating or even short-circuiting.

7. Option (D) is correct

Explanation: When four identical resistors of resistance 8Ω are connected in series, the total resistance R_S can

be calculated using the formula $R_S = n \times R$, where n is the number of resistors and R is the resistance of each resistor. In this case, $n = 4$ and $R = 8\Omega$, so $R_S = 4 \times 8\Omega = 32\Omega$.

When the same resistors are connected in parallel, the effective resistance R_P can be calculated using the formula $\frac{1}{R_P} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R}$, where R is the resistance of each resistor. Substituting the values, we get $\frac{1}{R_P} = \frac{1}{8\Omega} + \frac{1}{8\Omega} + \frac{1}{8\Omega} + \frac{1}{8\Omega} = \frac{1}{2\Omega}$.

Therefore, $R_P = 2\Omega$.

$$\frac{R_S}{R_P} = \frac{32}{2} = 16$$

8. Option (A) is correct

Explanation: The wiring with a 15 A current rating can handle the load and avoid overheating or damage as devices with higher power ratings require a higher current to function.

9. Option (C) is correct**.**

Explanation: Least count of any scale is the value measured by a single division on it.

10 div = 1.5 V

So, 1 div = 1.5 / 10 = 0.15 V

Hence, least count = 0.15 V

Reading shown = least count x no. of div. = 0.15 × 12 = 1.8 V

Hence, Reading shown = 1.8 V

10. Option (B) is correct

Explanation: Ammeter: Measures the current flowing through the circuit. It must be connected in series with the resistor to ensure the entire current flowing through the resistor also passes through the ammeter.

Voltmeter: Measures the potential difference (voltage) across the resistor. It must be connected in parallel with the resistor to measure the voltage drop across it.

This arrangement ensures accurate verification of Ohm's law, which states V = IR where V is the voltage, I is the current, and R is the resistance.

11. Option (B) is correct

Explanation: Heat dissipated in a resistive circuit:

$H = I^2Rt$

Where: H: Heat dissipated, I: Current, R: Resistance, t: Time

If the current I is doubled, the new heat dissipated becomes:

$H_{new} = (2I)^2Rt = 4I^2Rt = 4H$

The percentage change in heat dissipated is calculated as:

$$\text{Percentage change} = \frac{(H_{new} - H)}{H} \times 100$$

$$= \frac{(4H - H)}{H} \times 100 = 300\%$$

12. Option (B) is correct

Explanation: Both the bulbs will receive the same current as they are connected in series.

13. Option (B) is correct

Explanation: If V is constant, then H is inversely proportional to R because $H = V^2t/R$. Therefore, H will double if R is reduced to half.

14. Option (B) is correct

Explanation: Relation between Q, I, *t*:

Here, 'Q' represents the charge in a body

'I' represents the current carried in Ampere

'*t*' represents the time in seconds

The formula between these 3 quantities i.e. Electric Charge, Time, and Electric Current is:

$$Q = I \times t$$

Electric Charge = Electric Current × time

Relation between W, V, Q:

Here, 'Q' represents the charge in a body

'W' represents the work done to carry the charge Q

'V' represents the potential difference across the wire.

The amount of work done i.e. Win carrying a charge Q is calcalcuted by the product of the charge i.e. Q and the potential difference i.e. V

The formula between these 3 quantities i.e. Electric Charge, Potential Difference, and Work done in carrying the charge across it is:

Work Done = Electric Charge × Potential Difference

$$W = V \times Q$$

15. Option (D) is correct

Explanation: The rating of fuse wire must be slightly greater than the current flowing through the device.

Given, P = 1 kW = 1000 W, Voltage (V) = 220 V

Current (I) = P / V = 1000 / 220 = 4.5 A

Therefore, fuse wire of rating 5 A should be used.

16. Option (A) is correct

Explanation: Heating elements in electrical devices need to efficiently convert electrical energy into heat. This requires the material to have properties that allow it to withstand high temperatures and maintain its structural integrity.

Resistivity: High resistivity means the material can generate more heat when a current passes through it.

Melting Point: High melting point ensures the material can withstand the high temperatures generated without melting.

17. Option (C) is correct

Explanation: The resistance of a wire is influenced by its length, cross-sectional area, and material, but does not depend on its shape.

18. Option (C) is correct

Explanation: According to Ohm's Law, I = V/R, where I is the current, V is the voltage and R is the resistance. As the resistance increases, the current decreases.

19. Option (B) is correct

Explanation: Possible combinations are:

All in series: $2\ \Omega + 2\ \Omega + 2\ \Omega = 6\ \Omega$

All in parallel: $\frac{1}{2}+\frac{1}{2}+\frac{1}{2}=\frac{3}{2}=0.67\ \Omega$

Two in series and one in parallel = $2+2+\frac{1}{2}=4.5\Omega$

Two in parallel and one in series = $\frac{1}{2}+\frac{1}{2}+2=3\Omega$

So, she will not be able to get 0.75 Ω with combinations of given resistors.

20. Option (A) is correct

Explanation: The resistance R of a wire is given by

$$R = \rho \times A/l$$

where ρ is the resistivity, l is the length, and A is the cross-sectional area. For wire Y, the length is $2l$ and the radius is $2r$, so the area $A = \pi(2r)^2 = 4\pi r^2$.

Therefore, $R_Y = \rho \times 4\pi r^2//2l = 2R$.

The resistivity ρ remains the same for the same material. Hence, the correct row in the table is I: Resistance 2/R, Resistivity ρ.

21. Option (C) is correct

Explanation: When the resistance of R increases, the current in the circuit decreases according to the Ohm's law (V = IR). As the current decreases, the voltage drop across $R(V_2)$ will increase because of its higher resistance, while the voltage across the other component (V_1) will decrease as the current is smaller.

Assertion-Reason Questions (1 Mark)

1. Option (C) is correct

Explanation: The commercial unit of electrical energy is kilowatt-hour (kWh). It is equal to the energy consumed in the circuit at the rate of 1 kilowatt for 1 hour. Reason is false as 1 kWh = 3.6×10^6 J and not 10^8 joule (J).

2. Option (B) is correct

Explanation: The current rating of a circuit is determined based on the total current drawn by all connected appliances to ensure the safety of the wiring and prevent overloading. Appliances with metallic bodies are connected to an earth wire for safety, reducing the risk of electric shocks due to faulty appliances. So, while both statements are true, they are not directly linked as cause and effect.

3. Option (A) is correct

Explanation: The given assertion and reason are related to Ohm's law. Ohm's law states that the current flowing through a conductor is directly proportional to the potential difference applied across its ends, provided its temperature and other physical conditions remain constant. This can be mathematically represented as:

V = IR where V is the potential difference, is the current flowing, and R is the resistance of the conductor.

4. Option (B) is correct

Explanation: When resistances are connected between the same two points, it means that the current has multiple paths to flow through. This type of connection is called parallel connection. In a parallel connection, the voltage across each resistance is the same, while the current divides among the resistances. The total resistance in a parallel connection is less than the smallest individual resistance. When resistances are connected in parallel, the effective resistance decreases compared to a single resistance. The reason for this decrease in resistance is that when resistances are in parallel, the total current divides among the resistances, resulting in a lower overall resistance. By adding more resistances in parallel, the total resistance can be further reduced. Therefore, the reason given in the statement is correct. When the resistance is to be decreased, connecting the individual resistances in parallel is an effective method.

Level - 2

CASE BASED QUESTIONS (4 Mark)

1. (i) Properties of electric fuse:

(1) Low melting point: The fuse wire in an electric fuse is made of a material with a low melting point. This property allows the fuse to melt quickly when a current higher than the rated value passes through it, breaking the circuit.

(2) Good conductivity: While in a solid state, the fuse wire should still have good electrical conductivity to allow normal current to pass through without significant resistance.

(ii) Properties of heating elements:

(1) High resistance: Heating elements are designed to have high electrical resistance, which facilitates the conversion of electrical energy into heat energy when current flows through them.

(2) Good heat resistance: Heating elements should have good heat resistance to withstand the elevated temperatures generated during their operation.

(iii) (a) Principle: The electric fuse works on the principle of the heating effect of electric current. When a current higher than the rated value flows through the fuse wire, it heats up due to its electrical resistance.

Fuse wire's capability to save appliances:

(1) Low melting point: The fuse wire is chosen to have low melting point.

(2) Quick melting: When an excess current flows through the circuit, the fuse wire quickly reaches its melting point, causing it to melt and break the circuit.

(3) Interrupts the current: By breaking the circuit, the fuse interrupts the flow of excessive current, preventing it from reaching and potentially damaging electrical appliances.

(4) Protects devices: The fuse acts as a sacrificial element, sacrificing itself by melting to protect the electrical appliances and devices connected to the circuit.

(5) Safety measure: The use of a fuse is a safety measure to prevent fire hazards and protect electric equipment from damage due to high current or faults in the circuit.

OR

(b) Given:

P = 1100 W; V = 220 V, I = ?

P = VI

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

$$= \frac{1100\ W}{220\ V} = 5A$$

Now, if an electric fuse rated at 5 A is connected in this circuit, it will operate normally. The fuse is designed to handle a current of up to 5A. Since, the current flowing in the circuit is exactly 5A, the fuse will not blow and the circuit will continue to operate without any issues. However, if the current were to exceed 5A, the fuse would blow, interrupting the circuit and preventing damage to the electrical components.

2. (i) (1) When key K_1 is closed, only bulb A will glow.

(2) When key K_2 is closed, bulbs B, C, D and E glow simultaneously.

(ii)

$$\text{Current (I)} = \frac{\text{Power (P)}}{\text{Voltage (V)}} = \frac{11}{55} = 0.2\ A$$

(iii) (a) (1) Using Ohm's law, V = IR

$$\text{Resistance of bulb B} = \frac{\text{Voltage (V)}}{\text{Current (I)}}$$

$$= \frac{55V}{0.2A} = 275\ \Omega$$

(2) Total resistance of the combination of bulbs B, C, D and E

Since bulbs are connected in series, their equivalent resistance will be:

Total resistance (R_{total}) = 4 × R = 4 × 275 Ω

= 1100 Ω

OR

(b) Bulb A will keep glowing with same brightness. Other bulbs, i.e., B, D and E will stop glowing.

Reason: As the bulbs B, D and E are connected in series with bulb C, so no current will flow through them and thus they will not glow. The bulb A remains unaffected as it is connected in parallel combination.

3. (i) $R_s = 4\Omega + 6\Omega + 16\Omega = 26\ \Omega$

(ii) $\frac{1}{R_p} = \frac{1}{8} + \frac{1}{8} = \frac{2}{8}$

$R_p = 4\ \Omega$

(iii)(a) Total resistance = 26 Ω + 4 Ω = 30 Ω

Potential difference = V = 6V

$$\text{Current, } I = \frac{V}{R}$$

$$= \frac{6}{30} = \frac{1}{5} = 0.2\ A$$

OR

(b) 16 Ω

Justification: According to Ohm's law, when same current flows, the potential difference across a higher resistance is always higher.

Potential difference across 16 Ω ⇒ V = IR = 0.2 × 16 = 3.2 V

Potential difference across 8 Ω = V = IR_{Total} = 0.2 × 4 = 0.8 V

4. (i) $A_1 = A_3$

Since both are connected in series.

(ii) $A_2 < A_3$ Since they are in different branches.

(iii)(a) $V_1 = IR_1$

$$\frac{1}{R_1} = \frac{1}{3} + \frac{1}{3} = \frac{2}{3}$$

$$R_1 = \frac{3}{2} = 1.5\Omega$$

$V_1 = 1 \times 1.5\ \Omega = 1.5\ V$

OR

(b) $R_T = R_1 + R_2 + R_3$

$R_1 = 1.5\ \Omega$

$$R_2 = \frac{\text{Resistance}}{\text{No. of resistors}} = \frac{3}{3} = 1\Omega$$

$$R_3 = \frac{3}{4} = 0.75\Omega$$

$R_T = 1.5\ \Omega + 1 + 0.75 = 3.25\ \Omega$

5. (i) The net resistance is: $R_1 + \left(\frac{R_2 \times R_3}{R_2 + R_3}\right) + R_4$

$$= 15 + \left(\frac{30 \times 15}{30 + 15}\right) + 15$$

$$= 15 + 10 + 15$$

$$R = 40\ \Omega$$

(ii) (a) Voltage drop across R_4 = net current × R_4

$$\text{Net current} = \frac{V}{R}$$

$$= \frac{20}{40}$$

$$= 0.5\ A$$

$$\text{Voltage drop across } R_4 = 0.5 \times 15$$

$$= 7.5\ V$$

OR

(b) Power dissipated by the resistor R_1 is given by:

$$P = I^2Rt$$

$$I = \frac{V}{R} = \frac{20}{40}$$

$$I = 0.5\ A$$

$$\text{Therefore, Power} = (0.5)^2 \times 15 = 3.75\ W$$

(iii) Net current will decrease because R_3 is connected in parallel and removing it will increase the net resistance in the circuit thereby reducing the net current.

6. (i) $R = \frac{V}{I}$

$$R = \frac{12}{6} = 2\ \Omega$$

(ii) $R_A = \frac{12}{2} = 6\ \Omega$

$$R_B = \frac{12}{4} = 3\ \Omega$$

(iii) (a) For the given circuit, $R \propto l$ and $\rho \propto 1/l$

The resistance of 'A' is twice that of 'B' and so the current in both will not be the same but in the ratio of 1:2, so the current in 'A' will be 2A and that in 'B' will be 4A

$$I_A = \frac{V}{R_A} = \frac{12}{6} = 2A$$

$$IB = \frac{V}{R_B} = \frac{12}{3} = 4A$$

OR

(b) Resistivity is defined as the resistance offered by a conductor of unit length and unit cross-sectional area.

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

Factors affecting the resistivity of a conductor are:

(1) Nature of the material

(2) Temperature

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. (i) $P = VI$

$= 230 \times 3.5 = 805\ W$

(ii) $I \propto \frac{1}{R}$, so half the resistance means double the current.

Therefore, current in Y = 7.0 A

2. For series, total resistance is $R + 2R = 3R$

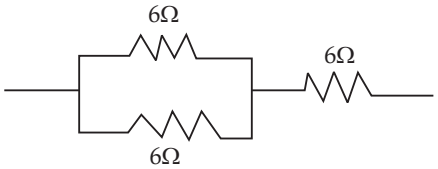
$$P_1 = \frac{V^2}{3R}$$

For parallel, total resistance is $\frac{2R}{3}$.

$$P_2 = \frac{V^2}{\frac{2R}{3}} = \frac{3V^2}{2R}$$

$$\frac{P_1}{P_2} = \frac{2}{9}$$

3. To get the desired resistance of 9 Ω, we should connect the two resistors in parallel and one resistor in series.

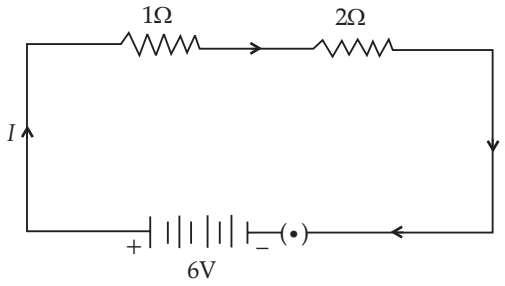


Resistance of two resistors connected in parallel

$$= \frac{6 \times 6}{6 + 6} = 3\Omega$$

The third 6 Ω is in series with 3 Ω. Hence, the equivalent resistance of the circuit is 6 Ω + 3 Ω = 9 Ω

4.



Total Resistance = 1Ω + 2Ω = 3Ω

Total applied voltage (V) = 6V

$$\text{Circuit Current (I)} = \frac{V}{R}$$

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

$$= 2A$$

Power consumed across 2 Ω resistor

$$= I^2R$$

$$= 2^2 \times 2$$

$$= 8 \text{ W}$$

5. $R_S = R_1 + R_2 + R_3$

$= 1 + 2 + 3 = 6\ \Omega$

As V = IR

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

$$I = \frac{2}{6}$$

$$I = \frac{1}{3} \text{ A}$$

Hence, *V*(voltage across 3W)

$$V = IR$$

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

$$= 1 \text{ volt}$$

6. Wire A will offer more resistance to the flow of current in the circuit.

This is because resistance is inversely proportional to the area of cross section. So if the diameter is more than resistance is less. Wire A has less diameter so it has a higher resistance.

7. Given, Charge, q = 500 coulomb

Current, $I = 25 \text{ mA} = 25 \times 10^{-3}$ A

Let assume that '*t*' seconds be the time in which electric source will be discharged completely.

We know,

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

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

$$t = \frac{500}{25 \times 10^{-3}}$$

$$t = \frac{500 \times 10^3}{25}$$

$$t = 20 \times 10^3$$

$$\Rightarrow \quad t = 20000 \text{ s}$$

$$\Rightarrow \quad t = \frac{20000}{3600} \text{h}$$

$$\Rightarrow \quad t = \frac{200}{36} \text{ h}$$

$$\Rightarrow \quad t = \frac{50}{9} \text{ h}$$

$$\Rightarrow \quad t = 5\frac{5}{9} \text{ h}$$

Hence, the time in which the electric source will be discharged completely is $5\frac{5}{9}$hrs

8. From the graph, slope of wire A is greater than slope of wire B.

For the conductor of the same dimensions greater the resistance, greater is the resistivity.

9. The change in the current flowing through the electrical component can be determined by Ohm's Law.

According to Ohm's law

$$V = IR$$

V: applied voltage

I: current

R: resistance

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

Now potential difference becomes one fourth,

$$V' = \frac{V}{4}$$

So current will be: $I' = \frac{(V/4)}{R}$

$$\Rightarrow \quad I' = \frac{V}{4R}$$

$$\Rightarrow \quad I' = \frac{I}{4}$$

When the potential difference is one fourth, the current through the component also decreases to one fourth of its-initial value.

10. The fuse will melt and its not possible to operate electric oven under these conditions.

Given that,

Power of electric oven, P = 3 kW = 3000 W

Voltage supply, V = 220 volts.

$$P = VI$$

where, I is flow of electric current, P is the power in watt and V is voltage.

So, on substituting the values, we get

$$3000 = 220 \times I$$

$$I = \frac{3000}{220}$$

$\Rightarrow$ $I \approx 13.64$ A

As the current rating is only 10A and the oven draws a current of 13.6 A, which is more than current rating.

Hence, the oven will stop working.

11. From Ohm's law, we have $V = IR$

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

Given V = 12 V and $R_1 = 2\ \Omega$, $R_2 = 8\ \Omega$ and $R_3 = 4\ \Omega$

Therefore, net resistance

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

$$= 2 + \left(\frac{8 \times 4}{8 + 4}\right)$$

$$= 2 + \frac{32}{12} = 2 + 2.67$$

$$R = 4.67\ \Omega$$

$$I = \frac{12}{4.67}$$

$$I = 2.57 \text{ A}$$

She can use ammeter S to measure the current in the circuit.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. (i) $R \propto l$

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

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

(ii) $R = \rho \frac{l}{A}$

$\rho = R \frac{A}{l}$ for A = 1 m^2 and l = 1m, we have ρ = R

Hence resistivity is the resistance offered by a wire of length 1 m having a cross sectional area of 1 m^2.

2. It prevents damage to the appliances and the electric circuit from overloading and short circuitiing.

Here P = 3 kW = 3000 W, V = 220 V, I = ?

P = VI

$$\text{I} = \frac{P}{V} = \frac{3000 \text{ W}}{220 \text{ V}} = 13.63\text{A}$$

13.63 A > Rating of fuse 5A, therefore fuse wire will melt and break the circuit.

3. (i) Ohm's law: 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.

Required formula: $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

(ii) $R_{eq} = R + \frac{R}{2} = \frac{3R}{2}$

4. (i) The three resistors are connected in series. So, the total resistance is

$R_1 + R_2 + R_3 = 2 + 4 + 6 = 12\ \Omega$

(ii) The current I is determined using Ohm's law.

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

$$I = \frac{6}{12} = 0.5 \text{ A}$$

Reading in the ammeter is 0.5 A

(iii) Reading of the voltmeter

V = IR

V = 0.5 A × 4 Ω = 2 V

5. Overloading occurs due to increase in voltage or if too many appliances are connected to a single socket. It happens when an excessive amount of electric current flows through the wire. It results in overheating of the wires and can cause damage to the circuit and appliances.

Causes: (1) Increase in voltage beyond the design limits of the circuit.

(2) Excessive appliances connected to a single socket or circuit.

(3) Contact be tween live and neutral wire. (any two)

Measures to avoid overloading:

(1) Too many electric appliances of high power rating should not be connected to single socket.

(2) Use good quality wires.

(3) Use good quality devices (any one)

6. (i) Alternating current can be transmitted over the long distances without the loss of energy. Also alternating voltage can be stepped up and stepped down using transformer.

(ii) The type of current used in household supply is alternating current (AC), whereas the current given by a battery of dry cells is direct current (DC). AC current changes its direction periodically, while DC current flows in one constant direction.

(iii) An electric fuse is a safety device made of a metal wire with a low melting point. It prevents damage as follows:

(1) Overloading: When excessive current flows through the circuit, the fuse wire heats up due to the high resistance of the material. If the

current exceeds the fuse's rated value, the wire melts and breaks the circuit, stopping the flow of electricity.

(2) Short Circuiting: In case of a short circuit, where the resistance drops significantly, the current increases rapidly. This causes the fuse to blow immediately, cutting off the power supply and protecting the circuit and appliances from damage.

7. (i) Given V = 240 V and R = 100 Ω

Therefore, Power (P) = $\frac{V^2}{R} = \frac{(240)^2}{100} = 576$ W

Energy consumed by bulb A = $P \times t$

$E = 576 \times 4 \times 7 \times 60 \times 60$

$E = 58{,}060.8$ kJ

(ii) When bulbs A and B are connected in series:

$R_{net} = R_1 + R_2 = 100 + 100$

$R_{net} = 200\ \Omega$

Total power consumed by bulb A when connected in series with bulb B

$$P_{tot} = \frac{V^2}{R_{net}} = \frac{(240)^2}{200} = 288 \text{ W}$$

$$P_A = \frac{P_{tot}}{2} = 144 \text{ W}$$

Power consumed by bulb A when connected without bulb B to 240 V

$$P_A = \frac{V^2}{R} = \frac{(240)^2}{100} = 576 \text{ W}$$

As $P_A' < P_A$, the brightness of the bulb A decreases when connected in series with bulb B.

8. (i) The current will flow through the additional wire that connects the points L and M (avoiding the bulb) as it offers a path of least/lower resistance as compared with the bulb.

(ii) $$\frac{3}{10} = \frac{1}{R_1} + \frac{1}{R_2} \quad \text{...(i)}$$

$R_1 + R_2 = 15,$

$R_1 = 15 - R_2$

Substituting in (i)

$$\frac{3}{10} = \frac{(15 - R_2 + R_2)}{(15 - R_2)R_2}$$

$$15R_2 - R_2^2 = \frac{150}{3} = 50$$

$R_2^2 - 15R_2 + 50 = 0$

$R_2 = 10\ \Omega, R_1 = 5\ \Omega$ or $R_1 = 10\ \Omega, R_2 = 5\ \Omega$

9. Ohm's Law states that the current (I) flowing through a conductor is directly proportional to the potential difference (V) across its ends, provided the physical conditions (e.g., temperature) remain constant.

$V = IR$

where R is the resistance of the conductor.

Factors on which the resistance of a cylindrical conductor depends:

(1) Length of the conductor (L): Resistance is directly proportional to the length of the conductor ($R \propto L$).

(2) Cross-sectional area (A): Resistance is inversely proportional to the cross-sectional area $\left(R \propto \frac{1}{A}\right)$

Calculation for the new resistance: If the wire is melted and redrawn to double its original length:

The volume of the wire remains constant ($V_{old} = V_{new}$).

Let the original length be L, the original cross-sectional area be A, and the new length be 2L.

$V = L \cdot A = 2L \cdot A_{new}$

Thus,

$$A_{new} = \frac{A}{2}$$

Resistance is given by:

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

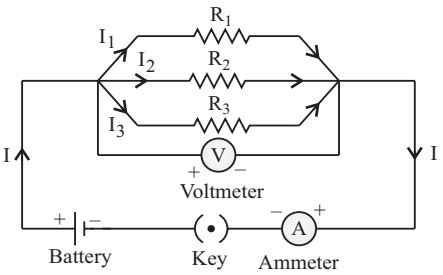
where r is the resistivity of the material.

For the new wire:

$$R_{new} = \rho\frac{2L}{A_{new}} = \rho\frac{2L}{A_{new}} = 4 \cdot \rho\frac{L}{A} = 4R$$

The resistance of new wire is 4R.

10.



The figure given above shows a circuit consisting of three resistors R_1, R_2, and R_3. Suppose the total current flowing in the circuit is I, then the current passing through resistance R_1 will be I_1, the current passing through resistance R_2 will be I_2 and the current passing through resistance R_3 will be I_3 Thus, the total current I is given as:

$$I = I_1 + I_2 + I_3 \quad \text{...(i)}$$

Since the potential difference across all the resistors is the same, so applying Ohm's law to each resistor we get:

$$I_1 = \frac{V}{R_1}$$

$$I_2 = \frac{V}{R_2}$$

$$I_3 = \frac{V}{R_3}$$

11. R_2 and R_3 are in parallel.

So, $$R_{Parallel} = \frac{R_2 \times R_3}{R_2 + R_3}$$

$$= \frac{10 \times 10}{10 + 10} = \frac{100}{20} = 5\Omega$$

Now, R_1, $R_{parallel}$ and R_4 are in series

$$R_{total} = 5 + 5 + 5 = 15\ \Omega$$

The equivalent resistance of the circuit is 15 Ω

12. (i) Electric power is the rate at which electrical energy is consumed or produced in an electric circuit. It is mathematically expressed as:

$$P = VI$$

where:

P is the electric power,

V is the potential difference, and

I is the current.

The SI unit of electric power is watt (W)

(ii) The two bulbs are connected in parallel across a 220 V mains. The total current is the sum of the currents drawn by each bulb. Using the power formula:

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

For the 100 W bulb:

$$I_1 = \frac{P_1}{V} = \frac{100}{20} = 0.4545A$$

For the 60 W bulb:

$$I_2 = \frac{P_2}{V} = \frac{60}{220} = 0.2727A$$

$$I_{Total} = 0.4545 + 0.2727$$

$$= 0.7272\ A \text{ or } 0.73\ A$$

13. (i) Joule's law of heating states that the heat dissipated across a resistor is directly proportional to the square of the current flowing through it, resistance of the conductor and duration of flow of current.

i.e., $H = I^2Rt$

(ii) Given,

Resistance (R) = 5 Ω

Voltage (V) = 6 V

Time (t) = 10 s

From Ohm's law:

$$V = IR$$

$$6 = I \times 5$$

$$I = \frac{6}{5} = 1.2\ A$$

Energy dissipated (H) = I^2Rt

Substituting we get,

$$H = 1.2 \times 1.2 \times 5 \times 10 = 72\ J$$

Hence, energy dissipated = 72 J

14. (i) Given:

Length (l) of the metal wire = 2m

Area of cross section (A) = $1.55 \times 10^{-6} m^2$

Resistivity (ρ) of the metal = 2.8×10^{-8} Ω-m

Resistance of a conductor is given by:

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

Thus, putting all the values, we get

$$R = \frac{2.8 \times 10^{-8}\Omega \times 2m}{1.55 \times 10^{-6} m^2}$$

$$R = \frac{5.6 \times 10^{-2}}{1.55}$$

$$R = 3.61 \times 10^{-2}\ \Omega$$

Thus, the resistance of the metal wire is 3.61×10^{-2} Ω

(ii) Alloys are used in electrical heating devices rather than pure metals because the resistivity of an alloy is more than the resistivity of pure metal. Also, the melting point of an alloy is high, so it does not melt or oxidize easily even at a higher temperature.

15. Given,

Power P = 4 kW,

Voltage, V= 220 V

(i) Since, P = VI.

Therefore current $I = \frac{P}{V} = \frac{4\ kW}{220\ V} = 18.18$ A.

(ii) Energy consumed in 2h = Pt = 4 kW × 2h = 8 kWh.

(iii) Cost of energy consumed = 8 × 4.50 = ₹ 36

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) P.d. across 4 Ω resistor = p.d. across R_2 as both are in parallel.

$1.5(A) \times 4(\Omega) = 6V$

(ii) Total current through 4Ω and R_2 = 2.0 A (given)

Current through 4Ω = 1.5 A (given)

Hence current through $R_2 = 2 - 1.5 = 0.5$ A

Using Ohm's law for R_2, we get

$$6V = 0.5\ A \times R_2$$

Hence $R_2 = \frac{6}{0.5} = 12\Omega$

(iii) P.d. across R_1 = Total p.d. – (p.d. acorss R_2) – (p.d. acorss 2.0 Ω)

p.d. across 2.0 Ω = 2 × 2 = 4V

p.d. acorss R_2 = 6V (calculated before)

Hence p.d. across R_1 = 12 – 6 – 4 = 2V

Current through R_1 = 2A

Using Ohm's Law, we get

$$R_1 = \frac{2V}{2A} = 1\Omega$$

2. (i) P = IV

$$I = \frac{P}{V} = \frac{24W}{12V} = 2A$$

Current in lamp A = 2A

(ii) Voltmeter reading = 12 V

Lamp A and Lamp B are in parallel.

Hence p.d. across the arm containing A = p.d. acorss arm containing B

= 12 V (from A)

(iii) P.d. across R_2 + p.d. across B = 12 V

p.d. across B = 6V (given)

Hence p.d. across R_2 = 12 V – 6V = 6V

Current through R_2 = Current through B = 3 A (given)

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

$$R_2 = \frac{6V}{3A} = 2\Omega$$

(iv) Current through R_1 = Total Current

= 3A + 2A = 5A

p.d. across R_1 = 15V – 12V = 3V

$$R_1 = \frac{3V}{5A} = 0.6\Omega$$

3. (i) Electric power is the rate at which electrical energy is dissipated or consumed. It is the rate of supplying energy to maintain the flow of current through a circuit.

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

(ii) (A) Energy consumed = 11 units

(1 unit = 1 kWh)

E = 11 kWh = 11 × 1000 = 11000 W

$$\text{Power, } P = \frac{\text{Electrical energy consumed}}{\text{Time}}$$

$$P = \frac{11\text{ kWh}}{5\text{h}} = 2.2\text{ kWh or } 2200\text{ W}$$

Thus, the power rating of the oven is 2200 W or 2.2 kW

(B) $I = \frac{P}{V}$

$$= \frac{2200}{220} = 10A$$

(C) $R = \frac{V^2}{P}$

$$= \frac{(220)^2}{2200} = 22\Omega$$

4. (i) $R = \rho\frac{l}{A}$

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

$$= \text{Ohm} \times \frac{(\text{metre})^2}{\text{metre}}$$

= ohm metre/Ωm

(ii) Here l = 3 m, A = 4×10^{-7} m^2, R = 60Ω

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

$$= \frac{60 \times 4 \times 10^{-7}}{3}$$

$$= 80 \times 10^{-7}\ (\Omega m)$$

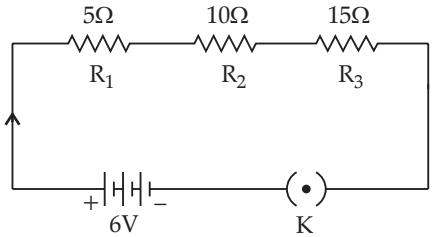
(iii) Resistivity will not change because resistivity does not depend on the dimension of the conductor and only depends on the nature of the material.

5. (i) Current becomes one-third of its initial value.

Ohm's law helps us in answering this question.

Ohm's law states that the potential difference across the ends of a conductor is directly proportional to the current flowing through it, provided its temperature remains the same.

(ii)



Total Voltage = V = 4 × 1.5 V = 6V

Total resistance, $R_s = R_1 + R_2 + R_3$

= 5Ω + 10Ω + 15Ω = 30Ω

(I) Current, $I = \frac{V}{R} = \frac{6V}{30\Omega} = 0.2A$

(II) V = IR = 0.2 A × 10Ω = 2V

6. (i) When 1 joule of work is done to move a charge of 1 coulomb from one point to other.

(ii) d = 0.2 mm = 2×10^{-4} m; R = 14 Ω

$\rho = 1.6 \times 10^{-8}$ Ωm; A = $\frac{\pi d^2 R}{4}$

$R = \frac{\rho l}{A} = \frac{4\rho l}{\pi d^2}$ or $l = \frac{\pi d^2 R}{4\rho}$

$l = \frac{22}{7} \times \frac{(2 \times 10^{-4})^2}{4 \times 1.6 \times 10^{-8}} \times 14$

= 27.5 m

When the diameter is doubled , $d = 2d$, $A' = 4A$

$\frac{R'}{R} = \frac{A}{A'}$ or $R' = \frac{RA}{A'} = \frac{RA}{4A}$

$\frac{R'}{14} = \frac{A}{4A}$

R′ = 3.5 Ω

Change (14.0 – 3.5) = 10.5 Ω

7. (i) The resistance R of a conductor the shape of a cylinder, of length l and area of cross section A is given as:

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

where ρ is a constant, which is known as the electrical resistivity of the material of conductor.

SI unit of resistivity ρ is Ω-m.

(ii) electrical resistivity (ρ) of the material of the wire is:

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

where R = resistance (3 Ω)

L = length of the wire (120 cm=1.2 m)

A = cross-sectional area of the wire

The wire is cylindrical so the cross-sectional area is given by:

$A = \pi r^2$

The radius r is half the diameter.

$r = \frac{\text{diameter}}{2} = \frac{0.4 \text{ mm}}{2}$

$= 0.2 \text{ mm} = 0.2 \times 10^{-3}$ m

Substitute r into the formula for A.

$A = \pi(0.2 \times 10^{-3})^2$

$= \pi \times 0.04 \times 10^{-6}$

$= 1.2566 \times 10^{-8}$ m^2

Rearrange the formula for R:

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

Substitute the known values (R = 3Ω, A = 1.2566 $\times 10^{-8}$ m^2, L = 1.2 m)

$\rho = 3 \times \frac{1.2566 \times 10^{-8}}{1.2}$

$\rho = 3.1415 \times 10^{-8}$ Ωm

8. (i) Given,

Power (P) = 880 W [when heating is at the maximum rate]

Power (P) = 330 W [when heating is at the minimum rate]

Voltage (V) = 220 V

Case I : When heating is at the maximum rate

We know,

P = VI

Substituting we get,

$880 = 220 \times I$

$I = \frac{880}{220} = 4A$

From V = IR

Substituting we get,

$220 = 4 \times R$

$R = \frac{220}{4} = 55\Omega$

Hence, when heating is at the maximum rate, I = 4 A and R = 55 Ω

Case II : When heating is at the minimum rate

Substituting we get current (I)

$330 = 220 \times I$

$I = \frac{330}{220} = 1.5$ A

Substituting we get resistance (R),

$220 = 1.5 \times R$

$R = \frac{220}{1.5} = 146.6\ \Omega$

Hence, when heating is at the minimum rate, I = 1.5 A and R = 146.6 Ω

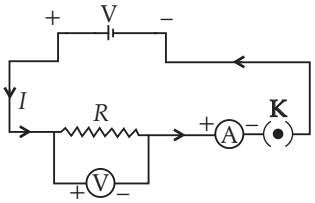
(ii) When the electric circuit is purely resistive, that is, a configuration of resistors only connected to a battery; the source energy continually gets dissipated entirely in the form of heat. This is called heating effect of electric current.

(iii) $H = I^2Rt$

This is known as Joule's law of heating.

9. (i) Current flowing through a conductor is directly proportional to the potential difference.

$V \propto I$



(ii) The ammeter should have a low resistance to make it easy for all the current to flow through the circuit without energy loss or heat loss. This means it does not impede or alter the flow of electric current.

(iii) We know that V = IR or $\frac{1}{R} = \frac{I}{V}$ = slope of graph given. The resistance increases as the slope decreases. Graph B clearly has a greater slope than graph A. As a result, B has less resistance than A. As far as we are aware combined series resistance is consistently greater than combined parallel resistance. As a result, A and B are series and parallel combinations, respectively.

10. (i) Ohm's Law states that the current flowing through a conductor is directly proportional to the potential difference applied across it, provided the temperature, pressure and other physical conditions remain constant.

Mathematically, Ohm's Law can be represented as:

$$V = IR$$

Where,

V = Potential difference (measured in volts, V)

I = Current flowing through the conductor (measured in amperes, A)

R = Resistance of the conductor (measured in ohms, Ω)

(ii) The physical quantity determined by the slope of the V-I curve given in the diagram is resistance (R).

The slope of the V-I curve is given by:

$$\text{Slope} = \frac{\Delta V}{\Delta I}$$

From the graph, we can see that the slope of the line is equal to 7.5 Ω. Therefore, the resistance of the conductor is 7.5 Ω.

(iii) 1 kilowatt-hour (kWh) is equal to the energy consumed by a device of 1 kilowatt (kW) power in one hour.

1 kilowatt-hour = 1000 watts × 3600 seconds

1 kilowatt-hour = 3,600,000 joules (J)

$$= 3.6 \times 10^6 \text{ J}$$

Therefore, 1 kilowatt-hour is equal to 3.6×10^6 joules.

11. (i) Resistance is the quality of a conductor that causes it to resist the flow of an electric current through it. It is the proportion of the potential difference between ends to the current flowing. Its SI unit is ohm (Ω).

(ii) Resistance of the conductor depends upon:

(1) Length,

(2) Area,

(3) Resistivity,

(4) Temperature (any two)

(iii)(1) $R = \frac{\rho l}{A}$

Where, ρ = electrical resistivity

l = length of the conductor

A = cross-sectional area of the conductor

Hence if the length is double then

$$\Rightarrow \quad R_1 = \rho\frac{(2l)}{A}$$

$$\therefore \quad R_1 = 2(R)$$

So, if the length of the resistance gets doubled, then resistance also gets doubled.

(2) Now when the radius is double then

$$\Rightarrow \quad R_2 = \frac{\rho l}{A}$$

$$\Rightarrow \quad R_2 = \frac{\rho l}{\pi(2r)^2}$$

$$\therefore \quad R_2 = \frac{1}{4}(R)$$

So if the radius gets doubled then resistance will be $\left(\frac{1}{4}\right)^{\text{th}}$ of initial resistance.

12. (i) No, the bulbs will not glow with the same brightness.

In Series Circuit: When the three bulbs are connected in series, the total resistance of the circuit increases (since resistances in series add up). The current through each bulb is the same because the current has only one path to flow. However, the voltage across each bulb is reduced because the source voltage is divided among the three bulbs. This results in lower power dissipation (P = VI) in each bulb, so the bulbs will glow dimmer.

In Parallel Circuit: When the three bulbs are connected in parallel, each bulb receives the full source voltage because they are connected directly across the source. The total resistance of the circuit decreases (since resistances in parallel combine as $\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$. This allows more current to flow through the circuit. Each bulb operates at its rated power $\left(P = \frac{V^2}{R}\right)$, so they glow with full brightness.

(ii) In the Series Circuit: No, the remaining bulbs will not glow. In a series circuit, the current flows through all components in a single path. If one bulb gets fused, it breaks the circuit, stopping the flow of current to all other bulbs.

In the Parallel Circuit: Yes, the remaining bulbs will continue to glow. In a parallel circuit, each bulb is connected independently to the source. If one bulb gets fused, the current still flows through the other branches, allowing the remaining bulbs to operate normally.

12 CHAPTER

Magnetic Effects of Electric Current

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (B) is correct

Explanation: The strength of the magnetic field produced by a current-carrying solenoid depends on:

Number of turns in the solenoid (A): A higher number of turns increases the magnetic field strength because the field lines are concentrated.

Radius of the solenoid (C): A smaller radius results in a more concentrated field, slightly affecting the field strength.

Material of the core of the solenoid (D): The core material can significantly affect the field strength. A ferromagnetic core enhances the field strength due to increased permeability.

The direction of the current (B) determines the orientation (polarity) of the magnetic field but does not affect the strength of the magnetic field.

2. Option (B) is correct

Explanation: When a current flows through a conductor, it creates a magnetic field around it. The direction of this magnetic field can be determined using the right-hand rule. When the currents in two parallel conductors are in the same direction, the magnetic fields they create attract each other. In the given scenario, the current in the rectangular loop (ABCD) and the straight conductor (XY) are in the same direction. Therefore, the magnetic field created by the loop will attract the conductor XY towards it, causing it to move towards side AB of the loop.

3. Option (C) is correct

Explanation: A solenoid is a coil of wire. When carrying current, a solenoid produces a magnetic field similar to the field of a bar magnet. In such a field, the magnetic field lines form circles centered on the wire. The direction of the magnetic field generated by a current is determined by the "right-hand rule."

4. Option (A) is correct

Explanation: For the given figure, the proton and electron are moving in opposite directions to each other and is perpendicular to the direction of magnetic field. Now, we know that the direction of current is taken opposite to the direction of motion of electron. So, both electron and proton have current in same direction. Therefore, the forces acting on them are given by Fleming's left hand rule and they are pointing into the plane of the paper.

5. Option (C) is correct

Explanation: The magnetic fields produced at the midpoint P, by the currents flowing in the same direction in the two parallel wires will be equal in magnitude but opposite in direction. Hence, the resultant magnetic field at P will be zero.

6. Option (C) is correct

Explanation: According to Fleming's left-hand rule, the direction of the force is parallel to the directions of the magnetic field and current. Here, the stream is flowing upward and the magnetic field is to the right (opposite to the flow of electron). The direction of the force is perpendicular to the directions of the magnetic field and current, according to Fleming's left-hand rule. We are aware that the flow of current happens in the opposite path to the way electrons move. As a result, the power is applied from the paper's plane upward. The direction of force experienced by positron will be into the paper.

7. Option (C) is correct

Explanation: Magnetic field lines enter from the south pole and exit from the north pole. A circular coil that conducts current has curved lines, a straight line running through the centre, and concentric circles at the coil's two opposite ends.

8. Option (D) is correct

Explanation: According to Fleming's Left hand rule, the current flows in the direction of the alpha particle, the field points in the direction of the paper's right side, and the force is directed out of the paper by thumb.

9. Option (B) is correct.

Explanation: If we observe the direction of the magnetic field by applying right hand thumb rule, then we will find that the direction of the magnetic field is from north to south below the wire.

10. Option (C) is correct

Explanation: A solenoid works similarly to a bar magnet. As a result, the magnetic field pattern associated with the solenoid and around the bar magnet is identical.

11. Option (D) is correct

Explanation: The magnetic field inside a long straight current-carrying solenoid is uniform and directed along its axis. This is because the solenoid produces a nearly uniform magnetic field within its interior due to the closely spaced circular loops of current, while the field outside is negligible.

12. Option (A) is correct

Explanation: Shape of magnetic field lines inside a solenoid is always parallel and straight and the magnetic field lines formed by a straight conductor is always concentric circles .

Assertion-Reason Questions (1 Mark)

1. Option (D) is correct**.**

Explanation: Assertion is false because the deflection of a compass needle is directly proportional to the strength of the magnetic field. Increasing the current increases the magnetic field, which will increase the deflection of the compass needle.

Reason is correct. The magnetic field (B) around a straight current-carrying conductor is proportional to the current (I).

2. Option (A) is correct**.**

Explanation: Assertion is true that magnetic field lines never intersect each other. This is because if they did intersect, it would imply that at the point of intersection, a compass needle would have to point in two different directions simultaneously, which is impossible. The reason provided explains this concept clearly and accurately stating the impossibility of compass needle pointing towards two directions at once due to the inherent nature of magnetic fields.

3. Option (A) is correct

Explanation: Magnetic field strength is directly proportional to the number of turns of the circular coil. Hence, strength of the magnetic field increases on increasing the number of turns in it because current in each circular turn has the same direction and the magnetic field due to each turn then just adds up.

4. Option (B) is correct

Explanation: Magnetic field lines are imaginary lines used to represent the direction of the magnetic field at different points in space. The tangent to a magnetic field line at any point gives the direction of the magnetic field at that point. The reason for magnetic field lines not intersecting each other is that the direction of the magnetic field at any point can only be a single direction, and if two field lines intersect, there will be two directions of the magnetic field at the intersection point, which is not possible. However, the reason does not directly explain why magnetic fields do not intersect each other.

5. Option (B) is correct

Explanation: Assertion is true. A current-carrying conductor placed in a magnetic field experiences a force due to the interaction between the magnetic field and the moving charges in the conductor. Reason is also true but irrelevant to the assertion. The net charge on a conductor remains zero because the flow of current involves the movement of free electrons, but the conductor as a whole does not gain or lose charge. However, this has no direct connection to the force experienced by the conductor in a magnetic field.

6. Option (B) is correct**.**

Explanation: Assertion is correct. Magnetic field lines represent the direction of the magnetic field at a point. If two magnetic field lines intersect, it would imply that the magnetic field has two different directions at the same point, which is not possible.

Reason is also correct. The magnetic field (B) produced by a current-carrying straight wire is directly proportional to the current (I) through the wire. While both the Assertion and the Reason are true, the Reason is not the explanation for the Assertion. The non-intersection of magnetic field lines is a fundamental property of field lines, independent of the magnitude of the current or the strength of the magnetic field.

7. Option (B) is correct**.**

Explanation: Assertion is correct. The magnetic field around a straight current-carrying conductor forms concentric circles in the plane perpendicular to the conductor. This can be visualized using iron filings, which align along the magnetic field lines.

Reason is also correct. A magnetic field is a vector quantity, meaning it has both magnitude and direction. The circular arrangement of the iron filings is due to the direction of the magnetic field around the conductor.

Both assertion and reason are true but reason does not explain why iron filings arrange themselves in concentric circles.

Level - 2

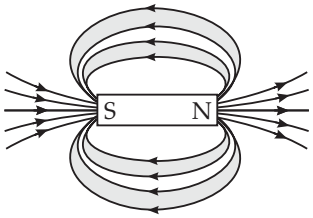
CASE BASED QUESTIONS (4 Mark)

1. (i) No, two magnetic field lines are not found to intersect each other. If two field lines intersect each other, it would mean that at the point of intersection, the compass needle would point in two directions at the same time, which is not possible.

(ii) (1) The magnetic field lines always make close loop.

(2) A tangent at a point on field shows the direction of magnetic field at that point.

(iii) (a) The space around the magnet in which compass rests in a definite direction and other magnet experiences a force is called the magnetic field.



OR

(b) (i) Outside the magnetic, the magnetic field lines always begin from the N-pole of a magnet and end on the S-pole of the magnet. Inside the magnet, however the direction of magnetic field lines is from the S-pole of the magnet to the N-pole of the magnet. Thus, the magnetic field lines are make closed curved not open.

(ii) The strength of magnetic field is determined by the closeness of field lines.

2. (i) According to Fleming's left-hand rule, the direction of force on the direction will be in the south direction.

(ii) The two conditions when magnetic field exerts no force on charge particle,

(1) On stationary electric charge.

(2) When charge particle moves parallel to the direction of magnetic field.

(iii) (a) Magnetic force on moving charge particle in magnetic is defined as,

$$F = qBv \sin\theta$$

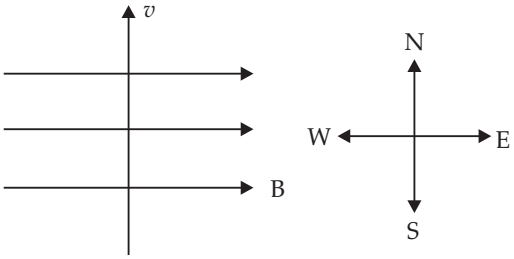
Magnitude of magnetic force,

Given: $q = 5\mu C$, $v = 5000$ m/s, B = 10 tesla, $\theta = 90°$

Now, $F = 5 \times 10^{-6} \times 10 \times 5000 \times \sin 90°$

$F = 25 \times 10^{-2}$ N

Direction of magnetic force,



According to Fleming's left-hand rule, direction of magnetic force perpendicularly downward to the paper plane.

OR

(b) Fleming's left-hand rule: According to this rule, stretch the thumb, forefinger and middle finger of your left hand such that they are mutually perpendicular. If first finger points in the direction of magnetic field and the middle finger in the direction of current, then thumb will point in the force acting on the conductor.

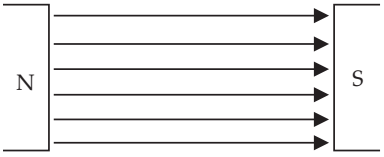
If the direction of magnetic field will reverse, the direction of force on current carrying wire will be reverse also.

Level - 3

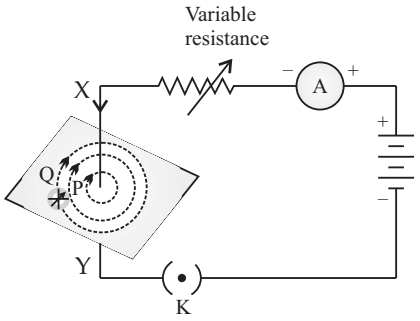
VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. (i) Two magnetic field lines do not intersect each other due to the fact that the resultant force on a north pole at any point can be only in one direction. But if the two magnetic lines intersect one another, this means that resultant force on a north pole placed at the point of intersection will be along two directions, which is not possible.

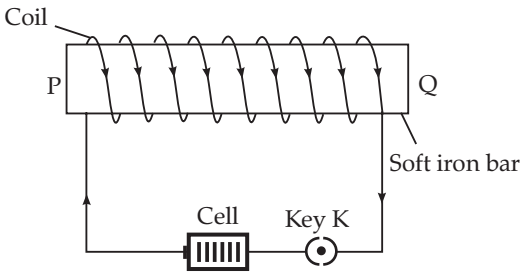
(ii) Straight and parallel lines represent a homogenous magnetic field inside a specified location. These lines demonstrate that the magnetic field is constant in intensity and direction across the region.



2.



3. A permanent magnet or current carrying solenoid is used to magnetise a piece of magnetic material.



Making a bar electromagnet

PQ is a soft iron rod whose end P behaves as south pole and end Q behaves a north pole when soft iron rod is placed in a line with magnetic field.

4. (i) The direction of magnetic field produced around a current-carrying conductor is given by right-hand thumb rule. If the conductor carrying current is held in the right hand in such a way that the thumb points in the direction of current, then the direction of curl of fingers gives the direction of the magnetic field.

(ii) The direction of force experienced by a straight conductor carrying current placed in a magnetic field, which is perpendicular to it is determined by Fleming's left-hand rule. Stretch the thumb and first two fingers of the left hand at right angles to each other with the first finger pointing in the direction of the field and the second finger in the direction of the current, then the thumb points in the direction of the motion.

5. (i) The magnetic field at P and Q is the same. Because the magnetic field lines inside the helical coil of wire which behaves like a solenoid is uniform/in the form of parallel straight lines.

(ii) (1) Increasing/decreasing the number of turn in the coil.

(2) Increasing/decreasing the current through the coil.

6. (i) The current in the loop is clockwise.

(ii) The rule used is the Right Hand Thumb rule.

The Right-Hand Thumb Rule states "If you curl the fingers of your right hand around the loop in the direction of the current, the thumb points in the direction of the magnetic field inside the loop."

7. (i) The Fleming's Left-Hand Rule is used to determine the direction of the force experienced by a current-carrying straight conductor placed in a magnetic field perpendicular to it.

(ii) The magnitude of the force (and hence the displacement) on the conductor depends on the angle (θ) between the current and the magnetic field.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. (i) Magnetic field strength is inversely proportional to the distance from the current carrying wire. Hence, when Mona moved the compass away from the current carrying wire, the magnetic effect was less on it and hence the deflection was less.

(ii) Magnetic field strength is directly proportional to the current in the wire. So, Mona could increase the current in the circuit to observe a greater deflection in the compass needle.

(iii) The battery suggests that the current is going from top of the plane to the bottom of the plane. Using the right hand thumb rule, we can say that the magnetic field will be clockwise.

2. (i) Rule to determine the direction of a magnetic field produced around a current carrying straight conductor.

Rule: Right-Hand Thumb Rule

The Right Hand Thumb rule states, "If you grasp the current-carrying conductor with your right hand such that the thumb points in the direction of the current, then the curled fingers around the conductor indicate the direction of the magnetic field."

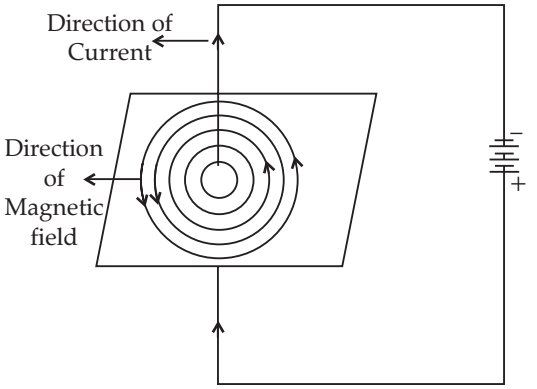
This rule helps determine the direction of the circular magnetic field lines around a straight current-carrying conductor.

(ii) Rule to determine the direction of force experienced by a current carrying straight conductor placed in a magnetic field which is perpendicular to it.

Rule: Fleming's Left Hand Thumb rule

According to this rule, ''stretch the thumb, forefinger and middle finger of your left hand such that they are mutually perpendicular. If first finger points in the direction of magnetic field and the middle finger in the direction of current, then thumb will point in the force acting on the conductor.''

3.



Right-hand thumb rule: This rule states that if current-carrying wire in your right hand with you pointing in the direction of electric current flow, the direction of your curling fingers indicates the direction magnetic field's lines of force.

Yes, it is in accordance with the right-hand rule.

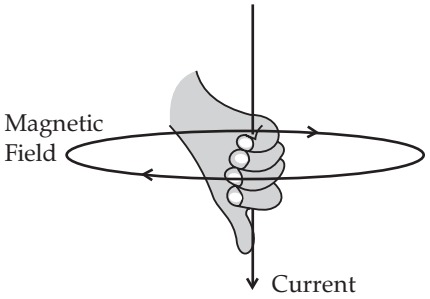
4. (i) Because a magnetic field exists around the bar magnet.

(ii) Crowding of iron filings at the ends of the magnet indicates that the strength of the magnetic field is maximum near the poles of the magnet.

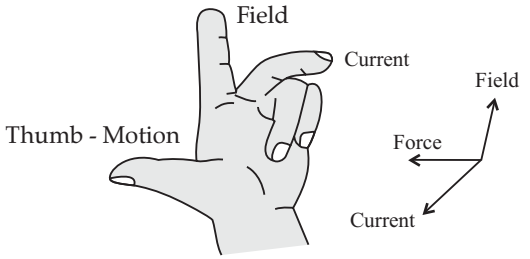
(iii) The lines represent magnetic field lines.

(iv) When a student places a cardboard horizontally in a current-carrying solenoid and sprinkles iron filings on it, the iron filings will arrange themselves in concentric circles around the solenoid. The pattern of the iron filings will show the magnetic field lines of the solenoid. The pattern will be uniform inside the solenoid and more spread out outside.

5. (i) (a) Right Hand Thumb Rule states that If you hold a current-carrying conductor in your right hand such that your thumb points in the direction of the electric current, the direction in which your fingers curling around the conductor gives the direction of the magnetic field".



(b) Fleming's Left Hand Rule states that if we arrange our thumb, forefinger and middle finger of the left-hand mutually perpendicular to each other, then the thumb points towards the direction of the force experienced by the conductor, the forefinger points towards the direction of the magnetic field and the middle finger points towards the direction of the electric current.



(ii) The direction of the force experienced by the proton is out of the plane of the paper.

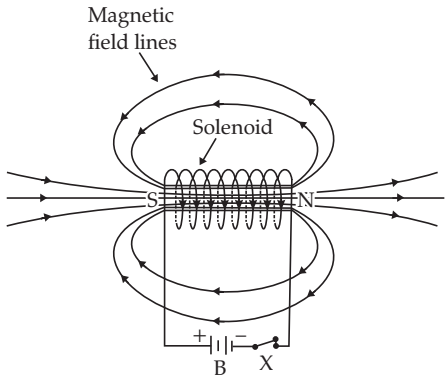
6. (i) Fleming's left hand rule is used to find the direction of force acting on a current carrying conductor, placed in a magnetic field.

According to this rule: Stretch the thumb, fore finger and middle finger of your left hand such that they are mutually perpendicular. If the forefinger points in the direction of magnetic field and the middle finger in the direction of current, then the thumb will point in the direction of motion or force acting on conductor.

(ii) (1) Force on electron is maximum in diagram (i) because here direction of motion of electron is at right angles to the magnetic field.

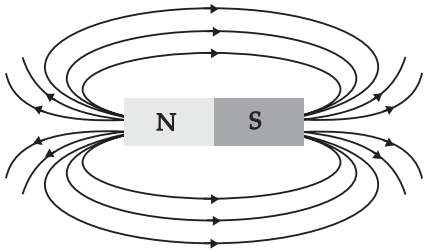
(2) Force on electron is minimum in diagram (iii) because here direction of motion of electron is along the direction of the magnetic field.

7. (i) (1)



Magnetic field lines of a current carrying solenoid

(2)



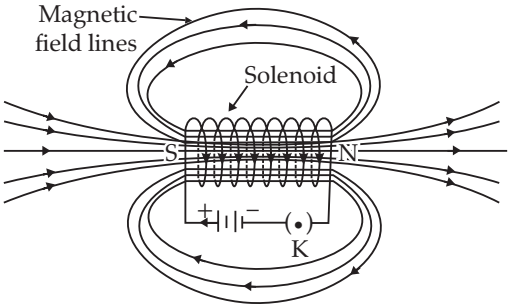
Magnetic field lines of a Bar magnet

(ii)

Magnetic field of a Solenoid	Magnetic field lines of a Bar magnet
(1) The strength of the magnetic field can be changed by changing the current.	The strength of the magnetic field for a bar magnet cannot be changed.

(2) The direction of magnetic field can be reversed by reversing the direction of current.	The direction of magnetic field for a bar magnet cannot be changed.
(3) It is a temporary magnetic field.	It is a permanent magnetic field.

8. (i)



(ii) Magnetic field strength outside of the solenoid is minimal. The magnetic field strength at the ends of the solenoid is half that inside. Field strength is thus;

Minimum – at point B; Maximum – at point A.

9. (i) (1) Increasing the current will increase the displacement to the left.

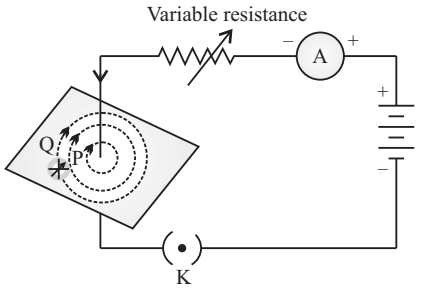
(2) Using a stronger magnet will also increase the displacement to the left.

(3) Reversing the current direction will reverse the direction of displacement and the conductor will move to the right.

(ii) Fleming's left hand rule is used to find the direction of force acting on a current carrying conductor, placed in a magnetic field.

According to this rule, Stretch the thumb, fore finger and middle finger of your left hand such that they are mutually perpendicular. If the forefinger points in the direction of magnetic field and the middle finger in the direction of current, then the thumb will point in the direction of motion or force acting on conductor.

10.



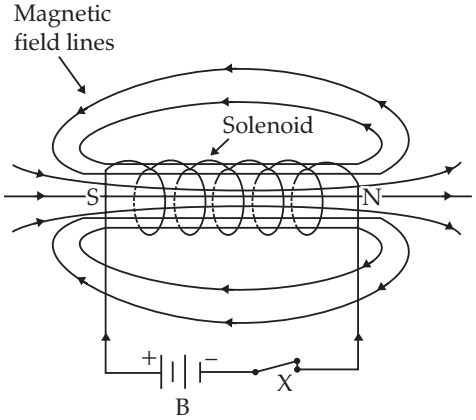
The Right Hand Thumb rule is used to find the direction of the magnetic fields. According to this rule, if we place our right hand thumb along the direction of the current flowing in a current carrying wire, the direction in which the fingers wrap the wire represents the direction of the magnetic field.

11. A solenoid is a coil of wire wound in the form of a cylinder, often closely packed, through which an electric current is passed. It generates a magnetic field similar to that of a bar magnet when current flows through it.

A solenoid behaves as a magnet when:

(1) An electric current is passed through it.

(2) The magnetic field lines form a pattern resembling that of a bar magnet, with a north pole and a south pole depending on the direction of the current.



12. (i)

Basis	Solenoid	Circular coil
Structure	A solenoid is a long cylindrical coil with multiple turns of wire wound closely in a helical shape.	A circular coil consists of one or a few circular loops of wire.
Magnetic field	The magnetic field inside a solenoid is strong, uniform, and resembles that of a bar magnet.	The magnetic field is strong at the center of the coil and weakens as you move away from it.
Application	Used to produce strong, uniform magnetic fields.	Used in devices like galvanometers and speakers.

(ii) Materials Needed:

An insulated copper wire.

A cylindrical object (e.g., a plastic or cardboard tube).

A battery or power source.

An iron rod (optional, for creating an electromagnet).

Procedure:

Take the cylindrical object as the base for the solenoid.

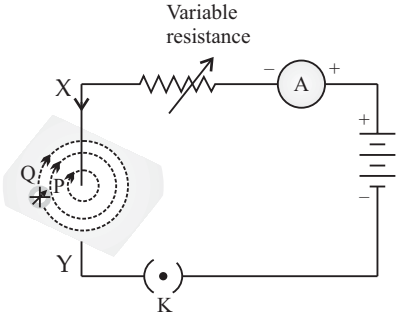
Wind the insulated copper wire tightly around the cylinder in a helical manner, making multiple turns close to each other.

Connect the two ends of the wire to the terminals of a battery or power source.

To increase the strength of the magnetic field, insert an iron rod inside the solenoid (this creates an electromagnet).

(iii) The strong magnetic field produced inside a current-carrying solenoid is used in electromagnets.

13.

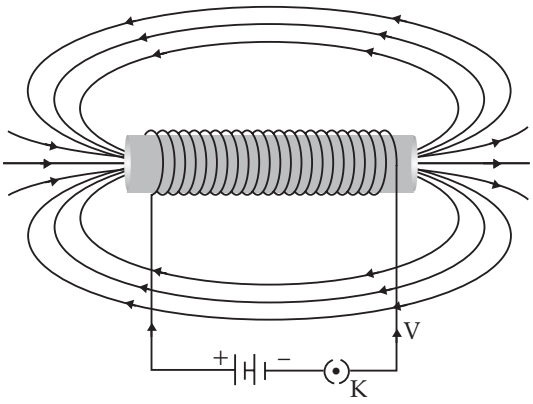


When current is passed through the conductor then concentric magnetic field lines will be produced. The strength of the magnetic field keeps on decreasing as we away from the wire.

We use the right hand thumb rule to find the direction of the magnetic field.

Right-hand Thumb Rule: If a current-carrying conductor is held by the right hand; keeping the thumb straight and if the direction of the electric current is in the direction of thumb, then the direction of wrapping of other fingers will show the direction of the magnetic field.

14. (i)



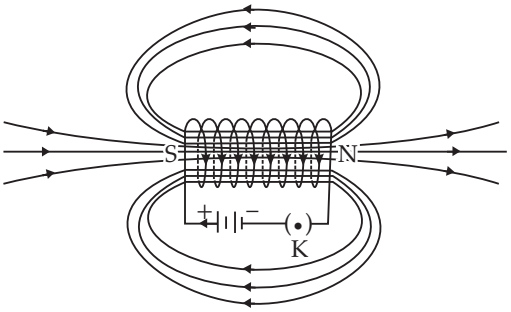
(ii) (1) Use of Properly Rated Fuses or Circuit Breakers: Ensure that the electrical circuit is equipped with fuses or circuit breakers rated appropriately for the maximum current that the circuit is designed to carry. Fuses or circuit breakers automatically disconnect the circuit when the current exceeds a safe limit, preventing overloading.

(2) Avoid Plugging Too Many Appliances into One Socket: Do not overload a single electrical socket by plugging in multiple high-power appliances. This can exceed the safe current rating of the socket and cause overheating, which could lead to a fire hazard. Use multi-socket extension cords with built-in protection if needed, but ensure they are rated for the load.

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. A solenoid is a long coil of wire wound in the form of a helix, which carries an electric current. When a current flows through the solenoid, it produces a uniform magnetic field inside the coil and a weaker magnetic field outside it.

The magnetic field lines around a solenoid emerge from the north pole and passing through the south pole makes a continuous loop. The magnetic field lines inside the solenoid become almost straight and parallel to each other. A schematic representation has been shown below:



A solenoid can be used to magnetize a piece of soft iron by placing the iron inside the solenoid while a current flows through the solenoid. The magnetic field produced by the solenoid induces a magnetic field in the soft iron, aligning its magnetic domains. Here's how it works:

(1) Place the soft iron inside the solenoid: The solenoid produces a magnetic field when the current flows through it.

(2) Magnetic induction: The magnetic field from the solenoid causes the magnetic domains in the soft iron to align in the same direction, magnetizing the iron.

(3) Result: The piece of soft iron becomes temporarily magnetized and behaves like a magnet while the current is flowing. Once the current is turned off, the soft iron loses its magnetism quickly, as it is made of a material that does not retain magnetism for long.

13 Our Environment

CHAPTER

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (C) is correct
   Explanation:
   - (A) is correct because producers (plants) form the first trophic level and absorb approximately 1% of the light energy from the sun.
   - (B) is correct as producers use most of the energy they capture for their own processes like respiration, growth, and reproduction.
   - (C) is incorrect because producers do not utilise 10% of the light energy and transfer the rest. In fact, they typically use most of the energy for their own needs and only about 10% of the energy is passed on to the next trophic level.
   - (D) is correct because only about 10% of the energy captured by producers is transferred to the next trophic level (herbivores).
2. Option (B) is correct.
   Explanation: Enrichment of oxygen in the atmosphere is not a role of decomposers. Oxygen is enriched in the atmosphere mainly through photosynthesis by producers (plants), not by decomposers.
3. Option (C) is correct
   Explanation: The food chain in which the organisms of the second trophic level are missing is (C) Tiger, grass, snake, frog. In this chain, grass represents the primary producers (the first trophic level), but there are no herbivores (primary consumers) at the second trophic level that feed on the grass. Instead, the snake and frog are secondary consumers, as they typically feed on smaller animals rather than directly consuming plant material. The tiger is at the top of the food chain, making it a tertiary or apex predator.
4. Option (A) is correct
   Explanation: In a food chain, only about 10% of the energy is transferred from one trophic level to the next, but with each transfer, a significant amount of energy is lost as heat due to various biological processes such as metabolism and movement. A food chain with fewer trophic levels has fewer energy transfers, which minimizes the total energy loss. Therefore, a food chain with only two trophic levels (producers and primary consumers) allows for more efficient energy transfer, as it experiences the least energy loss compared to food chains with more trophic levels.
5. Option (B) is correct
   Explanation: The correct statements are (a) and (c). Ozone is indeed a poisonous gas, which makes it harmful to humans and animals. However, it plays a critical protective role in the stratosphere by absorbing harmful UV radiation from the Sun. The formation of ozone occurs when UV radiation splits oxygen molecules (O_2) into individual oxygen atoms, which then combine with other oxygen molecules to form ozone (O_3).
6. Option (B) is correct
   Explanation: Non-biodegradable wastes are the waste that do not decompose naturally and can persist in the environment for a long time. Among the given options, ball point pen refills and empty medicine bottles made of glass are non-biodegradable because they are made of materials like plastic and glass, which do not easily break down.
7. Option (D) is correct
   Explanation: A natural ecosystem refers to an ecosystem that exists naturally without significant human intervention, where organisms interact with each other and their environment in a balanced, self-sustaining way. Among the given options, a cropland ecosystem (D) is a human- made ecosystem, as it is created and maintained for agricultural purposes. Human activities such as planting crops, irrigation, and pest control disrupt the natural balance of the ecosystem, making it different from natural ecosystems.
8. Option (B) is correct
   Explanation: Statement I and Statement IV are correct as every step in a food chain is called a trophic level and linkages between various food chains constitute a food web. On the other hand, Statement II is incorrect because decomposers break down organic matter, not inorganic matter, and Statement III is also incorrect because energy decreases as you move up the trophic level.
9. Option (C) is correct.
   Explanation: Biomagnification refers to the process where harmful chemicals, such as pesticides or heavy metals, accumulate in higher concentrations as they move up the food chain, affecting organisms at higher trophic levels.

10. Option (D) is correct
Explanation: Organisms that consume producers directly, such as plants or grass, are considered the primary consumers in the food chain. Both rabbits and mice feed on plants and seeds, making them primary consumers in this food web.

11. Option (A) is correct
Explanation: The energy plants receive from the Sun is used for various processes like photosynthesis, growth, respiration, and transport of substances. However, only the energy stored in the plant's biomass through growth (such as in leaves, stems, and fruits) is passed on to the next trophic level when herbivores consume the plant. Respiration and other processes like transport and reproduction use energy but do not store it in a way that can be transferred to the next consumer.

12. Option (B) is correct
Explanation: The action of sunlight is crucial to the formation of ozone in the Earth's atmosphere. Ozone is formed in the stratosphere when ultraviolet (UV) radiation from the sun interacts with oxygen molecules (O_2), causing them to break apart into individual oxygen atoms (O).

13. Option (C) is correct
Explanation: If all organisms of one trophic level in a food chain die, the populations of organisms in the lower trophic levels may increase. This is because the absence of predators or consumers at higher trophic levels reduces predation pressure, allowing organisms in the lower levels to thrive and reproduce.

14. Option (D) is correct
Explanation: Biomagnification refers to the process by which non-degradable chemicals, such as pesticides or heavy metals, accumulate in increasing concentrations at each trophic level in a food chain. These substances are not broken down by organisms and become more concentrated as they move up the food chain, reaching their highest concentration in the bodies of top consumers or apex predators. This can lead to harmful effects on these organisms and the ecosystem.

15. Option (B) is correct
Explanation: Biological magnification occurs when substances that are non-degradable (P) and are not easily broken down by organisms (R) accumulate in increasing concentrations at higher trophic levels. These substances cannot be excreted efficiently, leading to their buildup in the tissues of organisms.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (D) is correct
Explanation: If the lions are removed from a food chain it will affect the food chain because being top predators, they play a crucial role in regulating the population of herbivores. If lions are removed, herbivore populations could increase uncontrollably, leading to overgrazing and depletion of plants, which would eventually disrupt the entire ecosystem. However, the reason is true because plants are producers that make food through photosynthesis, while lions are consumers (carnivores) that rely on other animals for food. Thus, assertion is false but reason is true.

2. Option (B) is correct
Explanation: The assertion is true as the waste we generate daily can be biodegradable and non-biodegradable. Biodegradable waste breaks down naturally, while non-biodegradable waste, such as plastics, persists in the environment. However, improperly managed biodegradable waste can also create unhygienic conditions, attract pests, and contribute to pollution. Therefore, improper disposal of waste can lead to severe environmental issues Thus, both assertion and reason are true but reason is not the correct explanation of assertion because reason does not directly explain why waste is classified as biodegradable or non-biodegradable.

3. Option (B) is correct
Explanation: The assertion is true because oxygen is essential for all aerobic forms of life, as it is required for cellular respiration. The reason is also true as ozone (O_3) is formed when free oxygen atoms react with molecular oxygen in the presence of UV radiation. Both assertion and reason are true but reason does not explain assertion as process of ozone formation is unrelated to the role of oxygen in supporting aerobic life.

4. Option (B) is correct
Explanation: The assertion is true because the ozone layer protects the Earth's surface by absorbing most of the harmful ultraviolet (UV) radiation from the Sun which can cause serious health issues like skin cancer and cataracts, as well as harm ecosystems. The reason is also true, as chlorofluorocarbons (CFCs) are responsible for the depletion of the ozone layer. When released into the atmosphere, CFCs break down ozone molecules in the stratosphere, leading to thinning of the ozone layer and the formation of the ozone hole. Thus, both assertion and reason are true but reason is not the correct explanation of assertion.

5. Option (B) is correct.
Explanation: The assertion is correct because ozone (O_3) is indeed a molecule formed by three oxygen atoms, created when molecular oxygen (O_2) interacts with ultraviolet light, causing the oxygen molecules to split and recombine as ozone. The reason is also true, as ozone plays a crucial role in protecting the Earth's surface from harmful ultraviolet (UV) radiation from the Sun, which can cause various health problems. However, the reason does not directly explain the structure of ozone. Thus, both assertion and reason

are true but reason is not the correct explanation of assertion.

6. Option (A) is correct
Explanation: The assertion is correct because the energy passed to herbivores from autotrophs does not return to the autotrophs. This is because the flow of energy in a food chain is unidirectional. This means that in a food chain, once energy is transferred to one trophic level, i.e., from producers (autotrophs) to consumers (herbivores, carnivores, etc.), it moves forward through the chain but does not reverse direction. Thus, both assertion and reason are true and reason is the correct explanation of assertion.
7. Option (C) is correct
Explanation: The assertion is true because according to the 10% rule in ecological food chains, only about 10% of the energy is transferred from one trophic level to the next. Omnivores, which consume both plants (primary producers) and animals (herbivores or carnivores), receive energy from multiple trophic levels, typically from the level below them. However, the reason is not true. While omnivores can be secondary consumers (in the third trophic level), their position in the food chain can vary depending on their feeding habits. They do not always occupy a trophic level immediately above herbivores, as they can feed on both primary producers and various levels of consumers. Thus, assertion is true but reason is false.
8. Option (A) is correct
Explanation: While most organic kitchen waste like vegetable scraps and fruit peels can decompose to form compost, certain materials such as plastic milk packets cannot be broken down by natural biological processes. This is because materials like milk packets are made of non- biodegradable substances such as plastic or laminated layers, which cannot be decomposed by bacteria or other saprophytes. As a result, these materials do not break down in composting systems and remain in the environment for a long time. Thus, both assertion and reason are true and reason is the correct explanation of assertion.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i) Only 1% of the energy of sunlight that falls on leaves is convert into food energy by plants. So, if 10,000 J of solar energy falls on green plants, the amount of energy converted into food energy would be:
$(1/100) \times 10000 = 100$ J
(ii) Curd/yogurt is derived from milk, which comes from herbivorous animals (e.g., cows). Since Ravi is consuming a product made from an herbivore (milk from cows), he is consuming energy that originally came from plants, processed through herbivores. Thus, in terms of trophic levels, Ravi would occupy the third trophic level, as he is consuming the product from a primary consumer (the cow).
(iii) Decomposers, such as bacteria and fungi, are not typically included in the food chain because they break down organic matter from all trophic levels (producers, herbivores, carnivores) and recycle nutrients back into the soil, rather than forming part of a direct energy transfer through the food chain. They act at every trophic level of the food chain, breaking down the remains of dead organisms from producers, herbivores, and carnivores.
2. (i) In this food web, primary consumers are herbivores that feed on producers (like grass). From the given data of ecosystem, Grasshopper and the Cricket are primary consumers.
(ii) According to the 10% energy transfer rule in ecosystems, only about 10% of the energy from one trophic level is passed to the next. So, when a snake eats a frog, it would receive 10% of the energy that the frog gained from its food (which in turn would have gotten energy from primary consumers like grasshoppers or crickets).
(iii) Based on the food web provided, the two organisms competing for food are organism B and organism C as both feed on A only.

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. The process shown in the cartoon refers to biological magnification, where harmful substances like pesticides or heavy metals accumulate at higher trophic levels in the food chain. If humans occupy the last trophic level, they will be at risk of accumulating these toxins in their bodies, as they consume organisms from higher trophic levels. Since these substances are not easily broken down or excreted, they become more concentrated as they move up the food chain. This can lead to serious health issues for humans, including neurological damage, reproductive problems, and cancer.
2. The term used for the materials which cannot be broken down by biological processes is non-biodegradable. Two ways in which non-biodegradable materials harm various components of an ecosystem are:
(i) Soil and Water Pollution: Non-biodegradable materials like plastic, glass, and metals can accumulate in soil and water bodies, contaminating them. These pollutants can harm plants, aquatic life, and soil organisms, disrupting the natural balance and functioning of ecosystems.

(ii) Threat to Wildlife: Animals may mistake non-biodegradable materials for food, leading to ingestion. This can cause physical harm, such as blockages in the digestive system, poisoning, or death. Non-biodegradable waste like plastic can also entangle animals, leading to injuries or fatalities.

3. Decomposers are micro-organisms, such as bacteria, fungi, and certain invertebrates, that break down dead organic matter (plants, animals, and waste products) into simpler substances. They play a crucial role in recycling nutrients and maintaining the flow of energy in ecosystems.

Two consequences of their absence in an ecosystem are:

(i) Nutrient Depletion: Without decomposers, dead organic matter would accumulate, and essential nutrients would not be recycled back into the soil. This would lead to nutrient deficiencies, affecting plant growth and overall ecosystem productivity.

(ii) Disruption of the Food Chain: The absence of decomposers would mean that energy from dead organisms and waste materials would not be efficiently transferred to lower trophic levels. This could lead to an imbalance in the food web, affecting both producers and consumers.

4. A vegetarian food habit involves only two trophic levels food chain.

Produceer → Primary Consumer (herbivore)

An average of 10% of the amount of organic matter reaches to the next level of consumer, hence, it gets more energy.

5. Harmful chemicals get accumulated progressively at each trophic level in a food chain through a process called biological magnification. These chemicals, such as pesticides, enter the soil or water bodies from agricultural activities and are absorbed by plants or aquatic organisms. When herbivores consume these plants, the chemicals accumulate in their bodies, as they are non-degradable. At each higher trophic level, predators consume multiple contaminated prey, leading to a higher concentration of these chemicals in their tissues. Since humans occupy the top trophic level in the food chain, the highest concentration of harmful chemicals accumulates in our bodies, posing significant health risks.

6. Ponds and lakes, being large and natural ecosystems, maintain their cleanliness through self-regulating processes like water circulation, nutrient cycling, and decomposition by microorganisms. The larger volume of water dilutes waste, and harmful substances are naturally broken down, reducing the need for regular cleaning. In contrast, aquariums are small, controlled environments with limited water volume, where waste from fish, uneaten food, and decaying plants accumulate quickly. Without natural processes to break down waste and no dilution, harmful toxins like ammonia and nitrates build up, requiring regular cleaning and filtration to maintain a healthy environment.

7. The excessive use of pesticides in agriculture leads to their accumulation in rivers and ponds, causing serious concerns due to biomagnification. Pesticides washed into nearby water bodies through runoff are absorbed by aquatic plants and animals, and their concentration increases as they move up the food chain. This poses health risks to humans, who are at the top of the food chain, and can harm aquatic life, disrupting ecosystems and reducing biodiversity. This accumulation of harmful chemicals in water bodies not only affects the health of living organisms but also threatens the sustainability of ecosystems and food sources.

8. If 50 J of energy is available to the hawk, applying the 10% energy transfer rule:

- Energy at the snake (level before hawk) = 50 J × 10 = 500 J
- Energy at the frog (level before snake) = 500 J × 10 = 5000 J
- Energy at the grasshopper (level before frog) = 5000 J × 10 = 50,000 J
- Energy at the grass (first trophic level) = 50,000 J × 10 = 500,000 J

Thus, the energy at the first trophic level (grass) is 500,000 J, and at the third trophic level (frog) is 5000 J.

9. (i) One advantage of using cloth bags over plastic bags is that cloth bags are biodegradable and reusable, which makes them environmentally friendly by reducing pollution caused by non-biodegradable plastic bags.

(ii) Two methods for safely disposing of solid wastes in urban areas are:

(1) Recycling: Segregating waste into recyclable materials (like paper, glass, and metals) and processing them into new products.

(2) Composting: Converting organic waste (like food scraps and garden waste) into nutrient-rich compost for agricultural use.

10. (i) The phytoplankton level (producers) is likely to have the most amount of energy in the aquatic ecosystem. Although their biomass is smaller compared to other levels, they have the highest energy content because they form the base of the energy pyramid, and all other trophic levels depend on them for energy.

(ii) Aquatic ecosystems with inverted biomass pyramids are not sustainable because the biomass of the producers (phytoplankton) is much smaller than that of the consumers (zooplankton and fish). This imbalance requires producers to reproduce rapidly to sustain the energy demands of the consumers. If environmental conditions or other factors disturb the rapid regeneration of phytoplankton, the entire food web could collapse, leading to unsustainable ecosystem functioning.

11. The use of chlorofluorocarbons (CFCs) in aerosols, refrigeration, and air conditioning was primarily responsible for the marked decline in the ozone layer in the 1980s. CFCs, when released into the atmosphere, break down ozone molecules in the stratosphere, thinning the ozone layer.

The possible effect of this ozone depletion on human health is an increased risk of skin cancer due to higher exposure to ultraviolet (UV) radiation, as the ozone layer acts as a protective shield against harmful UV rays. Additionally, it can lead to eye damage, such as cataracts, and weaken the immune system.

12. The phenomenon likely responsible for the scientists' advisory is biomagnification, which occurs when

harmful substances, such as heavy metals like mercury, accumulate and increase in concentration as they move up the food chain.

The advisory to humans suggests limiting the consumption of fish like swordfish and king mackerel because these are tertiary consumers at the top of the food chain. As they consume smaller fish that contain mercury, they accumulate higher levels of mercury in their bodies. This increased mercury concentration poses a greater health risk to humans who eat them. In contrast, secondary consumers like tilapia and salmon accumulate lower levels of mercury, making them safer to eat in moderate amounts.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. In the given food chain: Plants → Deer → Lion, removing all the organisms of the second trophic level (Deer) would impact the first and third trophic levels as follows:

- **First Trophic Level (Plants):** The removal of deer, which are herbivores, will reduce the grazing pressure on plants. As a result, the plant population may increase since fewer deer will be consuming them.
- **Third Trophic Level (Lion):** Lions, being carnivores, depend on deer for food. If the deer population is removed, the lions will face a food shortage, which could lead to a decrease in their population due to lack of food.

Impact in the context of a Food Web:

In a food web, the impact on the third trophic level (lions) would not be the same. In a food web, organisms usually have multiple food sources and are part of several interlinked food chains. If one prey species (like deer) is removed, lions may shift to other available prey in the ecosystem, thereby reducing the direct impact on them. This flexibility in diet helps stabilise the population of apex predators (lions) in a food web, unlike in a simple food chain, where the removal of a single species (deer) can have a more dramatic effect on the higher trophic levels.

2. The gas 'X' is Ozone (O_3), which is primarily found in the ozone layer, which is located in the stratosphere.

Function of Ozone in the atmosphere: This layer performs an essential function by absorbing and blocking the majority of the harmful ultraviolet (UV) radiation from the sun. UV radiation is detrimental to living organisms, as it can cause skin cancer, cataracts, and damage to ecosystems.

Chemical linked to the decrease in ozone levels: The depletion of the ozone layer is largely linked to chlorofluorocarbons (CFCs). CFCs are chemicals that, when released into the atmosphere, break down ozone molecules. Once in the stratosphere, CFCs are broken down by UV radiation, releasing chlorine atoms that react with ozone, leading to its depletion.

International measures to check depletion: In response to the alarming depletion of the ozone layer, the Montreal Protocol was established in 1987. The protocol is an international treaty designed to phase out the production and use of ozone-depleting substances (such as CFCs, halons, and other chemicals). The Montreal Protocol has been successful in reducing the use of these chemicals and has contributed significantly to the recovery of the ozone layer.

3. The phenomenon involved is biomagnification, which refers to the process where the concentration of toxic substances, such as pesticides, increases as they move up through the food chain. It occurs because of:

(i) Pesticide Application: Chemicals known as pesticides are intended to eradicate or manage pests that cause harm to crops. Farmers use pesticides to keep insects, fungi, and other undesirable organisms away from their crops.

(ii) Uptake by Plants: When pesticides are administered to crops, the plants may assimilate certain residues. These leftovers may be located on the plant surface or within the plant tissues.

(iii) Ingestion by Herbivores: Herbivores, including insects and animals that devour vegetation, ingest pesticide residues found on or within the plants. The pesticide content in herbivores may exceed that in plants.

(iv) Bioaccumulation: The concentration of pesticides tends to rise as we go up the food chain. Higher concentrations of pesticides are accumulated by predators that prey on herbivores.

(v) Impact on Humans: The concentration of these compounds can be much higher in human tissues when humans eat higher trophic-level species, such as fish or livestock that have bioaccumulated pesticides. This is especially true of persistent organic pollutants, such as some pesticides, which the environment finds difficult to break down and remove.

(vi) Health Effects: Pesticides may be harmful to people's health. Long-term exposure to specific pesticides has been connected to several health concerns, such as malignancies, neurological impairments, and reproductive abnormalities.

4. (i) The ecosystem in food chain (b) is a terrestrial ecosystem, likely a forest or grassland, and the ecosystem in food chain (c) is a marine/pond ecosystem.

(ii) The first trophic level in all food chains consists of producers, as they are capable of synthesising their own food from inorganic substances using light or chemical energy. Producers, mainly plants and algae, utilize photosynthesis to convert solar energy into chemical energy, which is stored in carbohydrates. On average, producers capture only about 1% of the available solar energy for their metabolic processes.

(iii) The arrows in the diagram represent the unidirectional flow of energy, moving from producers to consumers. Energy is transferred when one organism consumes another. However, some energy is lost as heat during metabolic processes, which means it cannot flow back in the opposite direction. This is why the flow of energy in an ecosystem is always unidirectional.

5. Difference between Food chain and Food web

Food chain	Food web
A food chain is a linear sequence of organisms through which nutrients and energy flows from one organism to another.	A network of different food chains is called food web.
It consists of only one straight chain.	It consists of many interconnected food chains.
If one group of an organism disturbs, the whole chain will become unstable.	The food web does not become unstable by the removal of one group of organisms.
Food chain consists of only 4-5 trophic levels of different species.	Food web contains numerous trophic levels also of different populations of species.

If the population of deer decreases in a food chain consisting of deer, grass, and tiger, the following will likely happen:

- **First Trophic Level (Producers-Grass):** The population of grass may increase as the herbivores (deer) are consuming less grass. Without enough deer to graze on them, the grass may grow more abundantly.
- **Third Trophic Level (Tertiary Consumer-Tiger):** The population of tigers may decrease. Since tigers feed on deer, a decrease in the deer population means fewer prey for the tigers. This would likely lead to a reduction in the tiger population due to insufficient food availability.

6. (i) A kitchen garden is an artificial ecosystem because humans modify both the biotic (plants, animals) and abiotic (soil, water) factors to suit their needs, such as growing vegetables or herbs. In contrast, a forest is a natural ecosystem where the biotic and abiotic components evolve and interact naturally without human intervention. While a kitchen garden relies on human management and control, a forest is self-sustaining, driven by natural processes like competition, predation, and nutrient recycling.

(ii) Proper Balance of Producers, Consumers, and Decomposers: To create a self-sustaining system, it is essential to include all three trophic levels: producers (plants), consumers (herbivores, carnivores), and decomposers (bacteria, fungi). This ensures that the plants produce oxygen and food, herbivores and carnivores maintain balance, and decomposers break down organic matter to recycle nutrients back into the system. This cycle of energy and matter is crucial for sustainability.

Efficient Waste Management: A self-sustaining system should have a natural waste recycling mechanism, such as composting plant waste or using decomposers to break down organic matter. This prevents the accumulation of waste and ensures that essential nutrients are recycled back into the soil, supporting plant growth.

7. (i) The food chain involving the given organisms is: Plants (producers) → Rat (primary consumer) → Snake (secondary consumer) → Hawk (tertiary consumer)

(ii) On average, about 10% of the energy from one trophic level is passed on to the next level, while the rest is lost.

- Energy transferred to the second trophic level (rat) = 20,000 J
- Energy transferred to the third trophic level (snake) = 10% of 20,000 J = 2,000 J
- Energy transferred to the fourth trophic level (hawk) = 10% of 2,000 J = 200 J

Thus, 200 J of energy will be transferred from the snake (third trophic level) to the hawk (fourth trophic level).

8. Harmful chemicals, such as pesticides and heavy metals, enter the food chain when they are absorbed by plants and then consumed by herbivores. These chemicals accumulate as they move up the trophic levels because each predator consumes many contaminated organisms from lower levels. Since humans are at the top of the food chain and eat a variety of organisms, they accumulate the highest concentration of these harmful chemicals. This process, known as biomagnification, results in maximum chemical concentration in human bodies, leading to potential health risks like cancer, neurological disorders, and other long-term effects.

9.

Biodegradable Waste	Non-Biodegradable Waste
Waste that can be broken down by natural processes (e.g., bacteria, fungi) into simpler, non-toxic substances. Examples: food scraps, paper, leaves.	Waste that cannot be broken down by natural processes and remains in the environment for a long time. Examples: plastics, metals, glass.

Impacts on the Environment:

Biodegradable Waste:

(1) Soil Contamination: If not disposed of properly, it can decay and release harmful substances into the soil, affecting plant growth.

(2) Odor and Attracts Pests: Decomposing organic waste can produce foul odours and attract pests like rodents and flies, which can spread diseases.

Non-Biodegradable Waste:

(1) Pollution: Accumulation of non-biodegradable waste, such as plastics, can pollute land, water, and air, harming wildlife and ecosystems.

(2) Landfill Overflow: Non-biodegradable items take up space in landfills for decades, contributing to overburdened waste management systems and reducing available land.

10. (i) (a) Autotrophs (plants and algae) capture only about 1% of the available solar energy through photosynthesis to produce food.

(b) Only about 10% of the energy produced by autotrophs is transferred to the next trophic level (herbivores or primary consumers), as energy is lost at each step due to metabolic processes and heat.

(ii) Trophic levels are the various steps or levels in the food chain where transfer of food or energy takes place. Trophic levels represent the different feeding positions in a food chain. They include, producers (Autotrophs), primary consumers (Herbivores), secondary consumers (Carnivores) and tertiary Consumers (Top predators).

Food chains typically have 4 to 5 trophic levels because energy decreases significantly with each transfer. Only about 10% of the energy is passed on to the next level, while the rest is lost as heat. After 4-5 trophic levels, insufficient energy remains to support higher levels, limiting the number of trophic levels in an ecosystem.

11. Trophic Levels: Trophic levels refer to the different feeding positions in a food chain, representing the flow of energy from one organism to another. Each level in the chain is composed of organisms that occupy a similar position in the energy transfer process.

(i) Secondary Consumers are typically found at the third trophic level in a food chain. They are carnivores that feed on primary consumers (herbivores).

(ii) Tertiary Consumers are found at the fourth trophic level. These are apex predators that feed on secondary consumers.

If all organisms of a trophic level die, the flow of energy would be interrupted, as organisms at higher levels depend on those at lower levels for food. For example, if primary consumers (herbivores) die, secondary consumers (carnivores) lose their food source and may also perish. The death of organisms in one level can cause an ecological imbalance. For instance, without decomposers, organic waste would not break down, leading to a buildup of dead matter and a disruption in nutrient cycling. Additionally, the death of herbivores may result in overgrowth of plants, which can alter resource availability for other organisms in the ecosystem.