Sure shots Science Solutions (Most Probable)
10th session 2024-25

1. Chemical Reactions and Equations

1. (*c*) This is an oxidation-reduction reaction. A complete balanced equation is:

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

$x = 4; y = 2; z = 1$ ***(1 M)***

2. (*c*) In the given reaction, MnO_2 loses oxygen and forms $MnCl_2$. Therefore, it is said that MnO_2 is reduced to $MnCl_2$. Whereas, HCl loses hydrogen and forms Cl_2. Therefore, it is said that HCl is oxidized to Cl_2. ***(1 M)***

3. (*a*) This is a thermal decomposition reaction. When lead nitrate undergoes thermal decomposition, brown fumes of nitrogen dioxide are produced. ***(1 M)***

4. (*a*) Heat is released during an exothermic reaction along with the formation of products. ***(1 M)***

5. (*i*) On mixing the two solutions, white precipitate of barium sulfate will form.

$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$ ***(1 M)***

(*ii*) After 10 minutes, white precipitate will settle down at the bottom of the tube and solution above it becomes colorless. ***(1 M)***

6. (*i*) To make water more conductive before electrolysis, acid is added to the solution. This makes it simple for the current to move through the solution. At the cathode, hydrogen gas is released, whereas at the anode, oxygen gas is released. ***(1 M)***

The cathode gas collection volume is twice as large as the anode gas collection volume.

$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$ ***(1 M)***

(*ii*) Silver metal and chlorine gas are produced during the decomposition of silver chloride when it is exposed to light. The reaction is known as photolytic reaction. ***(1 M)***

7. The chemical equations for the various decomposition reactions are:

(*i*) $2H_2O + \text{electricity} \rightarrow 2H_2(g) + O_2$ ***(1 M)***

(*ii*) $CaCO_3 + \text{heat} \rightarrow CaO + CO_2$ ***(1 M)***

(*iii*) $2AgBr + \text{sunlight} \rightarrow 2Ag + Br_2$ ***(1 M)***

8. Combination Reaction:

(*iv*) $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ ***(½ M)***

(*vi*) $3H_2(g) + N_2(g) \rightarrow 2NH_3(g)$ ***(½ M)***

Decomposition Reaction:

(*i*) $ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$ ***(½ M)***

(*vii*) $CaCO_3(s) \xrightarrow{Heat} CaO(s) + CO_2(g)$ ***(½ M)***

Displacement Reaction

(*ii*) $Pb(s) + CuCl_2(aq) \rightarrow PbCl_2(aq) + Cu(s)$ ***(½ M)***

(*v*) $Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe$ ***(½ M)***

Double Displacement Reaction

(*iii*) $NaBr(aq) + AgNO_3(aq) \rightarrow AgBr(s) + NaNO_3(aq)$

2. Acids, Bases and Salts

9. (*b*) Milk of magnesia is basic in nature having pH around 10. ***(1 M)***

10. (*b*) Calcium hydroxide turns milky due to the formation of calcium carbonate which on passing excess of CO_2 forms calcium hydrogen carbonate which makes the solution clear again. ***(1 M)***

11. (*a*) (*i*) Since, compound X gets hardened when mixed with water, therefore, X is Plaster of Paris and its chemical formula is $CaSO_4.1/2H_2O$. ***(1 M)***

(*ii*) Baking soda is sodium hydrogen carbonate ($NaHCO_3$) and it is added to make cooking faster. ***(½ M)***

Baking powder is a mixture of baking soda and a mild edible acid such as tartaric acid. ***(½ M)***

12. (*i*) The 'G' and 'C' formulas are:

$G = Cl_2$ ***(½ M)***

$C = CaOCl_2$ ***(½ M)***

(*ii*) The chemical equation involved is

$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$ ***(1 M)***

(*iii*) Bleaching Powder is the common name for chemical C. Calcium Oxychloride is its chemical name. ***(1 M)***

13. (*i*) Dilution must take place by adding conc. acid into water by constant stirring. As dilution is an exothermic process, so it may be possible that acid may spill out if water is added to a bottle containing concentrated acid. ***(1 M)***

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(*ii*) When H_2SO_4 is added to NaOH, formation of salt (Na_2SO_4) takes place. As it is a neutral salt. Hence pH of the salt is 7.

$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$ ***(1 M)***

(*iii*) HCl can produces H^+ in aqueous solution. It can act as acid in aq. solution. Hence, it changes the colour of litmus paper only in aqueous solution. ***(1 M)***

14. Recrystallisation of sodium carbonate gives washing soda. ***(1 M)***

Its chemical equation is:

$Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3.10H_2O$ ***(1 M)***

It is a basic salt. ***(½ M)***

It is used for removing permanent hardness of water. ***(½ M)***

15. Tooth enamel is made up of calcium hydroxyapatite (a crystalline form of calcium phosphate). ***(½ M)***

Tooth enamel is the hardest substance in the body. It does not dissolve in water and starts to corrode when pH of the mouth becomes below 5.5. ***(1 M)***

Bacteria present in the mouth produce acid by causing degradation of sugar and food particles remain in the mouth after eating. ***(1 M)***

The best method to prevent this is to clean your mouth after eating food. Toothpastes which are basic in nature can neutralize the excess acid and help in prevention of tooth decay. ***(½ M)***

16. (*a*) Sodium chloride is NaCl and is formed by the reaction of acid, HCl and the base, NaOH. ***(½ × 2 = 1 M)***

(*b*) The cation and the anion present in calcium sulphate are Ca^{2+} and SO_4^{2-} respectively. ***(½ × 2 = 1 M)***

(*c*) Salts containing the same positive or negative radicals are known to belong to a family. ***(1 M)***

Sodium chloride (NaCl) and washing soda ($Na_2CO_3 \cdot 10H_2O$) both belong to the family of sodium salts, since both contain the same positive radical i.e., sodium ions. ***(1 M)***

OR

A pH scale is a scale used for measuring hydrogen ion concentration in a solution. ***(½ M)***

The salt obtained by the reaction of potassium hydroxide and sulphuric acid is potassium sulphate.

$KOH + H_2SO_4 \rightarrow \underset{\text{Potassium Sulphate}}{K_2SO_4} + H_2O$ ***(1 M)***

Since, this salt is formed by the reaction of strong base and strong acid, therefore, its pH would be 7(neutral). ***(½ M)***

3. Metals and Non-Metals

17. (*b*) Al_2O_3 is an amphoteric oxide which can react with HCl (an acid) as well as KOH (a base) to give corresponding salt and water. ***(1 M)***

18. (*b*) This is based on the concept of reactivity series in which more reactive metal will displace the less one from their respective salt solutions. ***(1 M)***

19. (*c*) Metal- Mercury

Non-Metal- Bromine

The above mentioned elements exists in the liquid state at the room temperature. ***(1 M)***

20. When silver is exposed to air, it combines with the sulphur in the air to generate a coating of silver sulphide.

$2Ag + H_2S \rightarrow \underset{\text{Silver sulphide}}{Ag_2S} + H_2$ ***(1 M)***

Copper vessels lose their shiny brown surface as copper reacts with moist CO_2 in the air, forming a green layer of copper carbonate and copper hydroxide.

$2Cu + H_2O + CO_2 + O_2 \rightarrow \underset{\text{Copper hydroxide}}{Cu(OH)_2} + \underset{\text{Copper carbonate}}{CuCO_3}$ ***(1 M)***

21. Carbon cannot reduce the oxides of sodium, magnesium, and aluminum because their reactivity exceeds that of carbon and also they have more affinity for oxygen. ***(1 M)***

In the reactivity series, these metals are placed at the top above carbon. ***(1 M)***

Electrolytic reduction (Electrolysis) is a process used to extract metals with high reactivity from their ores, such as sodium, magnesium, and aluminum. ***(1 M)***

For example, sodium is obtained by the electrolysis of its molten chloride. The metal is deposited at the cathode (the negatively charged electrode), whereas, chlorine is liberated at the anode (the positively charged electrode). ***(1 M)***

The reactions are –

At cathode: $Na^+ + e^- \rightarrow Na$ ***(½ M)***

At anode: $2Cl^- \rightarrow Cl_2 + 2e^-$ ***(½ M)***

22. (*i*) In the electrolytic refining process, the impure metal is made the anode and a thin strip of pure metal is made the cathode. ***(1 M)***

(*ii*) A solution of the metal salt is used as an electrolyte. In this case, the metal salt is acidified copper sulphate solution. ***(1 M)***

(*iii*) (A) When electric current is passed through the cell, copper from the impure anode dissolves into the electrolyte as copper ions. ***(1 M)***

These ions then migrate towards the cathode, where they gain electrons and deposit as pure copper. ***(1 M)***

OR

(*iii*) (B) In beaker 'A', the strip of zinc is dipped, and since zinc being more reactive than copper, therefore, will displace Cu from its salt solution. The reaction that occurs is

$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$ ***(1 M)***

In beaker 'B', since, the strip of silver is dipped, and silver being less reactive than copper, therefore, will not displace Ag from its salt solution and no reaction will occur. ***(1 M)***

23. (*a*) When copper is heated in air, it combines with oxygen to form copper(II) oxide, a black oxide. ***(½ M)***

$2Cu + O_2 \rightarrow 2CuO$

(Copper) Copper(II) oxide ***(½ M)***

(*b*) Some metal oxides, such as aluminum oxide and zinc oxide, show both acidic as well as basic behaviour. Such metal oxides that react with both acids, as well as bases to produce salts and water are known as amphoteric oxides. ***(½ M)***

Aluminum oxide reacts in the following manner with acids and bases –

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

$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ ***(½ M)***

(Sodium alumnate)

(*c*) (*i*) $Na_2O(s) + H_2O(l) \rightarrow 2NaOH\ (aq)$ ***(1 M)***

(*ii*) $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ ***(1 M)***

(Sodium alumnate)

Or

(*i*) SO_2 gas is formed on burning sulphur in oxygen.

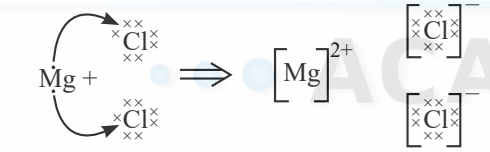
$S + O_2 \longrightarrow SO_2$ ***(½ M)***

(*ii*) SO_2 (Sulphur dioxide) is formed. ***(½ M)***

(*iii*) SO_2 formed is acidic in nature. ***(½ M)***

(*iv*) SO_2 turns moist blue litmus paper red but it does not have any action on dry litmus paper. ***(½ M)***

24. (*a*) (*i*)



(1 M)

(*ii*) • Ionic compounds conduct electricity in solution or in molten state. ***(½ M)***

• Ionic compounds are generally soluble in water and insoluble in solvents. such as kerosene, petrol, etc. ***(½ M)***

(*iii*) (A) By losing one electron, Na attains noble gas configuration and it forms ionic compound NaCl. Cl gains one electron by Na to achieve noble gas configuration.

$Na \rightarrow Na^+ + e^-$

$Cl + e^- \rightarrow Cl^-$

On adding both equation:

$Na^+ + Cl^- \rightarrow NaCl$ ***(2 M)***

Or

(*iii*) (B) (*i*) Ionic compounds have rigid structure and movement of ions is not possible in rigid structure. Hence, ionic solids do not conduct electricity. ***(1 M)***

(*ii*) H_2 is produced at the cathode and O_2 is produced at the anode during the electrolysis of a aqueous solution of NaOH. ***(1 M)***

4. Carbon and its Compounds

25. (*a*) The presence of sulphates, carbonates, and bicarbonates of calcium and magnesium in water causes water hardness and in such water, no lather is formed. Since, in test tube *P* and *Q*, none of the above mentioned salts are present, therefore, a good amount of lather will be obtained in these test tubes. ***(1 M)***

26. When acetic acid is added to sodium hydrogen carbonate powder in a test tube, then CO_2 is released with the brisk effervescence. The reaction is:

$NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + CO_2 + H_2O$

(1 M)

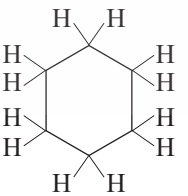
The presence of gas can be detected by passing gas through lime water which turns milky. The chemical reaction that takes place is: $CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$ ***(1 M)***

27. (*a*) The free electrons are responsible for the conduction of electricity as they move to conduct electricity. ***(½ M)***

However, since carbon forms covalent bonds by sharing electrons, thus it has no free electrons. ***(1 M)***

(*b*) An example of saturated compound in which carbon atoms are arranged in the ring is cyclohexane. ***(½ M)***

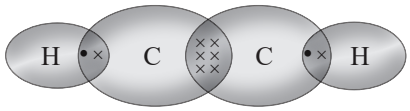
Its structure is



(½ M)

In this compound, the number of single bonds present are 18. ***(½ M)***

28. (*a*) Electron dot structure of ethyne is,



$H — C \equiv C — H$ ***(1 M)***

(*b*) Difference between covalent and ionic compounds,

(*i*) **Physical nature:** Ionic compounds are solids and are somewhat hard as compared to covalent compounds because of the strong force of attraction between the positive and negative ions. ***(1 M)***

(*ii*) **Melting and boiling points:** Ionic compounds have high melting and boiling points as compared to covalent compounds. ***(1 M)***

29. Esterification reaction: In this reaction, ethanoic acid reacts with absolute ethanol in the presence of an acid catalyst to give an ester. The chemical equation is:

$$\underset{\text{(Ethanoic acid)}}{CH_3 – COOH} + \underset{\text{(Ethanol)}}{CH_3 – CH_2OH} \overset{\text{Acid}}{\rightleftharpoons} \underset{\text{(Ester)}}{CH_3 – \overset{\overset{O}{\|}}{C} – O – CH_2 – CH_3} + H_2O$$

(1 M)

Saponification reaction: In this reaction, esters on treating with sodium hydroxide, which is an alkali, the ester is converted back to alcohol and sodium salt of carboxylic acid. The reaction is:

$CH_3COOCH_2CH_3 + NaOH \rightarrow CH_3CH_2OH + CH_3COONa$ ***(1 M)***

Use of ester:
Esters are used in making perfumes and as flavouring agents. ***(½ M)***

Use of saponification process:
It is used in the preparation of soap. ***(½ M)***

30. (*a*) (*i*) Compound *A* is CH_3CH_2OH (Ethyl Alcohol), B is C_2H_4 (Ethene), and C is $CH_3–CH_3$ (Ethane). ***(1 M)***

(*ii*) $\underset{\substack{\text{Ethyl alcohol}\\(A)}}{CH_3CH_2OH} \xrightarrow[443\ K]{\text{Conc. } H_2SO_4} \underset{\substack{\text{Ethene}\\(B)}}{CH_2 = CH_2}$ ***(1 M)***

(*iii*) The equation for the combustion of ethane is:

$2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l) + \text{heat} + \text{light}$ ***(1 M)***

(*iv*) This reaction is commonly used in the hydrogenation of vegetable oils using a nickel catalyst. ***(1 M)***

(*v*) The following reaction takes place when compound A(ethanol) reacts with sodium:

$2Na + 2CH_3CH_2OH \rightarrow 2CH_3CH_2O^- Na^+ + H_2\uparrow$

(Sodium ethoxide) ***(1 M)***

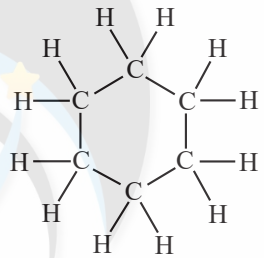
31. (*a*) (*i*) Carbon cannot form C^{4+} cation because it would require a large amount of energy to remove four electrons leaving behind a carbon cation with six protons in its nucleus holding on to just two electrons. ***(1 M)***

Carbon cannot also form C^{4-} anion because it would be difficult for the nucleus with six protons to hold on to ten electrons, that is, four extra electrons. ***(1 M)***

(*ii*) A homologous series is a series of compounds in which the same functional group substitutes for hydrogen in a carbon chain and successive members differs by the $–CH_2$ unit or by 14u molecular mass. ***(1 M)***

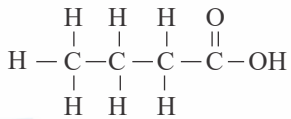
Example: The molecular formula for the two consecutive members of a homologous series of aldehydes are HCHO, CH_3CHO. ***(½ × 2 = 1 M)***

(*iii*) The structure of the molecule of cyclohexane is

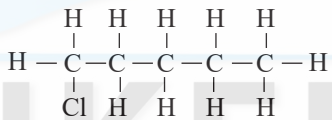


(1 M)

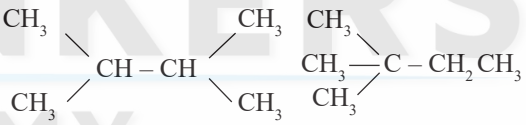
32. (*i*) Structure of butanoic acid is shown as: ***(½ M)***



Structure of Chloropentane is shown as: ***(½ M)***



(*ii*)



Structure (*i*) Structure (*ii*)

(1 M)

Structure (*i*) is 2,3-dimethylbutane and structure (*ii*) is 2,2-dimethylbutane

Both structures are isomers to each other due to same molecular formula (C_6H_{14}) but different in arrangement of atoms.

One more possible isomer of the compound is:
$H_3C — CH_2 — CH_2 — CH_2 — CH_2 — CH_3$
n-hexane ***(1 M)***

(*iii*) When all of the carbon atoms are connected by a single covalent bond and each carbon atom is directly connected to four other atoms, the hydrocarbon is said to be saturated. For example: alkanes. ***(½ M)***

General formula of the saturated hydrocarbon is: C_nH_{2n+2}.

Unsaturated hydrocarbons are those that have at least one double or triple carbon-carbon bond in their carbon chain or ring. ***(½ M)***

If carbon atoms are connected by double bonds, then it is referred to as alkene. ***(½ M)***

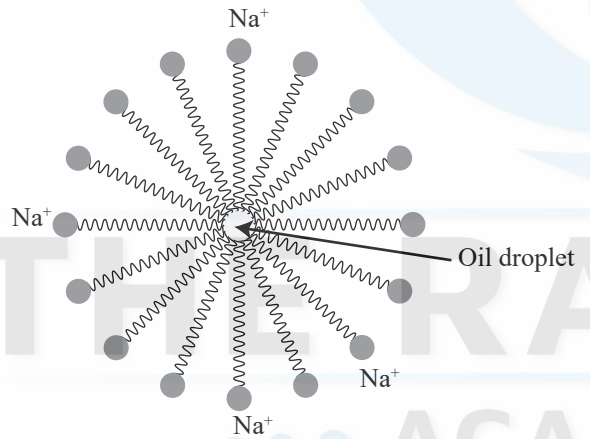
General formula of the alkene is: C_nH_{2n}.

If carbon atoms are connected by triple bonds, then it is referred to as alkyne. ***(½ M)***

General formula of the alkyne is: C_nH_{2n-2}.

33. Detergents are sodium salts of sulphonic acids or ammonium salts with chlorides or bromides ions whereas soaps are sodium and potassium salts of long chain carboxylic acids. ***(1 M)***

Most dirt is oily in nature and oil does not dissolve in water. The ionic-end of soap interacts with water while the carbon chain interacts with oil. The soap molecules, thus form structures called micelles where one end of the molecules is towards the oil droplet while the ionic-end faces outside. This forms an emulsion in water. The soap micelle thus helps in pulling out the dirt in water and we can wash our clothes clean. ***(2 M)***



Formation of micelles

Soap does not form lather with hard water because hard water contains calcium and magnesium salts and soap reacts with them to form the precipitate of calcium and magnesium salts of soap. As a result, no lather is formed. ***(1 M)***

Two problems that arise due to the use of detergents are:

1. Due to long unbranched chains, detergents are non biodegradable. ***(½ M)***
2. Detergents also causes water or soil pollution. ***(½ M)***

5. Life Processes

34. (*b*) Stomatal opening and closing are regulated by the osmotic flow of water into and out of the guard cells.

- Water entry swells guard cells, opens stomatal pore for gas exchange. ***(½ M)***
- Water exit shrinks guard cells, closes stomatal pore, reducing transpiration. ***(½ M)***

35. (*a*) (*i*) Enzyme trypsin: Breaks down proteins into smaller peptides. ***(1 M)***

(*ii*) Enzyme lipase: Breaks down fats into fatty acids and glycerol. ***(1 M)***

(*b*) The two functions of finger-like projections present in the small intestine:

(*i*) Increase the surface area of the small intestine for better absorption of nutrients. ***(½ M)***

(*ii*) Contain blood and lymph vessels, which absorb nutrients from the digested food and transport them to the bloodstream. ***(½ M)***

36. (*i*) Respiratory pigment is needed in multicellular organisms with large body size to facilitate the transport of oxygen to all parts of the body, as diffusion alone is inadequate for this purpose. ***(1 M)***

(*ii*) Reasons:

(*a*) Rings of Cartilage prevent the collapse of the air-passage (i.e., trachea) in the throat. ***(½ M)***

(*b*) During breathing, the lungs retain residual air, ensuring efficient oxygen absorption and carbon dioxide release. ***(½ M)***

(*c*) When we inhale, our ribs rise and our diaphragm flattens, causing the chest cavity to expand. This expansion draws air into the lungs, filling the expanded alveoli. ***(½ M)***

(*d*) Walls of alveoli contain an extensive network of blood vessels to facilitate efficient oxygen uptake and carbon dioxide removal. ***(½ M)***

37. Kidneys → Ureters → Urinary bladder → Urethra. ***(1 M)***

Glucose, amino acids, salts and major amount of water are re-absorbed from the initial filtrate as it flows in the tubular part of the nephron. ***(2 M)***

38. (*i*) Double circulation refers to the process where blood passes through the heart twice in one complete cycle of the body. ***(½ M)***

It consists of two pathways:

Systemic circulation: Between the heart and the body tissues. ***(½ M)***

Pulmonary circulation: Between the heart and the lungs. ***(½ M)***

(*ii*) The separation of the right side and the left side of the heart useful as

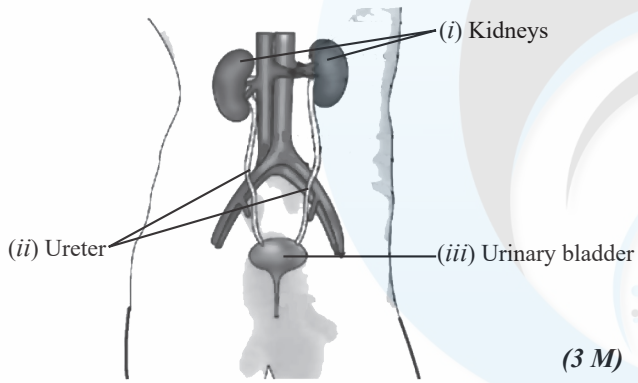
- It prevents mixing of oxygenated and deoxygenated blood. ***(½ M)***
- Ensures efficient oxygen supply to meet high energy demands. ***(½ M)***

It is useful in animals that have high energy needs, such as birds and mammals, which constantly use energy to maintain their body temperature. ***(½ M)***

39. (*a*) Excretion is the process of eliminating metabolic wastes from the body. It helps maintain the body's homeostasis by removing harmful substances like nitrogenous wastes, excess water, and ions that are produced during cellular metabolism. ***(1 M)***

(*b*) The basic filtration unit present in the kidney is called a nephron. It is a microscopic structure that plays a crucial role in removing waste products from the blood. ***(1 M)***

(*c*)



(3 M)

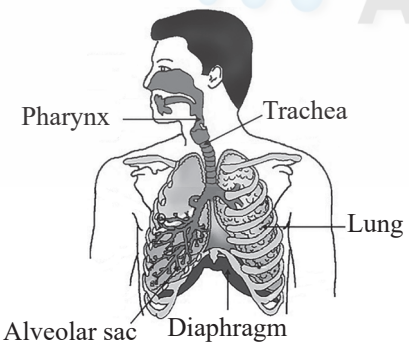
40. (*a*) The rate of breathing varies between aquatic and terrestrial organisms due to the following reasons:

Aquatic organisms, such as fishes, extract oxygen from water through their gills since it is present in a dissolved state. ***(1 M)***

Since the amount of dissolved oxygen in water is lower compared to the oxygen in the gaseous form in air, aquatic organisms need higher breathing rates to fulfill their oxygen requirements. ***(1 M)***

They breathe at a faster rate than humans to meet their body's demand for oxygen. ***(½ M)***

(*b*)



(2½ M)

41. (*a*) The correct sequence of steps followed during the journey of oxygen-rich blood from the lungs to various organs of the human body:

1. Oxygen-rich blood leaves the lungs and enters the left atrium of the heart. ***(½ M)***
2. The left atrium contracts, pushing the blood into the left ventricle. ***(½ M)***
3. The left ventricle contracts, pumping the blood into the aorta. ***(½ M)***
4. The aorta carries the oxygen-rich blood to various body organs through its branches and capillaries. ***(½ M)***
5. The organs utilize the oxygen and the carbon dioxide rich blood returns through veins to the right atrium of the heart. ***(½ M)***

(*b*) When the system of blood vessels develops a leak, blood loss occurs, reducing blood pressure and efficiency of the circulatory system. Platelets help clot the blood, plugging leaks to minimize blood loss and maintain pressure. ***(2½ M)***

42. (*a*) Two components of blood are:

Plasma: It is the liquid part of blood that contains water, proteins, and other molecules. Plasma helps in the transportation of nutrients, hormones, and other important substances throughout the body and to remove waste products by transporting them to the liver, lungs, kidneys, or skin. ***(1 M)***

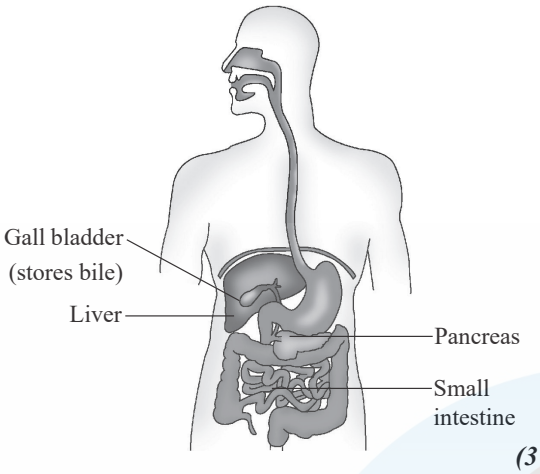
Blood cells: They are the solid components of blood that include red blood cells, white blood cells, and platelets. Red blood cells carry oxygen, white blood cells help fight infections, and platelets play a role in blood clotting. ***(1 M)***

(*b*) The oxygenated blood from the lungs enters the left atrium of the heart through the pulmonary veins and then to left ventricle. From left ventricle, it is pumped out through the aorta to all parts of the body. After giving up its oxygen, the deoxygenated blood returns to the heart's right atrium through vena cava, and then move to the right ventricle. From right ventricle, deoxygenated blood move to the lungs through the pulmonary artery for oxygenation. ***(1 M)***

(*c*) The valves present between the atria and ventricles prevent the backflow of blood from the ventricles to the atria. They ensure the one-way flow of blood from the atria to the ventricles and help regulate blood flow in the heart. ***(1 M)***

(*d*) Arteries have thicker walls and narrower lumens than veins. Veins, on the other hand, have thinner walls, a wider lumen and have valves that ensure one-way flow of blood. ***(1 M)***

43. (*a*)



(3 M)

(*b*) Two reasons for absorption of digested food in the small Intestine:

- Increased Surface Area: The small intestine has numerous villi and microvilli, increasing the surface area for efficient absorption of nutrients. ***(1 M)***
- Rich Blood Supply: The villi are richly supplied with blood vessels, which transport absorbed nutrients to the cells, aiding in their utilization. ***(1 M)***

44. (*i*) Process: Photosynthesis ***(½ M)***

Type of nutrition: Autotrophic ***(½ M)***

Autotrophic nutrition is the process where plants prepare their own food, using inorganic materials such as CO_2 and H_2O in presence of sunlight and chlorophyll. ***(½ M)***

$$6CO_2 + 12H_2O \xrightarrow{\text{Chlorophyll, Sunlight}} \underset{\text{(Glucose)}}{C_6H_{12}O_6} + 6O_2 + 6H_2O$$

(½ M)

(*ii*) The following events occurs during photosynthesis:

(*a*) Absorption of light energy by chlorophyll. ***(1 M)***

(*b*) Conversion of light energy to chemical energy and splitting of water molecules into hydrogen and oxygen. ***(1 M)***

(*c*) Reduction of carbon dioxide to carbohydrates. ***(1 M)***

6. Control and Coordination

45.

	Action	Part of the Brain
(*i*)	Maintaining posture and balance	Cerebellum
(*ii*)	Beating of heart	Medulla oblongata
(*iii*)	Thinking	Cerebral cortex
(*iv*)	Blood pressure	Medulla oblongata

(½ × 4 = 2 M)

46. Reflex action is a sudden response to environmental stimuli without conscious thought or control. ***(1 M)***

Reflex action path of sneezing:

Detection of Irritants in the Nose → Signal Sent Through Sensory Nerves → Signal Reaches Spinal Cord → Reflex Arc Triggers Motor Response → Expel Irritant Through Sneezing ***(2 M)***

47. When faced with a need to fight or escape, squirrels undergo immediate physiological changes in their bodies. These changes can be summarized as follows:

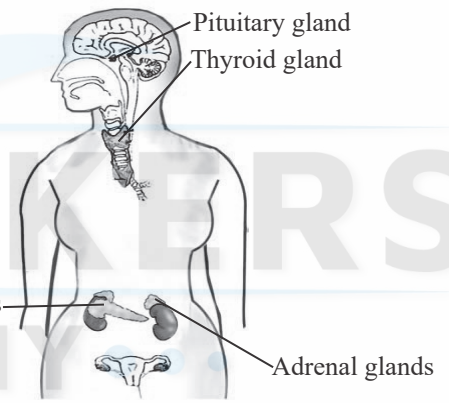
- Adrenaline Secretion: The adrenal glands secrete adrenaline directly into the blood, spreading the signal throughout the body. ***(1 M)***
- Increased Heart Rate: Adrenaline causes the heart to beat faster, increasing oxygen supply to muscles. ***(1 M)***
- Redirected Blood Flow and Breathing Rate: Blood flow to the digestive system and skin is reduced, diverting it to skeletal muscles. Breathing rate also increases due to diaphragm and rib muscle contractions. ***(1 M)***

48. Chemical communication is a more effective means of cell-to-cell communication in multicellular organisms compared to electrical impulses due to the following reasons:

Chemical communication occurs through hormones, eliminating the need for specialized tissue like nervous tissue used in electrical impulses. ***(1½ M)***

While electric communication is limited to specific regions connected by nerves, chemical communication is not region-specific and occurs throughout the body. ***(1½ M)***

49.



(3 M)

50. Plant hormones, also known as phytohormones, are chemical messengers that regulate various physiological processes in plants, such as growth, development, and response to environmental stimuli. ***(1 M)***

The plant hormones responsible for the following are:

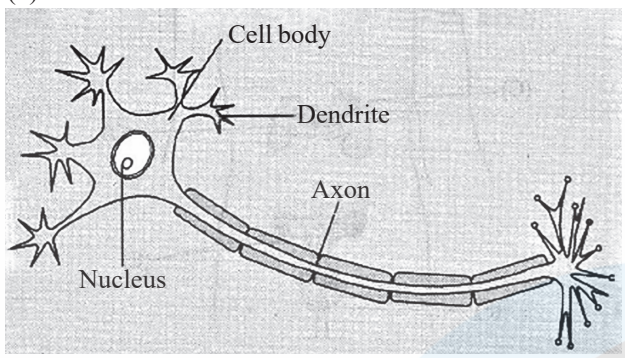
(*i*) Growth of stem: Gibberellins. ***(½ M)***

(*ii*) Promotion of cell division: Cytokinin. ***(½ M)***

(*iii*) Inhibition of growth: Abscisic acid (ABA). ***(½ M)***

(*iv*) Elongation of cells: Auxin. ***(½ M)***

51. (*a*)



(3 M)

(*b*) (*i*) Dendrite (*ii*) Axon (*iii*) Nerve ending. ***(1 M)***

(*c*) Neuromuscular junction is a chemical synapse formed by the contact between a motor neuron and a muscle fibre. ***(1 M)***

52. (*a*) Iodine is an essential nutrient that is required for the synthesis of thyroid hormones. That is why it is advisable to use the iodised salt in our diet in order to prevent its deficiency. ***(1 M)***

The deficiency of iodine in our diet can lead to a disease called goiter, which is characterized by the enlargement of the thyroid gland. ***(1 M)***

One of the symptoms of goiter is the swelling of the neck. ***(1 M)***

(*b*) • Sensory information is acquired at the dendritic tip, creating a nerve or electrical impulse. ***(½ M)***

• This impulse moves from dendrite to the cell body and then along the axon to its end. ***(½ M)***

• At the axon terminal, it triggers the release of chemicals across the synapse, initiating an impulse in the next neuron. ***(½ M)***

• This process continues, allowing impulses to reach muscles or glands. ***(½ M)***

7. How do Organisms Reproduce?

53. The functions of the different parts of the female reproductive system are:

	Part	Function
A.	Placenta	Provides oxygen and nutrients to the fetus, and removes waste products.
B.	Fallopian tube	Transports the egg from the ovary to the uterus.
C.	Uterus	Provides a site for the fertilised egg to implant and develop into a foetus.
D.	Ovary	Produces and releases eggs (ovulation).

(½ × 4 = 2 M)

54. (*a*) The difference between binary fission in *Amoeba* and *Leishmania*:

Binary Fission in *Amoeba*	Binary Fission in *Leishmania*
In *Amoeba*, the cell can split into two during division in any plane.	*Leishmania* have a whip-like structure at one end of the cell; binary fission occurs in a definite orientation in relation to this structure

(1 M)

(*b*) The malarial parasite, *Plasmodium*, reproduces through a process called multiple fission. During this process, the parasite undergoes a series of nuclear divisions followed by a division of cytoplasm, resulting in the formation of many daughter cells. ***(1 M)***

55. • Functions of testis:

(*i*) Produce sperms. ***(½ M)***

(*ii*) Produces male hormone/testosterone. ***(½ M)***

• Testes are located outside the abdominal cavity in scrotum, as formation of sperms need a lower temperature than the normal body temperature. ***(1 M)***

• Testosterone brings about changes in appearance seen in boys at the time of puberty, such as facial and body hair growth and voice deepening. ***(1 M)***

56. The process by which transfer of pollen grains occurs from anther to stigma of the flower of the same species is known as pollination. ***(1 M)***

Self-Pollination	Cross-Pollination
When the pollen grains transfer from anther to the stigma of the same flower, then this type of pollination is known as self pollination.	When the pollen grains transfer from anther of a flower to the stigma of the different flower then this type of pollination is called cross-pollination.

(1 M)

Significance of pollination:

Pollen grains play a crucial role in fertilization by facilitating the transfer of male gametes to female eggs, leading to seed production and the subsequent generation of new offspring. Hence, pollination is important to develop new offsprings. ***(1 M)***

57. (*i*) *Hydra* can reproduce asexually through two modes:

Budding: In this mode, a small bud grows out of the body of the parent organism, which eventually develops into a new individual. ***(1 M)***

Regeneration: In this mode, the organism can regenerate a new individual from a small piece of its body. ***(1 M)***

(*ii*) Vegetative propagation is a method of plant propagation in which new individuals are produced from vegetative parts of a parent plant, such as stems, roots, leaves or buds. ***(1 M)***

Two advantages of using vegetative propagation are:

Maintaining desirable traits: Vegetative propagation can be used to maintain the desirable traits of a plant variety since the new plant is genetically identical to the parent plant. ***(1 M)***

Faster growth: Plants raised by vegetative propagation can bear flowers and fruits earlier than those produced from seeds. ***(1 M)***

58. (A) (*i*) Three contraceptive techniques/devices are:

Surgical methods: Fallopian tubes in females are blocked *via* surgery. Side effects include infections if not performed properly. ***(1 M)***

Hormonal contraceptives: Oral contraceptive pills alter hormonal balance to prevent egg release. Side effects can include nausea, mood changes, hormonal imbalances. ***(1 M)***

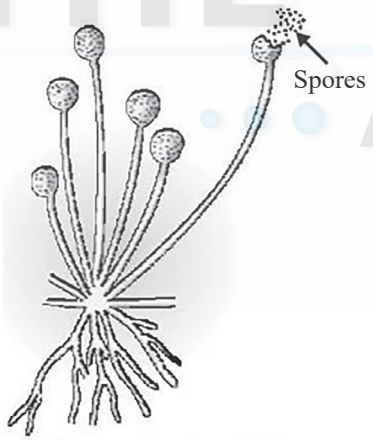
Intrauterine devices (IUDs): Devices like the copper-T are inserted into the uterus. They can cause side effects such as irritation of uterus. ***(1 M)***

(*ii*) What will happen if:

(*a*) Fertilisation takes place: The fertilised egg (zygote) begins to divide, forming an embryo that implants in the uterus lining, which has thickened to nourish the growing embryo. ***(1 M)***

(*b*) An egg is not fertilised: The unfertilised egg will live for about a day. If it's not fertilised, the thickened uterine lining is shed through menstruation, a process lasting roughly two to eight days. ***(1 M)***

59. (*a*) ***(2 M)***



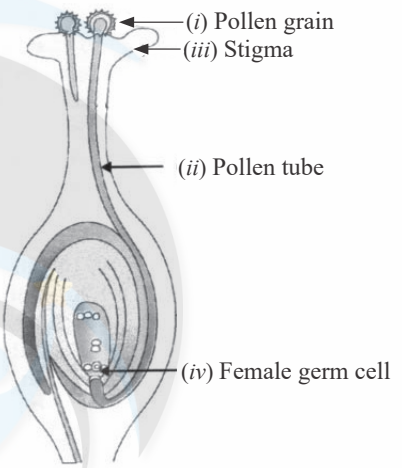
(*b*)

Budding	Fragmentation
(*i*) An outgrowth/ bud at a specific site develops into a tiny individual and detaches itself from the parent. e.g., *Hydra*/Yeast	(*i*) Organism simply breaks upon maturation into two or more pieces/ fragments that grow into new individuals. e.g., *Spirogyra*

(2 M)

(*c*) Vegetative propagation allows for earlier flowering and fruiting, propagates seedless plants, and ensures genetic similarity to the parent plant. ***(1 M)***

60. (*a*) ***(2 M)***



(*b*) The significance of the pollen tube is that it plays a crucial role in the process of sexual reproduction in plants. Pollen tube carries the male germ cell to reach the ovary and fuse with the female germ cell. ***(1 M)***

(*c*) (*i*) Seed: The ovules of the flower develop into seeds after fertilization. ***(1 M)***

(*ii*) Fruit: The ovary of the flower develops into the fruit after fertilization. ***(1 M)***

8. Heredity

61. (*a*) The sex chromosomes, X and Y, are different in size as the X chromosome is larger than the Y chromosome. ***(½ M)***

In humans, the mismatched pair of sex chromosomes is XY in males. ***(½ M)***

(*b*) Human beings have a total of 23 pairs of chromosomes, out of which one pair is the sex chromosomes. ***(½ M)***

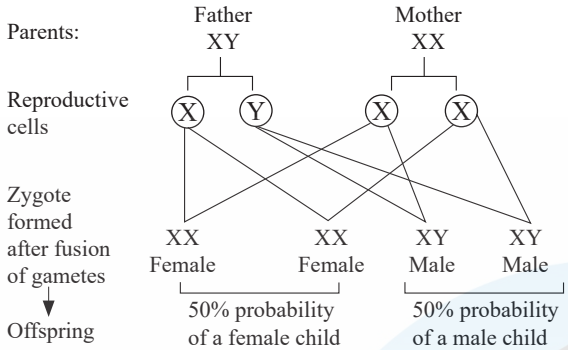
In males, the pair consists of one X chromosome and one Y chromosome (XY). In females, the perfect pair consists of two X chromosomes (XX). ***(½ M)***

(*c*) In some species of reptiles like turtles, the temperature at which the eggs are incubated determines the sex of the offspring.

Snails change their sex during their lifetime, which means that their sex is not genetically determined and depends on environmental factors. ***(2 M)***

Or

A flowchart to show that sex is determined genetically in human beings:



(2 M)

62. (*i*) An offspring of human being is not a true copy of his parents as

- it receives 50% of genetic material from each parent. ***(½ M)***
- Combination of genetic material from both parents leads to variations in traits and characteristics. ***(½ M)***

(*ii*) The following table summarizes the difference between F_1 and F_2 generations:

F_1 Generation	F_2 Generation
Obtained by crossing two distinct parents	Obtained by self-crossing the F_1 generation
The phenotypic ratio is typically uniform, exhibiting the dominant trait.	In a monohybrid cross, exhibits a phenotypic ratio of 3:1 (dominant to recessive) according to Mendel's laws.

(½ × 2 = 1 M)

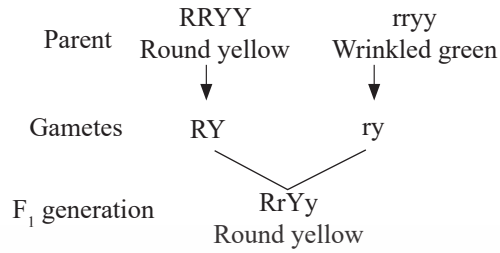
(*iii*) (A) Variations, or differences in traits among individuals of a species, are useful for survival because they increase the chances that some individuals can adapt to changing environments, resist diseases, and face new challenges, helping the species to survive and evolve over time. ***(2 M)***

Or

(*iii*) (B) Mendel's cross between two plants with a pair of contrasting characters, Round Yellow (RRYY) and Wrinkled Green (rryy), resulted in 4 types of combinations in the F_2 generation:

1. Round Yellow
2. Round Green
3. Wrinkled Yellow
4. Wrinkled Green

Here's the cross between the two homozygous parents, Round Yellow (RRYY) and Wrinkled Green (rryy):



	RY	rY	Ry	ry
RY	RRYY Round yellow	RrYY Round yellow	RRYy Round yellow	RrYy Round yellow
rY	RrYY Round yellow	rrYY Wrinkled yellow	RrYy Round yellow	rrYy Wrinkled yellow
Ry	RRYy Round yellow	RrYy Round yellow	RRyy Round green	Rryy Round green
ry	RrYy Round yellow	rrYy Wrinkled yellow	Rryy Round green	rryy Wrinkled green

The new combinations out of these are:
Round Green and Wrinkled Yellow. ***(1 M)***

New features emerge in the F_2 generation of a dihybrid cross as two characters are involved and their genes are independently inherited irrespective of the combination present in parents. ***(1 M)***

63. (*a*) Contrasting traits studied by Mendel:

(*i*) Tall and Dwarf stem height, ***(½ M)***

(*ii*) Inflated and Constricted pod shape. ***(½ M)***

(*b*)

Dominant	Recessive
Expressed in the phenotype even if only one allele of the pair is dominant.	Expressed in the phenotype only when both alleles of the pair are recessive.
Visible in both homozygous and heterozygous genotypes.	Visible only in homozygous recessive genotypes.

(½ × 2 = 1 M)

(*c*) Plants produced in the F_2 generation yellow-round seeded plants, yellow-wrinkled seeded plants, green-round seeded plants and green-wrinkled seeded plants are produced with the ratio of 9 : 3 : 3 : 1. This result/ratio suggests the independent assortment of the genes of seed colour and seed shape. ***(2 M)***

Or

(*c*)

Pure violet coloured flower (VV) × Pure white coloured flower (vv)

↓

Gametes (V) — (v)

↓

F_1 generation — Vv Violet coloured flower

↓ Selfing

Vv × Vv

↓

F_2 generation

	V	v
V	VV Purple	Vv Purple
v	Vv Purple	vv White

Genotypic ratio — VV : Vv : vv

1 : 2 : 1

Phenotypic ratio — 3 : 1

(2 M)

9. Light Reflection and Refraction

64. (*b*) Angle 2 is angle of incidence
Angle 4 is the angle of refraction
Angle 1 is the angle of emergence
Angle 3 is the lateral displacement ***(1 M)***

65. (*d*) Based on the diagram, it can be concluded that device *X* corresponds to a convex lens with a focal length of 8 cm. ***(1 M)***

66. (*c*) From diagram we can see that while passing from A to B, light bends towards normal. Hence $\angle 1 > \angle 2$. Through B , it travels in a straight path. As interface B-C and A-B are parallel, so $\angle 2$ and $\angle 3$ are equal and alternate interior angles. When light passes from B to C, light moves away from normal, so $\angle 4$ is greater than angle $\angle 3$. If we extend ray in medium A, it will intersect actual ray in C which shows that $\angle 1$ is less than $\angle 4$. ***(1 M)***

67. (*a*) The rainbow is indeed a natural spectrum of sunlight in the sky. When sunlight enters raindrops in the atmosphere, it undergoes dispersion and internal reflection, resulting in the separation of the white light into its component colors. This phenomenon occurs when the sun is low in the sky and raindrops are present, allowing for the formation of rainbows. Therefore, the presence of sunlight and water droplets in the air are necessary conditions for the formation of rainbows. ***(1 M)***

68. Absolute refractive index of glass

$$= \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium (glass)}} = \frac{4}{3} = \frac{c}{2\times10^8}$$

$$c = \frac{4\times2\times10^8}{3} = \frac{8}{3}\times10^8\,(m/s)$$ ***(1 M)***

Now,
Absolute refractive index of water

$$= \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium (water)}} = \frac{3}{2} = \frac{\frac{8}{3}\times10^8}{v}$$

$$\Rightarrow v = \frac{16}{9}\times10^8\,(m/s)$$ ***(1 M)***

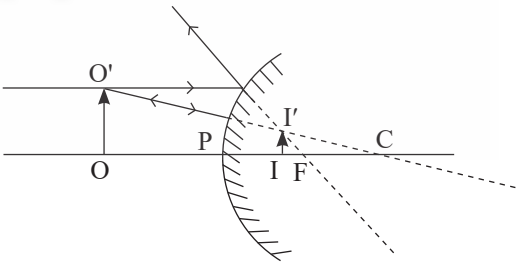
69. (*a*) It is a convex mirror. So focal length should be positive
Radius of curvature, R = +5 m
∴ focal length f = 5/2 = +2.5 m
The customer is standing in front of a mirror, so object distance is negative.
Object distance = –20m
According to the mirror formula,

As we know, $\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{2.5} = \frac{1}{v} + \frac{1}{-20}$

$$\frac{1}{v} = \frac{1}{2.5} + \frac{1}{20} = \frac{10}{25} + \frac{1}{20} = \frac{2}{5} + \frac{1}{20}$$

$$\frac{1}{v} = \frac{8+1}{20} = \frac{9}{20} \Rightarrow v = \frac{20}{9} = 2.22$$

Image formation on a convex mirror by ray diagram



(2 M)

Linear magnification for a mirror = image distance/ object distance = 2.22/20 = 0.11

Hence, linear magnification less than 1

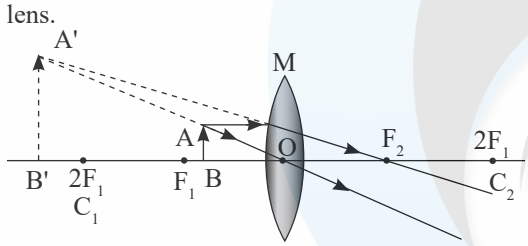
As we know that for convex mirror, all images are virtual.

Therefore, the image will be smaller than the actual size of the customer. The nature of the image is virtual, upright, and diminished. ***(1 M)***

(*b*) The mirror fitted in the instrument held by the dentist is a "concave mirror" which is a type of curved mirror. It is used to get a magnified and clear view of the teeth in the patient's mouth. ***(1 M)***

The image formed by the concave mirror appears larger and more detailed than the actual size of the teeth. The concave mirror is specifically used for examining the teeth in the back of the mouth which are difficult to see with direct vision. ***(1 M)***

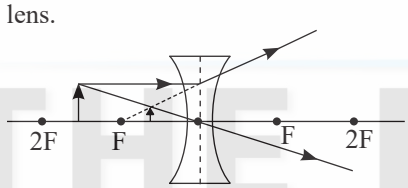
70. (*i*) Between optical centre and principal focus of a convex lens.



(1 M)

Here, the image formed is virtual, magnified and erect. So, magnification is positive and greater than one. ***(1 M)***

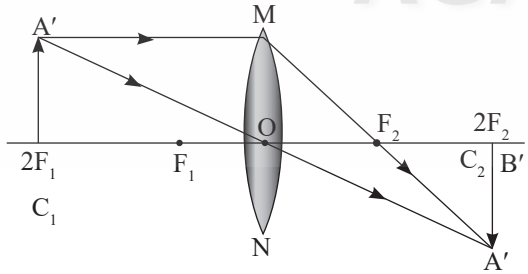
(*ii*) When an object is place anywhere in front of a concave lens.



(1 M)

Here, the image formed is diminished, virtual and erect. So, magnification is positive and less than one. ***(1 M)***

(*iii*) at 2F of a convex lens

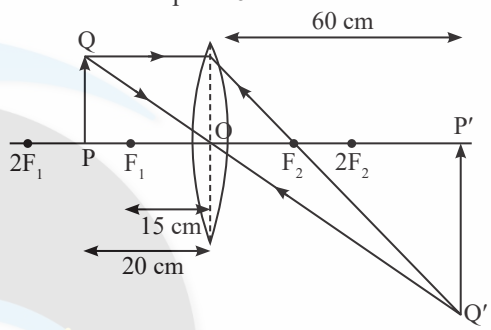


(1 M)

71. (*a*) Observation 3 indicates that the radius of curvature of the lens is 30 cm since the distance of the object and image is the same. Using the formula $f = R/2$, we can determine that the focal length of the lens is 15 cm. ***(1 M)***

(*b*) Option 6 is incorrect because the object distance for this observation is between the focus and pole of the lens. In such cases, the image formed is always virtual. However, in this case, a real image is formed since the image distance is positive. Therefore, we can conclude that option 6 is not correct. ***(1 M)***

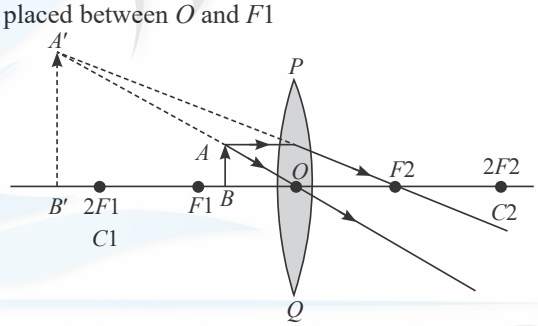
(*c*)



From the figure, object distance $u = -20$ cm and image distance $v = 60$ cm. We know, magnification $= v/u$

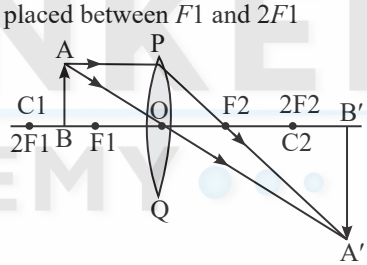
$= +\frac{60}{-20} = -3.$ ***(3 M)***

72. Magnified erect image of the object, here the object is placed between *O* and *F*1



(1½ M)

Magnified inverted image of the object, here the object is placed between *F*1 and 2*F*1



(1½ M)

Apply the lens formula:

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

Substitute the given value with sign conventions in the above equation:

$$\frac{1}{v} = -\frac{1}{10} - \frac{1}{20} = -\frac{3}{20} \Rightarrow v = -\frac{20}{3} = -6.6\,\text{cm}$$ ***(2 M)***

73. (*i*) The speed of light in diamond can be calculated using the formula:
Speed of light in diamond = Speed of light in vacuum/ refractive index of diamond
Substituting the given values, we get:
Speed of light in diamond = $3\times10^8/2.42 = 1.24\times10^8$ m/s
Therefore, the speed of light in diamond is 1.24×10^8 m/s.
(1 M)

(*ii*) The increasing order of the angle of refraction in glass, water, and carbon disulphide can be determined by using
Snell's law: $n_1\sin\theta_1 = n_2\sin\theta_2$
where n_1 and θ_1 are the refractive index and angle of incidence of the first medium, and n_2 and θ_2 are the refractive index and angle of refraction of the second medium.
For the same angle of incidence (θ), the angle of refraction (θ_2) will be minimum in the medium with the highest refractive index.
Therefore, the increasing order of the angle of refraction is: Carbon disulphide < Glass< Water
(1 M)

(*iii*) (A)

(*a*) The optical density of a medium is directly proportional to its refractive index. Therefore, the medium with the higher refractive index (glass with $n = 1.5$) is optically denser than the medium with the lower refractive index (water with $n = 1.33$). ***(1 M)***

(*b*) When a ray of light enters a thick glass container filled with water, it will undergo refraction at the water-glass interface. Since the light is incident normally (perpendicular to the interface), it will not change direction. After entering the glass, the light will continue to travel in a straight line but at a slower speed due to the higher optical density of glass compared to water. ***(1 M)***

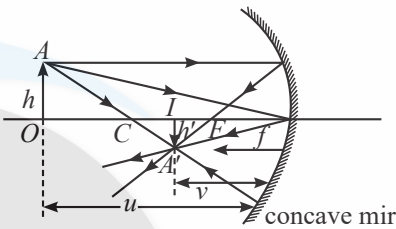
Or

(B)

(*i*) To find the speed of light in vacuum, we can use the given refractive index of glass:
Speed of light in glass = Speed of light in vacuum / Refractive index of glass
Substituting the given values, we get:
2×10^8 m/s = Speed of light in vacuum/3/2
Speed of light in vacuum = $(2 \times 10^8 \text{ m/s}) \times (3/2)$
$= 3 \times 10^8$ m/s
Therefore, the speed of light in vacuum is 3×10^8 m/s.
(1 M)

(*ii*) To find the speed of light in water, we can use the given refractive index of water:
Speed of light in water = Speed of light in vacuum/Refractive index of water
Substituting the given values, we get:
Speed of light in water = $(3 \times 10^8 \text{ m/s})/(4/3)$
$= 2.25 \times 10^8$ m/s
Therefore, the speed of light in water is 2.25×10^8 m/s. ***(1 M)***

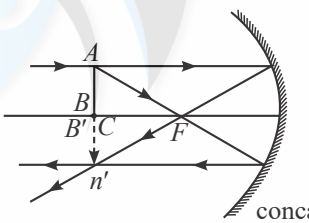
74. (*i*)



concave mirror

In Case (1), the object is positioned beyond the center of curvature (C). For concave mirrors, when the object is situated beyond C, the resulting image will form between C and the focal point (F), appearing inverted and diminished (smaller than the object). ***(1 M)***

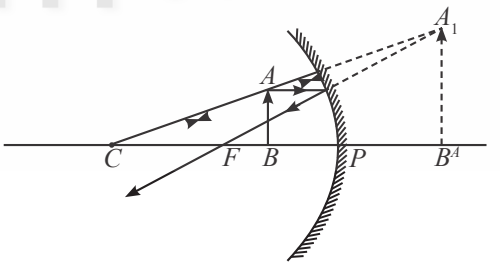
(*ii*)



concave mirror

In Case (2), the object is located at the center of curvature (C), indicating that the image formed will be real and of equal size to the object. ***(1 M)***

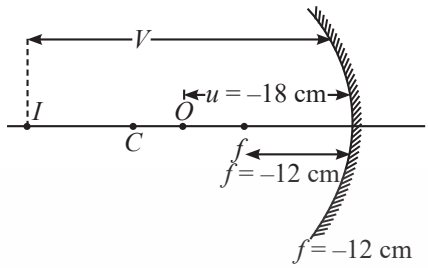
(*iii*) (A) We are aware that a virtual and expanded picture is created when an object is positioned between P and F of a concave mirror. ***(½ M)***
In case (3), the object distance (20 cm) is less than the focal length (30 cm). Therefore, the object is located between the mirror and the focal point. In such a case, the image formed will be virtual, erect, and larger than the object. ***(1 M)***



(½ M)

Or

(*iii*) (B)



Given:

Focal length of concave mirror, $f = -12$ cm

Distance of object from the mirror, $u = -18$ cm

Now, put this value in mirror formula,

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \qquad \textit{(½ M)}$$

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

$$\frac{1}{v} = \frac{1}{-12} - \frac{1}{-18} \qquad \textit{(½ M)}$$

$$\frac{1}{v} = -\frac{1}{12} + \frac{1}{18}$$

$$\frac{1}{v} = \frac{1}{-36}$$

$v = -36$ cm

Hence, image position is the 36 cm left side from the pole of the concave mirror *(1 M)*

10. Human Eye and Colorful World

75. (*a*) ∠i is the angle of incidence and ∠A is the angle of prism. *(1 M)*

76. (*i*) The defect of vision is myopia. *(½ M)*

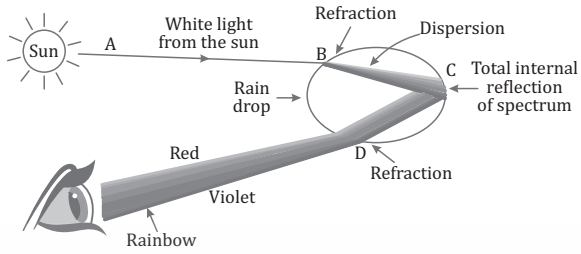
(*ii*) (*a*) The eye lens becomes too convex or curved.

(*b*) Depth of the eyeball is too much i.e. eyeball lengthened from front to back. When the length of the eyeball is too long as compared to the focusing power of the lens of the eye and cornea. *(1 M)*

(*iii*) Concave lens is used for the correction of this defect. *(½ M)*

77. When sunlight enters a water droplet, it is refracted and dispersed into its component colours due to the difference in the speed of light in air and water. The colours of the rainbow, in order from the outer edge to the inner edge, are red, orange, yellow, green, blue, indigo, and violet. *(1 M)*

A labeled diagram of the formation of a rainbow is shown below:



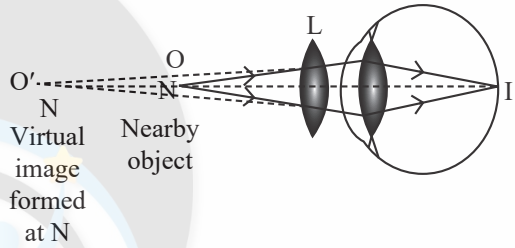
(2 M)

78. (*a*) Hypermetropia as the image is formed beyond the retina. *(1 M)*

(*b*) (*i*) Due to greater focal length of the, lens and

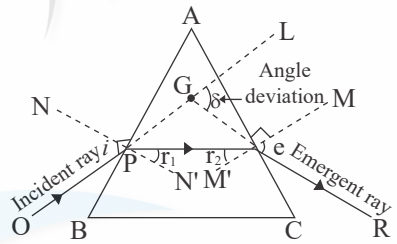
(*ii*) As eyeball becomes smaller. *(1 M)*

(*c*) It can be corrected by using a convex lens of suitable focal length as shown below.



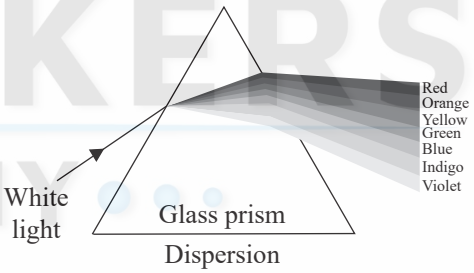
(1 M)

79. (*a*) Path of monochromatic light passing through a prism



(1½ M)

(*b*) when a narrow beam of white light passes through a prism,it scatters into seven colours.



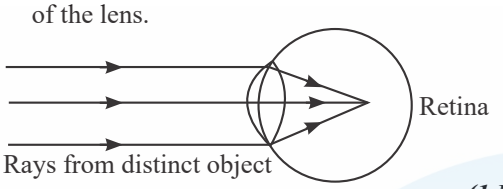
(1½ M)

80. (*a*) There can be two possible reasons for the student's myopia:

(1) The eyeball of the student may be too long, causing the image to form in front of the retina.

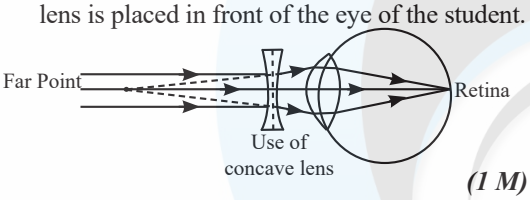
(2) The curvature of the lens of the student may be too much, causing the image to form in front of the retina. *(1 M)*

(*i*) The student is unable to see distinctly the objects placed beyond 5 m from his eyes because the image of the distant object forms in front of the retina and not on it. This happens because the light rays from the distant object are brought to a focus in front of the retina due to the elongated eyeball or excessive curvature of the lens.



(1 M)

(*ii*) The type of corrective lens used to restore proper vision is a concave lens, which is thinner at the center and thicker at the edges. The concave lens causes the light rays to diverge before they enter the eye, which helps to move the image back onto the retina. The corrective lens is placed in front of the eye of the student.



(1 M)

(*b*) The power of the lens can be calculated using the formula $P = 1/f$, where P is the power of the lens and f is the focal length of the lens. According to the new Cartesian sign convention, the focal length of the corrective lens is –5 m, as the image formed by the lens is virtual and on the same side as the object. Therefore, the power of the lens is –0.2 dioptres. ***(2 M)***

11. Electricity

81. Joule's law of heating states that the amount of heat produced when a current flows through a conductor is directly proportional to the square of the current (I), the resistance (R) of the conductor, and the time (t) for which the current flows. The mathematical expression for Joule's law of heating is:

$H = I^2 R t$ ***(1 M)***

82. The resistance of a uniform cylindrical conductor of a given material depends on the following factors:

1. Length of the conductor: The resistance of a conductor is directly proportional to its length. This means that if the length of the conductor is increased, its resistance also increases. ***(½ M)***
2. Cross-sectional area of the conductor: The resistance of a conductor is inversely proportional to its cross-sectional area. This means that if the cross-sectional area of the conductor is increased, its resistance decreases. ***(½ M)***
3. Temperature of the conductor: The resistance of a conductor increases with an increase in temperature. This is because the increase in temperature causes an increase in the vibrations of the atoms in the conductor, which in turn increases the collisions between the free electrons and the atoms. ***(½ M)***
4. Nature of the material: The resistance of a conductor depends on the nature of the material of which it is made. Some materials have a higher resistance than others. ***(½ M)***

83. (*i*) Effective resistance of the circuit

R_3 and R_4 are in series and both are parallel to R_2

$R_3 + R_4 = 10$ Ohm

Effective Resistance across $R_2(R')$

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

$R' = 5$ Ohm

Now, R_1', R' and R_5 are in series

Effective resistance of the circuit = $R_1 + R' + R_5$

$= 5 + 5 + 10$

$= 20$ Ohm ***(1 M)***

(*ii*) Current drawn from battery

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

$$I = \frac{20}{20} \Rightarrow I = 1\text{A}$$ ***(1 M)***

(*iii*) Potential difference across 5–ohm resistor

$V = IR \Rightarrow V = 1 \times 5$

$V = 5\text{V}$ ***(1 M)***

84. (*i*) The relation between resistance (R) and electrical resistivity (ρ) of the material of a conductor in the shape of a cylinder of length l and area of cross-section A is given by:

$$R = \frac{\rho l}{A}$$ ***(½ M)***

To derive the SI unit of electrical resistivity, rearrange the equation:

$$\rho = \frac{RA}{l}$$ ***(½ M)***

The SI unit of resistance (R) is ohms (Ω), the area (A) is in square meters (m^2), and the length (l) is in meters (m). ***(½ M)***

Therefore, the SI unit of electrical resistivity (ρ) is ohm-meters ($\Omega \cdot m$). ***(½ M)***

(*ii*) Given:

Length of the wire (l) = 3 m

Resistance (R) = 60Ω

Area of cross-section (A) = $4 \times 10^{-7}\ m^{-2}$

Using the formula $R = \frac{\rho l}{A}$, we can rearrange it to solve for ρ:

$\rho = \frac{RA}{l}$ ***(½ M)***

$\rho = \frac{(60\Omega) \times (4 \times 10^{-7}\ m^2)}{3m}$

$\rho = \frac{240 \times 10^{-7}}{3}\ \Omega \cdot m$ ***(½ M)***

$\rho = 80 \times 10^{-7}\ \Omega \cdot$

$\rho = 8 \times 10^{-6}\ \Omega \cdot m$ ***(1 M)***

(*iii*) If the wire (from part '*ii*') is stretched so that its length is doubled, the new length l' would be $2 \times 3\ m = 6\ m$.

But we know that, the resistivity of a substance is unaffected by changes in its length or area of cross-section. It is solely determined by the material's inherent properties and temperature, leading to no alteration in its resistivity with changes in length or cross-sectional area.

Hence there is no change in resistivity of the wire.

(1 M)

85. (*i*) Electric power is defined as the rate at which electrical energy is transferred or converted in an electric circuit. ***(½ M)***

It is expressed in terms of potential difference (V) and resistance (R) using the formula:

$P = \frac{V^2}{R}$ ***(½ M)***

Where:

P is the electric power,

V is the potential difference (voltage), and

R is the resistance.

(*ii*) (*a*) To calculate the power rating of the oven, we can use the formula:

$P = \frac{E}{t}$

Where:

P is the power,

E is the electrical energy consumed (given as 11 units),

t is the time taken (given as 5 hours).

Substituting the given values:

$P = \frac{11\,\text{units}}{5\,\text{hours}}$

P = 2.2 units / hour ***(1 M)***

(*b*) To find the current drawn by the oven, we can use the formula:

$P = VI$

Where:

P is the power (which we calculated in part (*a*)),

V is the voltage (given as 220 V),

I is the current.

Rearranging the formula to solve for I:

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

Substituting the given values:

$I = \frac{2.2\,\text{units / hour}}{220V}$

I = 0.01 A ***(1 M)***

(*c*) To find the resistance of the oven when it is red hot, we can rearrange the power formula:

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

to solve for R:

$R = \frac{V^2}{P}$ ***(½ M)***

Substituting the given values:

$R = \frac{(220V)^2}{2.2\,\text{units / hour}}$ $R = \frac{48400V^2}{2.2\,\text{units / hour}}$

R = 22000 ohms ***(½ M)***

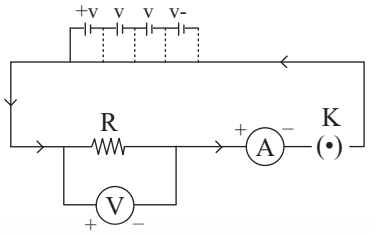
So, the resistance of the oven when it is red hot is approximately 22000 ohms. ***(1 M)***

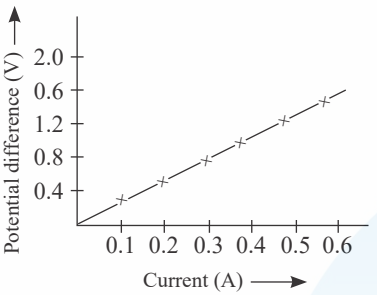
86. (*i*) Electric current is directly related to the potential difference across the terminals of a conductor. This relationship is described by Ohm's law, which states that the current flowing through a conductor is directly proportional to the potential difference across its ends, provided the physical conditions such as temperature remain constant. Mathematically, Ohm's law can be expressed as:

$I = V/R$

where I is the current flowing through the conductor, V is the potential difference across its ends, and R is the resistance of the conductor. ***(1 M)***

To verify this relationship, here is a labeled circuit diagram:



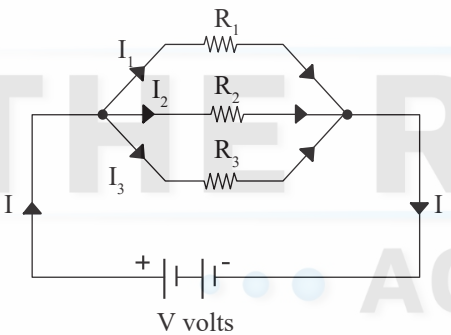


(2 M)

(*ii*) An ammeter is an instrument used to measure the flow of electric current in a circuit. It should have low resistance to prevent its own resistance from affecting the circuit being measured. If the ammeter has high resistance, it will draw a significant amount of current from the circuit, leading to inaccurate measurements. Therefore, to ensure accurate measurements, an ammeter should have low resistance. ***(1 M)***

(*iii*) The slope of V-I graph gives the resistance. Since the straight line A is less steep, its resistance is less. We know that, in a parallel combination, the equivalent resistance is less than in series combination. So, A represents the series combination and B represents the parallel combination. ***(1 M)***

87. (*a*) Using the given diagram,



(1 M)

Let the current passing through resistance R_1, R_2, and R_3 will be I_1, I_2 and I_3 and potential difference be V.

The total current in the circuit will be,

$$I = \frac{V}{R_{eq}}$$

As, $I_1 = \frac{V}{R_1}$, $I_2 = \frac{V}{R_2}$, $I_3 = \frac{V}{R_3}$

So, the net current will be,

$$\frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

Factoring out V, we get

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$ ***(2 M)***

(*b*) As two resistors of 12Ω connected in parallel.

V = 6V

$$\therefore \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_{eq}} = \frac{1}{12} + \frac{1}{12} = \frac{2}{12}$$ ***(1 M)***

According to Ohm's law,

$V = IR \Rightarrow 6 = I \times 6$

$$\frac{6}{6} = I \Rightarrow I = 1 \text{ ampere}$$ ***(1 M)***

88. (*a*) From the diagram we can see that the conductor and electric lamp are connected in series combination, so resistance of the coil will be

$R_T = R_L + R_C = 20 + 4$

or $R_T = 24\Omega$ ***(1 M)***

(*b*) According to Ohm' s law , V = IR

I = V/R

= 6 /24 = 0.25 A ***(1 M)***

(*c*) As, V = IR

(*i*) Potential difference across lamp will be

$V_L = 0.25 \times 20 = 5V$ ***(1 M)***

(*ii*) Potential difference across conductor will be

$V_C = 0.25 \times 4 = 1V$ ***(1 M)***

(*d*) As, power (P) = VI

So, power of the lamp will be = 0.25 × 5 = 1.25 watt ***(1 M)***

12. Magnetic Effects of Electric Current

89. (*c*) The correct pattern of magnetic field lines of the field produced by a current carrying circular loop is concentric circles around the loop. ***(1 M)***

90. (*d*) Out of the page. ***(1 M)***

91. (*b*) Assertion (A) is correct because when a current-carrying straight conductor is placed perpendicular to the direction of magnetic field, it experiences a force known as magnetic force.

Reason (R) is also correct because the net charge on a current-carrying conductor is zero. This is because the current is made up of equal and opposite charges moving in opposite directions, which cancel out each other's effect.

Hence, both assertion (A) and reason (R) are correct, and reason (R) is not the correct explanation of assertion (A). ***(1 M)***

92. (*a*) When a current is passed through the aluminum rod from end *B* to end *A*, the rod experiences a force perpendicular to both the direction of the current and the direction of the magnetic field. According to Fleming's left-hand rule, this force is directed towards end *A* of the rod. Therefore, the rod moves towards end *A*, away from the magnetic field. ***(1 M)***

(*b*) When the axis of the rod '*AB*' is moved and aligned parallel to the magnetic field and current is passed through the rod in the same direction, no force is experienced by the rod. This is because the angle between the direction of the current and the direction of the magnetic field is zero, and hence there is no force on the rod. ***(1 M)***

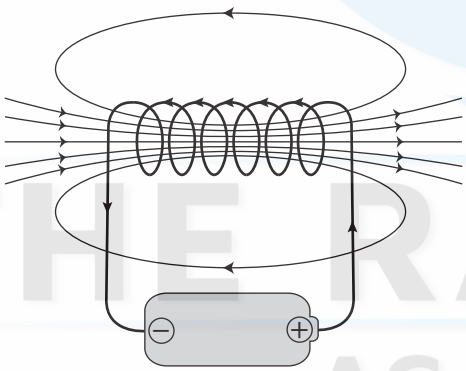
93. Magnetic field lines of a bar magnet are used to show the direction and strength of the magnetic field around it.

The direction of the magnetic field lines arise from the North Pole of the magnet and combine to its South Pole.

The closer the magnetic field lines are to each other, the stronger the magnetic field is in that region. ***(1 M)***

This proves that a magnetic field is a physical quantity that has both direction and magnitude and the direction of the magnetic field is shown by the direction of the magnetic field lines, and the strength of the magnetic field is shown by the density of the magnetic field lines. ***(1 M)***

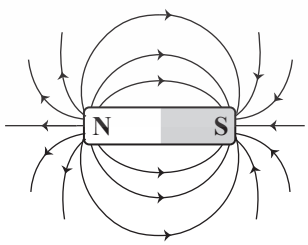
94. (*i*) (1)



Solenoid

(1 M)

(2)



(1 M)

(*ii*) Two distinguishing features between the fields.

S.No.	Bar Magnet	Solenoid
1.	Magnetism always exists in a bar magnet.	Magnetism exists until an electric current flows through it.
2.	Poles can't be interchanged.	Poles can be interchanged.

(1 M)

95. (*a*) 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 the first finger points in the direction of magnetic field and the second finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor. ***(1 M)***

The direction of force experienced by a straight current carrying conductor AB placed in a uniform magnetic field is into the page. ***(1 M)***

(*b*) The electron will experience a force in the out of the page. This is due to the fact that electrons have a negative charge and move opposite to the direction of conventional current flow. Therefore, the direction of the current will be downwards and the force will be in the direction to out of the page. ***(1 M)***

13. Our Environment

96.

Waste Type	Difference	Impacts on Environment if Not Disposed off Properly
Biodegradable Waste	Can be broken down naturally by living organisms like bacteria, fungi, etc.	1. Spread of diseases, 2. Attracts pests.
Non-Biodegradable Waste	Cannot be broken down naturally by living organisms.	1. Pollution, 2. Biological magnification.

(3 M)

97. The phenomenon involved is known as "biological magnification." ***(1 M)***

It happens because:

- Pesticides used on crops can wash into soil or water bodies and are absorbed by plants. These non-degradable chemicals accumulate progressively at each trophic level. ***(1 M)***
- Human beings, at the top of the food chain, accumulate the highest concentrations of these chemicals in their bodies. ***(1 M)***

98.
- Gas X: Ozone (O_3) ***(½ M)***
- Essential Function: Shields Earth from harmful ultraviolet (UV) radiation from the sun. ***(½ M)***
- Decrease in level of ozone is due to a chemical called chlorofluorocarbons (CFCs). ***(1 M)***
- Measures taken by the United Nations Environment Programme (UNEP) in 1987:

  CFC Production Freeze: An agreement to halt CFC production at 1986 levels. ***(½ M)***

  CFC-free Refrigerators: Now, it's compulsory for manufacturers worldwide to produce refrigerators without using CFCs, promoting eco-friendly practices. ***(½ M)***

99. (*i*) Food chain of four trophic levels comprising the following : Hawk, snake, plants, rat.

Plant → rat → snake → hawk. ***(1 M)***

(*ii*) Energy is transferred from one trophic level to next trophic level. Only 10% of available energy will transfer to next trophic level.

As per the question, energy available at second trophic level = 20,000 J

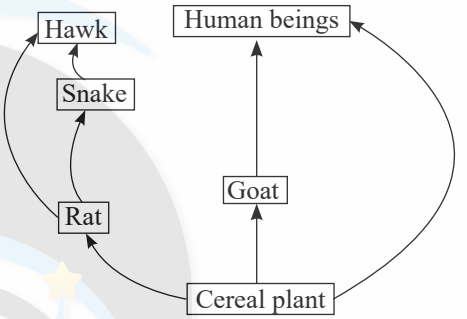
Energy transferred from second to third trophic level = 10% of 20,000 J = 2000 J

Energy transferred from third to fourth trophic level = 10% of 2000 J = 200 J ***(2 M)***

100. (*a*) Cereal Plant ⟶ Human beings. ***(1 M)***

(*b*) Growing cereal plants in soil rich in pesticides can have several negative consequences, including reduced crop yields and toxicity in food. Pesticides being non-biodegradable accumulate progressively at each trophic level leads to Biomagnification. ***(1 M)***

(*c*)



(1 M)