SCIENCE

SET-3   Paper & Solution

Time: 2½ Hrs.   Max. Marks: 60
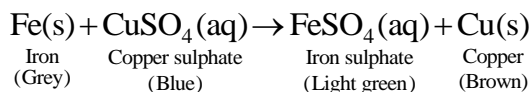
General Instructions:

1. The question paper comprises of two Sections, A and B. You are to attempt both the sections.
2. All questions are compulsory.
3. The candidates are advised to attempt all the questions of Section A and Section B separately.
4. There is no overall choice. However, internal choice has been provided in some questions. You are to attempt only one option in such questions.
5. Question numbers 1–6 in Section A and 19 to 21 in Section B are very short answer questions. These questions carry one mark each.
6. Question numbers 7–12 in Section A and 22 to 24 in Section B are short answer questions and carry two marks each.
7. Question numbers 13–16 in Section A and 25 and 26 in Section B are also short answer questions and carry three marks each.
8. Question numbers 17 and 18 in Section A and 27 in Section B are long answer questions and carry five marks each.

SECTION A

Question 1. What change in the colour of iron nails and copper sulphate solution you observe after keeping the iron nails dipped in copper sulphate solution for about 30 minutes.

Solution: When iron nails are dipped in copper sulphate solution for about 30 minutes, iron nails become brownish in colour and the blue colour of copper sulphate solution fades and changes to light green.

$$\underset{\substack{\text{Iron} \\ \text{(Grey)}}}{Fe(s)} + \underset{\substack{\text{Copper sulphate} \\ \text{(Blue)}}}{CuSO_4(aq)} \rightarrow \underset{\substack{\text{Iron sulphate} \\ \text{(Light green)}}}{FeSO_4(aq)} + \underset{\substack{\text{Copper} \\ \text{(Brown)}}}{Cu(s)}$$

Marks: 1

Question 2. State two characteristic features of carbon which when put together give rise to large number of carbon compound.

Solution: Two characteristic features of carbon which give rise to a large number of carbon compounds are:
(a) Catenation: Carbon has the unique ability to form bonds with other atoms of carbon giving rise to large molecules i.e. carbon has a tendency to catenate.
(b) Tetravalency: Since carbon has a valency of four, it is capable of bonding with four other atoms of carbon or atoms of some other mono-valent element.

Marks: 1

Question 3. Explain why a ray of light passing through the centre of curvature of a concave mirror gets reflected along the same path.

Solution: A ray of light passing through the centre of curvature of a concave mirror falls on the mirror along the normal to the reflecting surface. Hence, it gets reflected along the same path following the laws of reflection.
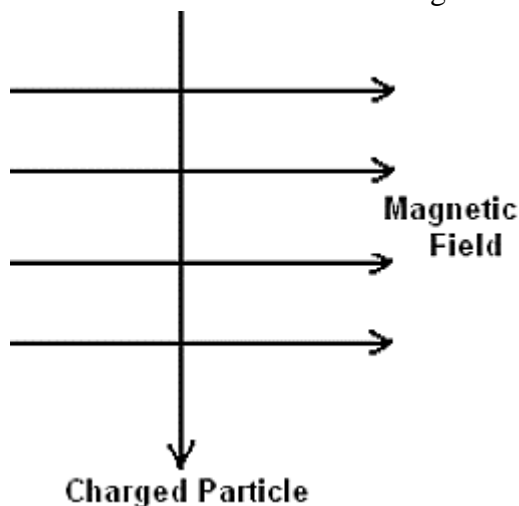
Marks: 1

Question 4. What is the nature of the image formed by a concave mirror if the magnification produced by the mirror is +3?
Solution: The nature of the image formed by a concave mirror if the magnification produced by the mirror is +3 is virtual, erect and magnified.
Marks: 1

Question 5. A charged particle enters at right angles into a uniform magnetic field as shown. What should be the nature of charge on the particle if it begins to move in a direction pointing vertically out of the page due to its interaction with the magnetic field?

Solution: Using Fleming's left hand rule we can easily find out that the nature of the charge on the particle is positive.
Marks: 1

Question 6. Name the part of our eyes that helps us to focus near and distant objects in quick succession.
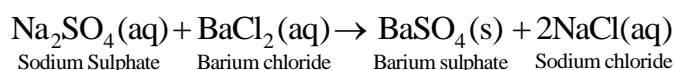**Solution:** Eye lens help us to focus near and distant objects in quick succession.
Marks: 1

Question 7. What happen when an aqueous solution of sodium sulphate reacts with an aqueous solution of barium chloride? State the physical conditions of reactants in which the reaction between them will not take place. Write the balanced chemical equation for the reaction and name the type of reaction.
Solution: When an aqueous solution of sodium sulphate reacts with an aqueous solution of barium chloride, insoluble barium sulphate along with solution of sodium chloride is formed.
If the reactants are in solid state, then reaction will not take place between sodium sulphate and barium chloride.

$$\underset{\text{Sodium Sulphate}}{Na_2SO_4(aq)} + \underset{\text{Barium chloride}}{BaCl_2(aq)} \rightarrow \underset{\text{Barium sulphate}}{BaSO_4(s)} + \underset{\text{Sodium chloride}}{2NaCl(aq)}$$

Reaction between aqueous solution of sodium sulphate and aqueous solution of barium chloride is a double displacement reaction.
Marks: 2

Question 8. What is the main constituent of biogas? How is biogas obtained from biomass? Write any two advantages of using this gas.
**Solution:** The main constituent of biogas is methane.

Biogas is obtained by the anaerobic degradation of biomass in the presence of water.

Two advantages of using biogas are:

1. It burns without smoke and hence does not cause air pollution.

2. It has a high calorific value.

Marks: 2

Question 9. In the figure given below a narrow beam of white light is shown to pass through a triangular glass prism. After passing through the prism it produces a spectrum XY on a screen.
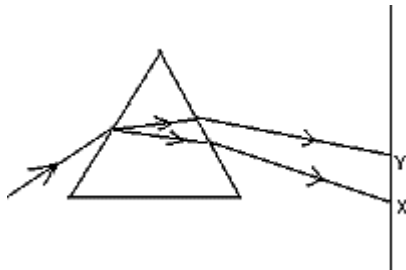
(a) State the colour seen at X and Y.

(b) Why do different colours of white light bend through different angles with respect to the incident beam of light?

Solution: (a) Red color will be seen at Y and violet colour will be seen at X.

(b) Different colors of white light travel at different speeds through the glass prism.

Hence, they bend through different angles with respect to the incident beam of light.

Marks: 2

Question 10. What is a solenoid? Draw the pattern of magnetic field lines of a solenoid through which a steady current flows. What does the pattern of field lines inside the solenoid indicate?

Solution: A coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder is called a solenoid.

Magnetic field lines of a solenoid through which a steady current is flowing:
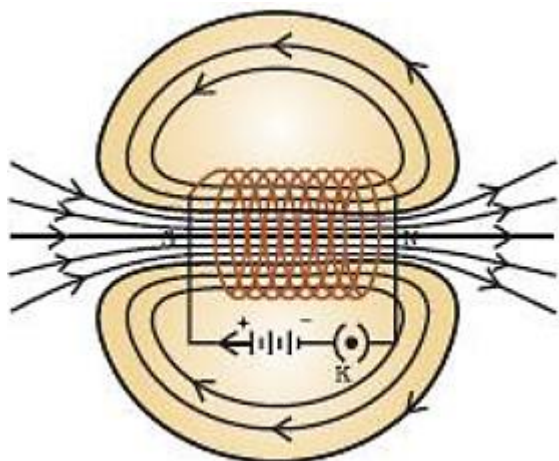
The field lines inside the solenoid are in the form of parallel straight lines. This indicates that the magnetic field is the same at all points inside the solenoid. That is, the field is uniform inside the solenoid.

Marks: 2

Question 11. A coil of insulated wire is connected to a galvanometer. What would be seen if a bar magnet with its north pole towards one face of the coil is

(i) moved quickly towards it,

(ii) moved quickly away from the coil and

(iii) placed near its one face?

Name the phenomena involved.

Solution: (i) A momentary deflection in the galvanometer will be seen, indicating a flow of current in the circuit.

(ii) A momentary deflection in the galvanometer (but in opposite direction) will be seen, indicating a flow of current in the opposite direction in the circuit.

(iii) No deflection in the galvanometer will seen, indicating that not current flows in the circuit.

The phenomenon involved is electromagnetic induction.

Marks: 2

Question 12. Mention any four limitations in harnessing wind energy on a large scale.

Solution: Four limitations in harnessing wind energy on a large scale are:

(a) Wind energy farms can be established only at those places where wind blows at least with a speed of 15 km/h for the most part of the year.

(b) There should be some back-up facilities (like storage cells) to take care of the energy needs during a period when there is no wind.

(c) Establishment of wind energy farms requires large area of land.

(d) Since the tower and blades are exposed to the vagaries of nature like rain, sun, storm and cyclone, they need a high level of maintenance.

Marks: 2

Question 13. At what distance should an object be placed from a convex lens of focal length 18 cm to obtain an image at 24 cm from it on the other side. What Will be magnification produced in this case?

Solution: Focal length, f = +18 cm

Image distance, v = +24 cm

Object distance, u = ?

Magnification, m = ?

According to lens formula:

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

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

$$\frac{1}{u} = \frac{1}{24} - \frac{1}{18}$$

$$\frac{1}{u} = \frac{3-4}{72}$$

$$u = -72 \, cm$$

$$m = \frac{v}{u} = \frac{24}{-72} = -0.33$$

Marks: 3

Question 14. No chemical reaction takes place when granules of a solid, A, are mixed with the powder of another solid, B. However when the mixture is heated, a reaction takes place between its components. One

of the products, C, is a metal and settles down in the molten state while the other product, D floats over it. It was observed that the reaction is highly exothermic.

(i) Based on the given information make an assumption about A and B and write a chemical equation for the chemical reaction indicating the conditions of reaction, physical state of reactants and products and thermal status of reaction.

(ii) Mention any two types of reaction under which above chemical reaction can be classified.

Solution: (i) Based on the given information, solid A can be assumed to be manganese dioxide (MnO_2) and solid B can be assumed to be aluminium powder (Al). When manganese dioxide is heated with aluminium powder, the following reaction takes place:

$$\underset{A}{3MnO_2(S)} + \underset{B}{4Al(S)} \xrightarrow{\text{Heat}} \underset{D}{2Al_2O_3(s)} + \underset{C}{3Mn(1)} + \text{Heat}$$
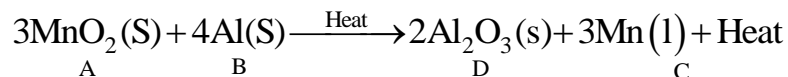
The reaction is highly exothermic reaction and a lot of heat is evolved.

(ii) (a) Displacement reaction

(b) Exothermic reaction

(c) Redox reaction

Marks: 3

Question 15. Name the functional group of organic compounds that can be hydrogenated. With the help of suitable example, explain the process of hydrogenation mentioning the conditions of the reaction and any one change in physical property with the formation of the product. Name any one natural source of organic compounds that are hydrogenated.

Solution: The functional groups of organic compounds that can be hydrogenated are alkenes and alkynes.

$$\underset{\text{Ethene}}{H_2C=CH_2} \xrightarrow[\text{Nickel Catalyst}]{H_2} \underset{\text{Ethane}}{CH_3-CH_3}$$
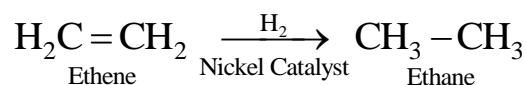
Unsaturated hydrocarbons undergo addition reactions with hydrogen in the presence of catalysts such as palladium or nickel to give saturated hydrocarbons. During this reaction, unsaturated compounds like vegetable oils which are in liquid state are converted to animal fats in solid state. Vegetable oil is an example of natural source of organic compound that are hydrogenated.

Marks: 3

Question 16. Atoms of eight elements A, B, D, E, F, G and H have the same number of electronic shells but different number of electrons in their outermost shell. It was found that elements A and G combine to form an ionic compound. This compound is added in a small amount to almost all vegetable dishes during cooking. Oxides of elements A and B are basic in nature while those of E and F are acidic. The oxide of D is almost neutral.

Based on the above information answer the following questions:

(i) To which group or period of the periodic table, do the listed elements belong?

(ii) What would be the nature of compound formed by a combination of elements B and F?

(iii) Which two of these elements could definitely be metals?

(iv) Which one of the eight elements is most likely to be found in gaseous state at room temperature?

(v) If the number of electrons in the outermost shell of element C and G be 3 and 7 respectively, write the formula of the compound formed by the combination of C and G.

Solution: (i)

Elements	Group	Period
A	1	3rd
B	2	3rd
C	13	3rd
D	14	3rd
E	15	3rd
F	16	3rd
G	17	3rd
H	18	3rd

(ii) Nature of the compound formed by combination of element B and F is ionic.

(iii) Elements A and B are definitely metals.

(iv) Element H belonging to group 18 is most likely to be found in gaseous state at room temperature.

(v) Formula of the compound formed by combination of C and G is CG_3.
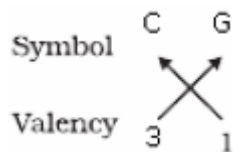
Marks: 3

Question 17. Write the name and symbols of two most reactive metals belonging to group I of the periodic table. Explain by drawing electronic structure how either one of the two metals reacts with a halogen. With which name is the bond formed between these elements known and what is the class of the compound so formed known? State any four physical properties of such compounds.
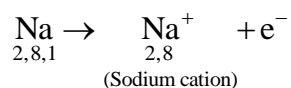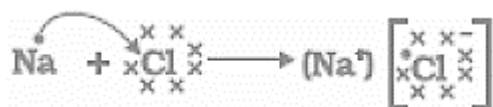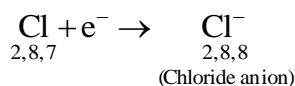
<div align="center">OR</div>

What is meant by refining of metals? Name the most widely used method of refining impure metals produced by various reduction processes. Describe with the help of a labeled diagram how this method may be used for refining of copper.

Solution: Names and symbols of the two most reactive metals belonging to group I of the periodic table:

No.	Name of metals	Symbol of metals
1.	Sodium	Na
2.	Potassium	K

Formation of sodium chloride:

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

$$\underset{2,8,7}{Cl} + e^- \rightarrow \underset{2,8,8}{Cl^-}$$
(Chloride anion)

Sodium and chloride ions, being oppositely charged are held by strong electrostatic forces of attraction. Bond formed between sodium and chloride ion is ionic bond.

The class of compounds formed by the transfer of electrons from a metal to a non-metal is known as ionic compounds or electrovalent compounds.

Physical properties of ionic or electrovalent compounds:

1. Ionic compounds are solids and are somewhat hard.

2. Ionic compounds have high melting and boiling points.

3. Ionic compounds are generally soluble in water and insoluble in solvents such as kerosene, petrol, etc.

4. Ionic compounds conduct electricity in aqueous solution and in molten state. They do not conduct electricity in solid state.

<div align="center">OR</div>

Process of obtaining pure metal from its impure form is called refining of metals. The most widely used method for refining impure metals is electrolytic refining.

Electrolytic refining of copper:
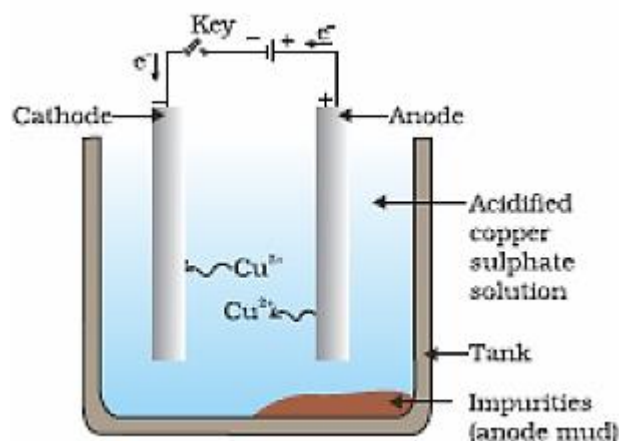
In electrolytic refining of copper, electrolyte is a solution of acidified copper sulphate. Anode is made up of impure copper. Cathode is made up of a strip of pure copper metal.

On passing current through the electrolyte, pure copper metal from the anode dissolves into the electrolyte i.e., acidified copper sulphate.

$$\underset{\substack{(Impure \\ copper)}}{Cu} \rightarrow Cu^{2+} + 2e^-$$
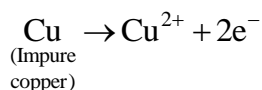
At cathode: An equivalent amount of pure metal from the electrolyte is deposited on the cathode.

$$Cu^{2+} + 2e^- \rightarrow \underset{\substack{(Pure \\ copper)}}{Cu}$$
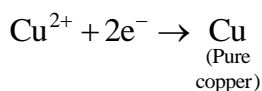
The soluble impurities go into the solution, whereas, the insoluble impurities settle down at the bottom of the anode and are known as anode mud.

Marks: 5

Question 18. Derive the expression for the heat produced due to a current 'I' flowing for a time interval 't' through a resistor 'R' having a potential difference 'V' across its ends. With which name is the relation

known? How much heat will an instrument of 12 W produce in one minute if it is connected to a battery of 12 V?

<div align="center">OR</div>

Explain with the help of a labeled circuit diagram how you will find the resistance of a combination of three resistors, of resistance R_1, R_2 and R_3 joined in parallel. Also mention how you will connect the ammeter and the voltmeter in the circuit when measuring the current in the circuit and the potential difference across one of the three resistors of the combination.

Solution: Let us take a resistor of resistance R. Let the current flowing through this resistor is equal to I and the potential difference across it is equal to V. Suppose in time t, Q amount of charge flows through the resistor

Work done in moving this charge, W = VQ   … (1)

According to the definition of electric current,

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

$$Q = I \times t$$

Putting this in equation (1),

W = V × I × t

This work done is dissipated as heat.

Hence, heat produced, H = W = VIt

H = VIt   … (2)

According to Ohm's law, V = IR.

Putting this in equation (2),

H = IR × It

H = I²Rt

This relation is known as Joule's law of heating

Numerical:

Power, P = 12 W

Potential difference, V = 12 volt
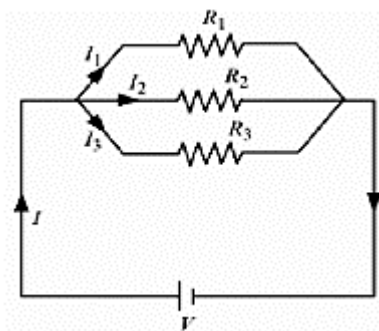
Time duration, t = 1 min = 60 s

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

$$H = P \times t$$

= 12 W × 60 s

= 720 J

The heat generated by the instrument is 720 J.

<div align="center">OR</div>

The given figure shows a circuit consisting of three resistors R_1, R_2 and R_3 connected in parallel. The total current in the circuit (I) gets divided among the three resistors as I_1, I_2 and I_3.

Thus, $I = I_1 + I_2 + I_3$ ----- (1)

Applying Ohm's law for each resistor,

$$\left. \begin{array}{l} I_1 = \dfrac{V}{R_1} \\[2mm] I_2 = \dfrac{V}{R_2} \\[2mm] I_3 = \dfrac{V}{R_3} \end{array} \right\} \quad \text{----- (2)}$$

Let the equivalent resistance of the circuit be R_{eq}.

Applying Ohm's law for the equivalent circuit,

$$I = \dfrac{V}{R_{eq}} \quad \text{----- (3)}$$

Using eqns. (1), (2) and (3),

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

$$\dfrac{1}{R_{eq}} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$$

This is the expression for the equivalent resistance of a parallel combination of three resistances. An ammeter has to be connected in series with the combination of all these resistors so that the current passing through the ammeter is equal to the total current through the circuit.

The voltmeter has to be connected in parallel to that resistor across which the potential difference has to be measured.

Marks: 5

SECTION-B

Question 19. Name the green dot like structures in some cells observed by a student when a leaf peel was viewed under a microscope. What is this green colour due to?
Solution: The green dot-like structures are chloroplasts. This green colour is due to the presence of chlorophyll.
Marks: 1

Question 20. How is the spinal cord protected in the human body?
Solution: The spinal cord is protected by the vertebral column or backbone.
Marks: 1

Question 21. How is the increasing demand for energy adversely affecting our environment?
Solution: Our increasing demand for energy is depleting our natural resources and polluting the environment in one or the other way.
Marks: 1

Question 22. What are hormones? Name the hormone secreted by thyroid and state its function?

Solution: A hormone is a chemical compound synthesized by a group of cells or endocrine glands that affect cells in other parts of the body and is also used for control and coordination in the organisms.
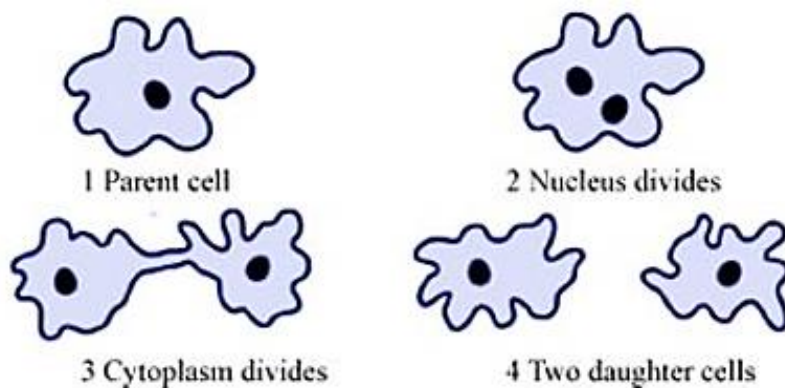
Thyroid gland secretes the hormone thyroxin.

Thyroxin regulates carbohydrate, protein and fat metabolism in the body so as to provide the correct balance for growth.

Marks: 2

Question 23. With the help of diagrams show the different stages of binary fission in Amoeba.

Solution:

Marks: 2

Question 24. Given one example each of characters that are inherited and the ones that are acquired in humans. Mention the difference between the inherited and the acquired characters.

Solution: Example of inherited trait - Shape of the eye or hair colour.

Example of acquired trait – Building of muscles while exercising.

Inherited characters affect the DNA of germ cells and hence can be passed on to the future generations. Acquired characters do not cause changes in DNA of the germ cells and hence cannot be passed on to future generations.

Marks: 2

Question 25. Write the full form of DNA. Name the part of the cell where it is located. Explain its role in the process of reproduction of the cell.

Solution: DNA – Deoxyribonucleic acid.

DNA is present in the nucleus of the cell.

DNA in the cell nucleus is the information source for making proteins and is thereby, responsible for inheritance of features. A basic event in reproduction process is DNA copying, accompanied by the creation of an additional cellular apparatus after which the DNA copies separate, each with its own cellular apparatus.

The consistency of DNA copying during reproduction is important for the maintenance of body design features. Variations occur in the DNA copying reactions during reproduction, due to which the surviving cells are similar to, but subtly different from each other. This inbuilt tendency for variation during reproduction is the basis for evolution.

Marks: 3

Question 26. Explain the phenomenon of "biological magnification." How does it affect organisms belonging to different tropic levels particularly the tertiary consumers?

Solution: When non-biodegradable substances such as pesticides, enter the food chain, they get accumulated progressively at each trophic level. This results in a cumulative increase in the concentration of the substance in successively higher trophic levels of the food chain. This phenomenon is known as biological magnification.

For example - Pesticides entering our food chain through soil or water are not degradable and hence gets progressively accumulated at each trophic level, with maximum accumulation in human bodies.

Biomagnification of a toxic substance has the potential to cause harm to organisms, particularly to the tertiary consumers. This is because tertiary consumers occupy the top level in a food chain and hence maximum concentration of such chemicals gets accumulated in their bodies.

Marks: 3

Question 27. Explain the process of digestion of food in mouth, stomach and small intestine in human body.

OR

(a) List the three events that occur during the process of photosynthesis. Explain the role of stomata in this process.

(b) Describe an experiment to show that "sunlight is essential for photosynthesis."

Solution: i. Mouth - In mouth, large food pieces are crushed with the help of our teeth and mixed with saliva secreted by the salivary glands, using the tongue. Salivary amylase, the enzyme present in saliva, breaks down starch to give sugar.

ii. Stomach - The muscular walls of the stomach help in mixing the food thoroughly with the digestive juices secreted by the gastric glands present in the wall of the stomach. These glands release hydrochloric acid, a protein digesting enzyme called pepsin, and mucus, which protects the inner lining of the stomach. The hydrochloric acid creates an acidic medium which facilitates the action of the enzyme pepsin.

iii. Small intestine - The small intestine is the site of the complete digestion of carbohydrates, proteins and fats. It receives the secretions of the liver and pancreas for this purpose.

Bile juice from liver makes the acidic food coming from stomach alkaline for facilitating the action of pancreatic enzymes. Bile also emulsifies fats so as to increase the efficiency of enzyme action.

The pancreas secretes pancreatic juice which contains enzymes like trypsin for digesting proteins and lipase for breaking down emulsified fats.

The walls of the small intestine contain glands which secrete intestinal juice. The enzymes present in it finally convert the proteins into amino acids, complex carbohydrates into glucose and fats into fatty acids and glycerol.

OR

(a) 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.

Stomata help in exchange of gases (carbon dioxide and oxygen) for the purpose of photosynthesis.

(b)
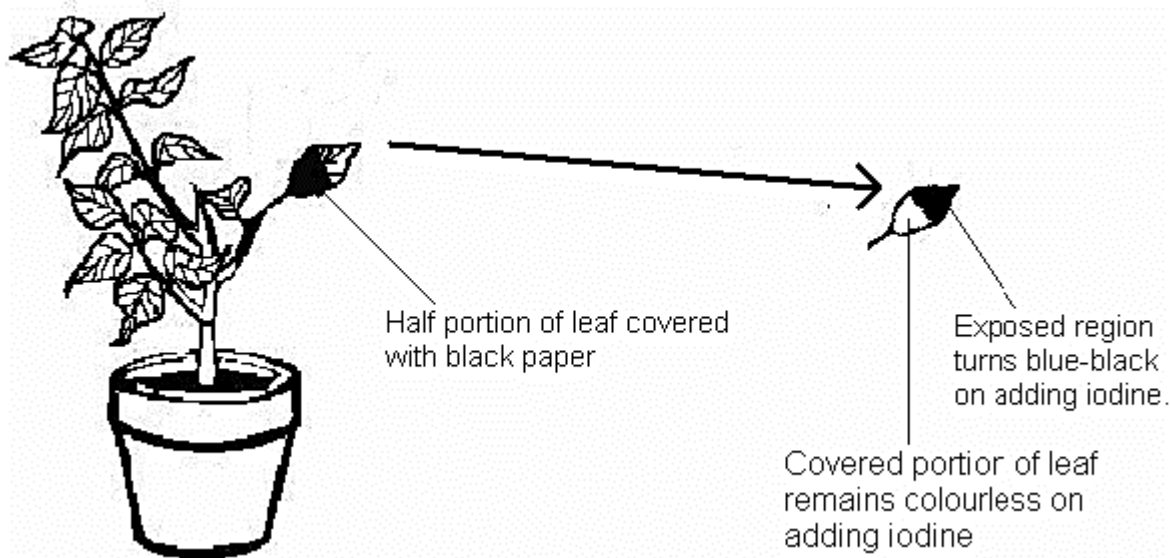
Experimental set-up to show that light is essential for photosynthesis:

i. Keep a potted plant in a dark room for three days so that all the starch gets used up.

ii. Now cover one half of a leaf of this plant with black paper or metal foil on both sides.

iii. Then keep the plant in sunlight for about six hours.

iv. Pluck the leaf which was half covered and remove the paper or foil.

v. Mark the covered area.

vi. Dip this leaf in boiling water for a few minutes.

vii. Then immerse it in a beaker containing alcohol.

viii. Carefully place this beaker in a water-bath and heat till the alcohol begins to boil.

ix. The leaf gets decolourised.

x. Now, dip the leaf in a dilute solution of iodine for a few minutes.

xi. Take out the leaf and rinse off the iodine solution. Observe the colour of the leaf.

The part containing starch will be turned blue-black by iodine.

You will find that the portion of the leaf exposed to sunlight will turn blue-black whereas the covered half of the leaf remains colourless. This is because the covered part did not receive sunlight and hence could not form carbohydrates.

This proves that light is essential for photosynthesis.

Marks: 5