CBSE Class 10 Science 2026 — Set 3 — Answer Key

English Medium

Time Allowed: 3 Hours | Maximum Marks: 80

General Instructions:

1. This question paper contains 39 questions. All questions are compulsory.
2. Section A has 20 MCQs carrying 1 mark each.
3. Section B has 6 questions carrying 2 marks each.
4. Section C has 7 questions carrying 3 marks each.
5. Section D has 3 questions carrying 5 marks each.
6. Section E has 3 case-study based questions carrying 4 marks each.
7. Draw neat diagrams wherever required.

Section A

Multiple Choice Questions (1 mark each)

Q.1 [1 mark]

Pravin was given a list of characteristics associated with the process of anaerobic respiration in humans, in the table given below: Location — (i) Muscle Cell; Condition — (ii) Requires presence of Oxygen (O2) and Carbon dioxide (CO2); End Product — (iii) 3-Carbon molecules. Which of the above characteristics is/are related to the above process?

(a) (i) and (ii)

(b) (i) and (iii) <<

(c) (ii) and (iii)

(d) (i) only

Explanation:

Anaerobic respiration in humans occurs in muscle cells (i) and produces lactic acid, a 3-carbon molecule (iii).

It occurs in the ABSENCE of oxygen, so (ii) is incorrect.

Correct: (i) and (iii).

Q.2 [1 mark]

Observe the figure given below and identify the incorrect step for the activity set-up (destarching experiment with a watch-glass containing potassium hydroxide under a bell-jar):

(a) Both plants are kept in the dark room for three days before placing them in separate glass jars.

(b) Both plants are covered with separate wooden bell-jars. <<

(c) Use vaseline to seal the bottom of the jars with the glass plates.

(d) Both potted plants were kept in sunlight for a few hours before the iodine test for the presence of starch.

Explanation:

The bell-jars must be transparent (glass), not wooden, so that sunlight can reach the plant for photosynthesis.

A wooden bell-jar would block light, making the setup invalid.

Hence (B) is the incorrect step.

Q.3 [1 mark]

Walking in a straight line and riding a bicycle are activities which are possible due to coordination of which part of the brain?

(a) Fore-Brain / Cerebrum

(b) Mid-Brain / Cerebellum

(c) Hind-Brain / Cerebellum <<

(d) Hind-Brain / Medulla

Explanation:

Precision of voluntary actions and maintenance of posture and balance (walking straight, riding a bicycle) are controlled by the cerebellum, which is part of the hind-brain.

Q.4 [1 mark]

In a synapse, the chemical signal is transmitted from:

(a) Dendritic end of one neuron to axonal end of another neuron.

(b) Axon to cell body of the same neuron.

(c) Cell body to axonal end of the same neuron.

(d) Axonal end of one neuron to dendritic end of another neuron. <<

Explanation:

At a synapse, the nerve impulse travels from the axonal end (terminal) of one neuron across the synaptic gap to the dendritic end of the next neuron via chemical neurotransmitters.

Q.5 [1 mark]

Organisms of a higher trophic level which feed on several types of organisms belonging to a lower trophic level form the:

(a) Food web <<
(b) Ecosystem
(c) Ecological pyramid
(d) Food chain

Explanation:
When organisms at a higher trophic level feed on many different types of organisms at lower levels, the interconnected feeding relationships form a food web (not a single linear food chain).

Q.6 [1 mark]

In accumulation of toxic substances at higher trophic levels of an ecosystem through the food chain, which of the following organisms is affected the most?

(a) Small aquatic plants
(b) Human beings <<
(c) Small fish
(d) Large fish

Explanation:
Due to biomagnification, toxic substances become progressively more concentrated at each higher trophic level.
Human beings occupy the top of the food chain and are therefore affected the most.

Q.7 [1 mark]

The growth of tendrils in grapes plants is due to:

(a) Effect of light
(b) Effect of gravity
(c) Rapid cell division in tendril cells in contact with the support
(d) Rapid cell division in tendril cells that are away from the support <<

Explanation:
When a tendril touches a support, the cells on the side away from (opposite to) the contact grow/divide more rapidly than those in contact, causing the tendril to curl

around the support (thigmotropism).

Q.8 [1 mark]

Assertion (A): Natural replenishment of soil will not take place in absence of microbes. Reason (R): Microbes, comprising of bacteria and fungi, break down dead remains and waste products of organisms, and they go into the soil. Select the correct answer from the codes given below.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A). <<

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Explanation:

Both statements are true.

Microbes (bacteria and fungi) decompose dead remains and wastes, returning nutrients to the soil.

This decomposition is exactly why soil cannot be naturally replenished without microbes, so R correctly explains A.

Q.9 [1 mark]

Assertion (A): The basic filtration unit in the kidneys, like in the lungs, is a cluster of very thin-walled blood capillaries. Reason (R): Each capillary cluster in the kidney is associated with the cup-shaped end of a coiled tube called Bowman's capsule. Select the correct answer from the codes given below.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A). <<

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Explanation:

Both A and R are true: the basic filtration unit (nephron) has a glomerulus, a cluster of thin-walled capillaries, and each is associated with the cup-shaped Bowman's capsule. However, R describes the Bowman's capsule structure and does not explain WHY the filtration unit is a capillary cluster, so R is not the correct explanation of A.

Q.10 [1 mark]

(i) Chlorofluorocarbons (CFCs) have been linked to depletion of ozone layer. In 1987, the United Nations Environment Programme (UNEP) succeeded in making an agreement. State this agreement. (ii) What is the role of ozone in our atmosphere?

Answer: (i) The Montreal Protocol — an agreement to freeze/reduce CFC production at 1986 levels (to phase out ozone-depleting substances). (ii) Ozone in the upper atmosphere shields the Earth's surface by absorbing harmful ultraviolet (UV) radiation from the Sun, protecting living organisms.

Explanation:

(i) The 1987 UNEP agreement is the Montreal Protocol, under which nations agreed to freeze and reduce CFC production at 1986 levels.

(ii) The ozone layer absorbs harmful UV radiation, which otherwise damages organisms (e.g., causes skin cancer).

Q.11 [1 mark]

What kind of respiration provides more energy and why?

Answer: Aerobic respiration provides more energy because glucose is completely broken down in the presence of oxygen into carbon dioxide and water, releasing much more energy (ATP) than anaerobic respiration, in which glucose is only partially broken down.

Explanation:

In aerobic respiration glucose is completely oxidised to CO_2 and H_2O releasing a

large amount of energy, whereas in anaerobic respiration glucose is only partially broken down (to lactic acid or ethanol + CO_2), releasing much less energy.
Hence aerobic respiration yields more energy.

Q.12 [1 mark]

Separation of right side and left side of the heart is useful to keep oxygenated and deoxygenated blood from mixing. Various organisms have different types of heart. (I) Fill in the blanks (i) to (iii) correctly according to the type of organisms and their evolution in terms of blood circulation: Fish — (i) ____ chambers, Mixed blood, Single circulation; (ii) ____ — 3-chambered, Mixed blood, Incomplete double circulation; Birds and Mammals — 4-chambered, Separated oxygenated and deoxygenated blood, (iii) ____ circulation. (II) Which type of circulation is most efficient?

Answer: (i) 2 (two-chambered); (ii) Amphibians (and reptiles); (iii) Double circulation (complete double circulation). (II) Complete double circulation (as in birds and mammals) is the most efficient.

Explanation:
Fish have a 2-chambered heart with single circulation.
Amphibians (and most reptiles) have a 3-chambered heart with incomplete double circulation.
Birds and mammals have a 4-chambered heart with complete double circulation, which is most efficient because it fully separates oxygenated and deoxygenated blood, allowing high energy needs and body-temperature maintenance.

Q.13 [1 mark]

In xylem tissue, vessels and tracheids of the roots, stems and leaves are interconnected to form a continuous system of water-conducting channels reaching all parts of the plant. Explain how this is achieved.

Answer: Water is absorbed by root hairs from the soil by osmosis. This creates a difference in ion concentration between the root and soil, so water moves into the root and continuously into the xylem, creating a column of water that is steadily

pushed upward (root pressure). More importantly, when transpiration occurs from the leaves (loss of water vapour through stomata), it creates a suction (transpiration pull) that pulls the column of water upward through the interconnected xylem vessels and tracheids, from roots to stem to leaves, reaching all parts of the plant.

Explanation:

Two mechanisms: (1) Root pressure — active uptake of ions into root xylem draws water in by osmosis, pushing water up.

(2) Transpiration pull — evaporation of water from leaf surfaces creates suction that pulls the continuous water column upward through the interconnected xylem.

Transpiration pull is the major force in tall plants.

Q.14 [1 mark]

Show the cross and observations made by Mendel when he crossed pure tall pea plant with a pure short pea plant to get F1 progeny.

Answer: Cross: Pure Tall (TT) × Pure short (tt). Gametes: T and t. F1 progeny: all Tt. Observation: All F1 plants are Tall (100% tall), because the tall trait (T) is dominant over the short trait (t). The short trait does not appear in the F1 generation.

Explanation:

Parents: TT (tall) × tt (short).

Each parent contributes one allele, so all F1 offspring are Tt.

Since T (tallness) is dominant, all F1 plants appear tall even though they carry the recessive short allele (t).

Ratio in F1 = 100% tall.

Q.15 [1 mark]

Read the passage: Not all plants carry out photosynthesis by the same mechanism. In most plants it depends directly on gaseous carbon dioxide that diffuses into the leaf. However, some plants can store carbon dioxide in the vacuole of the leaf cells as part of a complex carbon compound, which is

transported to the chloroplast and releases carbon dioxide when required for photosynthesis. This mechanism evolved as an adaptation in plants which do not open stomata during the daytime to conserve water for survival in dry (desert) conditions. Attempt (a): (i) Which process in these plants is minimised to help the plants survive in dry conditions? (ii) Which part of the leaf is responsible for exchange of gases during photosynthesis?

Answer: (i) Transpiration (loss of water vapour) is minimised — by keeping the stomata closed during the day, these desert plants reduce water loss. (ii) The stomata (tiny pores, mainly on the leaf surface) are responsible for the exchange of gases during photosynthesis.

Explanation:

(i) By closing stomata during the hot daytime, the plants minimise transpiration, conserving water in dry/desert conditions.

(ii) Gaseous exchange (intake of CO_2, release of O_2) occurs through the stomata on the leaf.

OR

Q.15 [1 mark]

Read the passage (same as Q15 about desert plants storing CO_2 and keeping stomata closed in daytime). Attempt (b): (i) List the events that occur during the process of photosynthesis. (ii) When are such desert plants likely to take in carbon dioxide from the environment, unlike other plants? (iii) Draw a labelled diagram of stomata with open stomatal pore.

Answer: (i) Events of photosynthesis: (1) Absorption of light energy by chlorophyll; (2) Conversion of light energy to chemical energy and splitting of water molecules into hydrogen and oxygen; (3) Reduction of carbon dioxide to carbohydrates (glucose). (ii) Such desert plants take in carbon dioxide from the environment at night (during the night-time), when they open their stomata, storing it as an organic acid to be used for photosynthesis during the day. (iii) A labelled diagram of a stoma should show: the open stomatal pore, the two bean/kidney-shaped guard cells surrounding the pore, and the chloroplasts and nucleus inside the

guard cells (with surrounding epidermal cells).

Explanation:

(i) The three main events are light absorption by chlorophyll, conversion of light energy to chemical energy with splitting of water (photolysis) into H_2 and O_2, and reduction of CO_2 to carbohydrate.

(ii) Desert plants open stomata and take up CO_2 at night to avoid daytime water loss, storing it as a complex acid for daytime photosynthesis.

(iii) Diagram: open pore flanked by two guard cells containing chloroplasts and nucleus.

Q.16 [1 mark]

Attempt either (a) or (b) : (a) Observe the given diagram (a leaf with an adventitious bud and young plant at its marginal notch) and answer the questions that follow : (i) Give the name of the structure and type of reproduction shown in the above diagram. (ii) State one advantage and one disadvantage of the above mentioned method of reproduction. (iii) Give reason : Asexual reproduction lacks genetic variation. (iv) Why have higher organisms resorted to sexual reproduction in spite of its complexity ?

Answer: (i) The diagram shows a leaf of Bryophyllum with adventitious buds at its marginal notches that grow into young plants; the type of reproduction is asexual, by vegetative propagation. (ii) Advantage: new plants arise quickly from a single parent (no seeds needed), so a large number of identical plants can be raised and they flower and fruit earlier. Disadvantage: offspring are genetically identical to the parent, so there is no variation and the whole population is vulnerable to a disease or environmental change. (iii) Asexual reproduction involves a single parent and offspring arise by mitotic cell division, so they are genetically identical (clones); there is no mixing of genetic material, hence no variation. (iv) Higher organisms adopted sexual reproduction because it combines DNA from two parents, producing genetic variation among offspring. This variation is the basis of evolution and helps the species survive changing environments.

Explanation:

(i) Leaf of Bryophyllum with adventitious buds: vegetative propagation (asexual).

(ii) Advantage: fast, single parent, early flowering;

Disadvantage: no genetic variation, so poor adaptability.

(iii) Single parent + mitosis gives identical DNA (clones), no variation.

(iv) Sexual reproduction combines genes from two parents, creating variation that drives evolution and adaptation.

OR

Q.16 [1 mark]

(b) Observe the given diagram (a cell with labelled Nucleus, Cytoplasm and Cyst (protective wall), dividing into many cells at stage P and then released) and answer the questions that follow : (i) Give the name and type of reproduction shown in the above diagram. (ii) Comment on the processes taking place in stage P. (iii) Name an organism which reproduces by the above mentioned method. (iv) Name the method that can be used to raise plants that have lost their capacity to produce seeds. List any two advantages of growing plants by such a method.

Answer: (i) Multiple fission (asexual reproduction): the cell withdraws into a protective cyst. (ii) In stage P the nucleus of the cell inside the cyst divides repeatedly, and the cytoplasm divides around each nucleus, forming many daughter cells within the cyst; on favourable conditions the cyst wall breaks and the daughter cells are released. (iii) Plasmodium (or Amoeba) reproduces by multiple fission. (iv) Vegetative propagation (e.g. cuttings, layering, grafting, tissue culture). Two advantages: (1) plants that cannot produce viable seeds (e.g. banana, orange, rose) can still be grown; (2) the new plants are genetically identical to the parent and bear flowers/fruits earlier than plants grown from seeds.

Explanation:

(i)-(iii) A cell enclosed in a cyst whose contents divide into many cells that are then released is multiple fission (e.g.

Plasmodium, Amoeba).

(ii) In P repeated nuclear and cytoplasmic division gives many daughter cells inside the cyst.

(iv) Vegetative propagation raises seedless plants, gives genetically identical plants, and early flowering/fruiting.

Q.17 [1 mark]

Which of the following is an example of a displacement reaction?

(a) The combustion of natural gas

(b) The reaction of a reactive metal with dilute acid <<

(c) The electrolysis of water

(d) The reaction of quick lime with water

Explanation:

A reactive metal displaces hydrogen from a dilute acid (e.g., $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$), a single-displacement reaction.

Combustion is oxidation, electrolysis of water is decomposition, and quick lime + water is a combination reaction.

Q.18 [1 mark]

To a small amount of copper oxide in a beaker, when we add dilute hydrochloric acid slowly with stirring, the change in the colour of the solution is due to the formation of:

(a) Copper(II) oxide, which is black in colour.

(b) Copper(I) chloride, which is blue in colour.

(c) Copper(II) chloride, which is blue-green in colour. <<

(d) Copper(I) oxide, which is black in colour.

Explanation:

$CuO + 2HCl \rightarrow CuCl_2 + H_2O$.

The blue-green colour of the solution is due to the formation of copper(II) chloride ($CuCl_2$).

Q.19 [1 mark]

In the following equation, $x\ KI + H_2O_2 \rightarrow I_2 + y\ KOH$, x and y respectively

are:

(a) 2, 2 <<

(b) 1, 2

(c) 2, 1

(d) 1, 1

Explanation:

Balancing 2KI + H2O2 →

I2 + 2KOH: K = 2 on each side, I = 2 on each side, H = 2 on each side, O = 2 on each side.

So x = 2 and y = 2.

Q.20 [1 mark]

Consider the structures 'X' (a straight-chain butane, CH3–CH2–CH2–CH3) and 'Y' (a branched isobutane / 2-methylpropane). Which of the following statements are correct? (i) 'X' and 'Y' are homologues. (ii) 'X' and 'Y' have the same structural formula, but different molecular formula. (iii) 'X' and 'Y' have the same molecular formula, but different structural formula. (iv) 'X' and 'Y' are structural isomers.

(a) (i) and (iii)

(b) (i) and (iv)

(c) (ii) and (iv)

(d) (iii) and (iv) <<

Explanation:

Both X (n-butane) and Y (isobutane) have the molecular formula C4H10 but different structural arrangements (straight vs branched chain).

Hence they have the same molecular formula but different structural formulae (iii) and are structural isomers (iv).

Correct: (iii) and (iv).

Section B

Very Short Answer Questions (2 marks each)

Q.21 [2 marks]

The reaction of calcium with cold water is:

(a) Less violent, but the heat evolved is sufficient for the hydrogen to catch fire.

(b) Very violent and exothermic and hydrogen catches fire.

(c) Exothermic, but the heat evolved is not sufficient for the hydrogen to catch fire. <<

(d) Slow and endothermic.

Explanation:

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$.

The reaction is exothermic but less vigorous than sodium;

the heat evolved is not sufficient to ignite the hydrogen gas produced, which instead sticks to the calcium surface as bubbles.

Q.22 [2 marks]

Three set-ups (i), (ii), (iii) each have two iron nails dipped in a beaker connected to a battery, switch and bulb. The beakers contain (i) glucose solution, (ii) alcohol solution and (iii) dilute HCl. In which case/cases will the bulb glow, considering that all other connections of electric circuit are complete and working?

(a) Case (i) only

(b) Case (ii) only

(c) Cases (ii) and (iii)

(d) Case (iii) only <<

Explanation:

The bulb glows only if the solution conducts electricity, i.e.

contains ions.

Glucose and alcohol do not ionise in water, so (i) and (ii) do not conduct.

Dilute HCl gives H^+ (H_3O^+) and Cl^- ions, so it conducts.

The bulb glows in case (iii) only.

Option (D).

Q.23 [2 marks]

When zinc reacts with NaOH, the product formed is:

(a) Na2O

(b) ZnO

(c) Na2ZnO2 <<

(d) Zn(OH)2

Explanation:

Zinc, being amphoteric, reacts with sodium hydroxide: Zn + 2NaOH → Na2ZnO2 (sodium zincate) + H2.

The product is sodium zincate, Na2ZnO2.

Q.24 [2 marks]

Assertion (A): There are large number of compounds with many carbon atoms linked to each other. Reason (R): Carbon-Carbon bond is very strong and stable. Select the correct answer from the codes given below.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A). <<

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Explanation:

Both statements are true.

Carbon shows catenation, forming a large number of compounds with many carbon atoms bonded to each other, precisely because the strong and stable C–C bond allows long, stable chains.

Thus R correctly explains A.

Q.25 [2 marks]

Show the formation of the following ionic compounds by transfer of electrons between the combining atoms: (i) Sodium oxide (Na2O); (ii) Magnesium

chloride (MgCl2). (Given: Atomic number: Na = 11, Mg = 12, O = 8, Cl = 17)

Answer: (i) Na2O: Each Na atom (2,8,1) loses 1 electron to become Na+ (2,8). Oxygen (2,6) gains 2 electrons to become O2- (2,8). Two Na atoms donate one electron each to one O atom: 2Na → 2Na+ + 2e-, O + 2e- → O2-. The ions combine as (Na+)2 O2- = Na2O. (ii) MgCl2: Mg (2,8,2) loses 2 electrons to become Mg2+ (2,8). Each Cl atom (2,8,7) gains 1 electron to become Cl- (2,8,8). Mg donates one electron to each of two Cl atoms: Mg → Mg2+ + 2e-, 2Cl + 2e- → 2Cl-. The ions combine as Mg2+ (Cl-)2 = MgCl2.

Explanation:

(i) Na (2,8,1) → Na+ + e-; two Na atoms give 2 electrons to O (2,6) → O2- (2,8). Electrostatic attraction of 2Na+ and O2- gives Na2O.

(ii) Mg (2,8,2) → Mg2+ + 2e-; each of two Cl (2,8,7) gains 1 electron → Cl- (2,8,8). Mg2+ with two Cl- gives MgCl2.

Q.26 [2 marks]

2 g of green coloured crystals of ferrous sulphate are heated in a dry boiling tube. Name the type of chemical reaction taking place. Write the balanced chemical equation for the reaction. Is this an exothermic or an endothermic reaction?

Answer: Type of reaction: Thermal decomposition reaction. Balanced equation: 2FeSO4 (heat) → Fe2O3 + SO2 + SO3. It is an endothermic reaction (heat is absorbed).

Explanation:

On heating, green ferrous sulphate crystals lose water and then decompose: 2FeSO4 →

Fe2O3 + SO2 + SO3.

This is a thermal decomposition reaction, which absorbs heat, hence endothermic.

Section C

Short Answer Questions (3 marks each)

Q.27 [3 marks]

Attempt (a): Give reasons: (i) For dilution of an acid, acid is added into water and not water into acid. (ii) Dry HCl gas does not turn blue litmus red whereas dilute hydrochloric acid does. (iii) Blue colour of Copper(II) sulphate crystals turns white on heating.

Answer: (i) Dissolving a concentrated acid in water is highly exothermic; adding water to acid can cause the mixture to spit/splash violently and may crack the container. Adding acid slowly to a large volume of water disperses the heat safely, so acid is added to water. (ii) Dry HCl gas has no free hydrogen ions (H+) because ions are produced only in the presence of water; without H+ ions it cannot show acidic behaviour, so it does not turn blue litmus red. Dilute HCl contains water, which allows HCl to ionise and produce H+ ions, so it turns blue litmus red. (iii) Copper(II) sulphate crystals ($CuSO_4 \cdot 5H_2O$) are blue due to water of crystallisation. On heating, they lose the water of crystallisation to form anhydrous copper sulphate ($CuSO_4$), which is white.

Explanation:

(i) Acid-into-water is safe because heat is dissipated in the large water volume; water-into-acid causes dangerous splashing.

(ii) Acidic (H+) behaviour needs water to ionise HCl; dry gas has no H+, so no litmus change.

(iii) Blue colour is from water of crystallisation; heating removes it giving white anhydrous $CuSO_4$.

OR

Q.27 [3 marks]

Attempt (b): Write the preparation of the following compounds with balanced chemical equation: (i) NaOH by chlor-alkali process; (ii) Baking Soda; (iii) Plaster of Paris.

Answer: (i) Chlor-alkali process (electrolysis of aqueous sodium chloride/brine): $2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2 + H_2$. (Sodium hydroxide forms at the cathode, chlorine at the anode, and hydrogen at the cathode.) (ii) Baking soda (sodium

hydrogen carbonate): NaCl + H2O + CO2 + NH3 → NH4Cl + NaHCO3. (iii) Plaster of Paris: prepared by heating gypsum at about 373 K (100°C): CaSO4·2H2O (heat, 373 K) → CaSO4·½H2O + 1½H2O. (Plaster of Paris is calcium sulphate hemihydrate, CaSO4·½H2O.)

Explanation:

(i) Electrolysis of brine (chlor-alkali) gives NaOH, Cl2 and H2.

(ii) Baking soda is made by the reaction of brine with CO2 and ammonia (Solvay-type step).

(iii) Heating gypsum (CaSO4·2H2O) at 373 K drives off ¾ of the water, leaving Plaster of Paris, CaSO4·½H2O.

Q.0

Read the passage: An electrochemical process is used for refining metals by selectively dissolving and depositing them through electrolysis. Electrolytic refining is used for metals like Copper, Zinc, Tin, Nickel, Silver and Gold. (a) Define anode mud.

Answer: Anode mud is the insoluble residue (impurities) that settles down below the anode during the electrolytic refining of a metal. It consists of the soluble and insoluble impurities (often including valuable metals such as gold, silver and platinum) present in the impure metal anode, which are not deposited on the cathode.

Explanation:

During electrolytic refining, the impure metal anode dissolves;

the impurities that do not go into solution or deposit on the cathode collect as a residue beneath the anode, called anode mud (which often contains precious metals).

Q.0

(b) In electrolytic refining of copper, name the anode and the cathode.

Answer: Anode: a block/plate of impure copper (impure metal). Cathode: a thin strip/sheet of pure copper.

Explanation:

In electrolytic refining of copper, the impure copper is made the anode and a thin strip of pure copper is made the cathode, with a solution of copper sulphate (acidified) as the electrolyte.

Q.0

(c)(i) With the help of chemical equations, show the extraction of copper from its ore Cu2S.

Answer: Copper is extracted from copper(I) sulphide (Cu2S) by roasting the ore in air (self-reduction). Step 1 — partial roasting: 2Cu2S + 3O2 (heat) → 2Cu2O + 2SO2. Step 2 — the copper(I) oxide formed reacts with remaining copper(I) sulphide: 2Cu2O + Cu2S (heat) → 6Cu + SO2. Thus copper metal is obtained.

Explanation:

On roasting Cu2S in air, part of it forms Cu2O (2Cu2S + 3O2 → 2Cu2O + 2SO2). This Cu2O then reacts with the remaining Cu2S (auto-reduction): 2Cu2O + Cu2S → 6Cu + SO2, giving metallic copper.

Q.0

(c)(ii) [Alternative to Q28(c)(i)] Draw a neat and labelled diagram showing electrolytic refining of copper.

Answer: Diagram of electrolytic refining of copper should show: a vessel/tank containing an electrolyte of acidified copper sulphate solution (CuSO4 + dilute H2SO4); the anode labelled as a thick block of impure copper connected to the positive terminal of a battery; the cathode labelled as a thin strip of pure copper connected to the negative terminal; and the anode mud collecting below the anode. On passing current, pure copper deposits on the cathode and impure copper dissolves from the anode.

Explanation:

A correct labelled diagram must include: battery with (+) connected to impure-copper anode and (−) to pure-copper cathode, electrolyte of acidified copper sulphate, and anode mud settling below.

Current passage transfers copper from anode to cathode.

Q.29 [3 marks]

Attempt (a): (i) What is homologous series? Which two of the following organic compounds belong to the same homologous series? C2H4, C4H10, C3H4, C4H8. (ii) Write the product(s) in the following reactions: (I) CH3–CH2–OH + CH3COOH (Acid) →; (II) C2H5OH + O2 (Burning) →. (iii) Why does micelle formation take place when soap is added to water?

Answer: (i) A homologous series is a group of organic compounds having the same general formula and similar chemical properties, in which successive members differ by a –CH2– group (14 mass units). Among the given compounds, C2H4 and C4H8 belong to the same homologous series (alkenes, general formula CnH2n). (ii) (I) CH3CH2OH + CH3COOH →(acid) CH3COOC2H5 (ethyl ethanoate/ethyl acetate) + H2O — an esterification reaction. (II) C2H5OH + 3O2 →(burning) 2CO2 + 3H2O (combustion). (iii) A soap molecule has a hydrophilic (water-loving) ionic head and a hydrophobic (water-repelling) hydrocarbon tail. When soap is added to water, the molecules arrange themselves in clusters (micelles) with the hydrophobic tails pointing inward (away from water, trapping the oil/dirt) and the hydrophilic heads pointing outward (into the water). This arrangement forms micelles, which dissolve/emulsify the dirt.

Explanation:

(i) Homologous series: same general formula, successive members differ by –CH2–; C2H4 and C4H8 are both alkenes (CnH2n).

(ii)(I) Ethanol + ethanoic acid with acid catalyst → ester (ethyl ethanoate) + water.

(II) Complete combustion of ethanol gives CO2 + H2O (balanced: C2H5OH + 3O2 → 2CO2 + 3H2O).

(iii) Micelles form because soap's hydrophobic tails cluster away from water while hydrophilic heads face the water, trapping dirt inside.

OR

Q.29 [3 marks]

Attempt (b): (i) Name the following compounds: (I) CH3–CO–CH3; (II) H–C≡C–H (structure shown with CH3 group / the drawn structure). (ii) Name the reaction which is commonly used in the conversion of vegetable oils to fats. (iii) Why is the melting point of C4H10 higher than C3H8? (iv) What happens when a piece of sodium is dropped into ethanol? (v) Write the products in the following reaction: CH3COOC2H5 + NaOH →.

Answer: (i) (I) CH3–CO–CH3 is propanone (acetone). (II) The compound shown is propyne (CH3–C≡CH). (ii) Hydrogenation (also called hydrogenation/catalytic hydrogenation, an addition reaction using a nickel catalyst) is used to convert vegetable oils to fats (vanaspati ghee). (iii) C4H10 (butane) has a larger molecular mass and larger size than C3H8 (propane); the larger molecule has stronger intermolecular (van der Waals) forces of attraction, so more energy is needed to melt it, giving a higher melting point. (iv) When sodium is dropped into ethanol, it reacts to form sodium ethoxide and hydrogen gas is evolved (brisk effervescence): 2Na + 2C2H5OH → 2C2H5ONa + H2. (v) CH3COOC2H5 + NaOH → CH3COONa (sodium ethanoate/sodium acetate) + C2H5OH (ethanol). This is saponification/alkaline hydrolysis of an ester.

Explanation:

(i) CH3COCH3 = propanone (acetone); the second structure is propyne (CH3–C≡CH).

(ii) Oils to fats = hydrogenation (Ni catalyst, addition of H2).

(iii) Larger C4H10 has stronger intermolecular forces than C3H8 → higher melting point.

(iv) Na + ethanol → sodium ethoxide + H2 gas.

(v) Ester + NaOH → sodium salt of acid (CH3COONa) + alcohol (C2H5OH), i.e. saponification.

Q.30 [3 marks]

The correct way to connect an ammeter and a voltmeter in an electric circuit is:

(a) Ammeter in parallel and voltmeter in series

(b) Ammeter and voltmeter both in parallel

(c) Ammeter in series and voltmeter in parallel <<

(d) Ammeter and voltmeter both in series

Explanation:

An ammeter (low resistance) measures current and is connected in series, while a voltmeter (high resistance) measures potential difference and is connected in parallel across the component.

Q.31 [3 marks]

Observe the given ray diagram showing refraction (dispersion) through a prism and choose the correct option for colour of rays 1 and 2 (ray 1 is deviated least, ray 2 is deviated most):

(a) Blue (ray 1), Red (ray 2)

(b) Green (ray 1), Yellow (ray 2)

(c) Red (ray 1), Violet (ray 2) <<

(d) Violet (ray 1), Red (ray 2)

Explanation:

In dispersion through a prism, red light bends (deviates) the least and violet light bends the most.

If ray 1 is the least-deviated ray it is red, and ray 2 the most-deviated is violet.

Correct: Red (ray 1), Violet (ray 2).

Q.32 [3 marks]

Assertion (A): The needle of a compass, kept in an external magnetic field, always aligns itself in the North-South direction of the Earth. Reason (R): The behaviour of the needle of the compass is similar to the behaviour of a freely suspended bar magnet. Select the correct answer from the codes given below.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true. <<

Explanation:

Assertion is false: when placed in an EXTERNAL magnetic field, the compass needle aligns along that external field, not necessarily along the Earth's North-South direction (it aligns N-S only in the Earth's field alone).

The Reason is true — a compass needle behaves like a freely suspended bar magnet.

So A is false, R is true.

Q.33 [3 marks]

A ray of light enters into medium B from medium A as shown in the given figure (the ray bends away from the normal NN' on entering B) : (a) Which one of these two media is optically denser than the other medium ? Justify your answer. (b) If the speed of light in medium A is VA and in medium B is VB, then what is the refractive index of medium B with respect to medium A ?

Answer: (a) Medium A is optically denser than medium B. Justification: the ray bends away from the normal on passing from A into B (angle with the normal is larger in B), which happens when light goes from a denser to a rarer medium, where its speed increases. (b) Refractive index of medium B with respect to medium A, nBA = VA / VB.

Explanation:

(a) A ray bending away from the normal on entering B means B is optically rarer and A is optically denser (light speeds up in B).

(b) nBA = speed of light in A / speed of light in B = VA/VB.

Section D

Long Answer Questions (5 marks each)

Q.34 [5 marks]

Attempt (a): What happens when light is scattered from (i) very fine particles

and (ii) very large size particles of medium? Justify your answer in each case.

Answer: (i) When light is scattered by very fine (small) particles, the scattering is stronger for shorter wavelengths, so mainly blue light (shorter wavelength) is scattered. This is why the clear sky appears blue. (ii) When light is scattered by very large particles, particles of a size comparable to or larger than the wavelength scatter all wavelengths (colours) of light almost equally, so the scattered light appears white. This is why clouds (large water droplets) appear white.

Explanation:

(i) Fine particles scatter light of shorter wavelengths (blue) more strongly (Rayleigh-type scattering) →
blue sky.
(ii) Large particles scatter all wavelengths nearly equally →
scattered light is white (e.g., white clouds).

OR

Q.34 [5 marks]

Attempt (b): With the help of a ray diagram, explain any phenomenon of formation of spectrum in nature.

Answer: Formation of a rainbow: A rainbow is a natural spectrum formed after rain, caused by dispersion of sunlight by tiny water droplets suspended in the atmosphere. The ray diagram should show a water droplet with a ray of white sunlight entering it; at the first surface the light refracts and disperses into its component colours; the dispersed light then undergoes total internal reflection at the inner (back) surface of the droplet; and finally it refracts again as it exits the droplet, separating further into the seven colours (violet to red). Because each colour bends by a slightly different angle, an observer with the Sun behind them sees a coloured arc (red on the outer edge, violet on the inner edge) — the rainbow.

Explanation:

A rainbow forms by dispersion: sunlight refracts and splits into colours on entering a water droplet, undergoes total internal reflection at the back surface, and refracts again on leaving, producing the spectrum (red outside, violet inside).

The ray diagram must show refraction–internal reflection–refraction in a droplet.

Q.0

Study the given diagram (rays from N' focussed to a point behind the retina of the eye) and answer the questions that follow : (a) Write the name of the eye defect shown in the diagram. Where is the image formed in this eye defect with respect to the retina of the eye ?

Answer: The eye defect is hypermetropia (far-sightedness). The image is formed behind the retina.

Explanation:

In the figure the rays from the near object converge at a point behind the retina, so the eye cannot see nearby objects clearly: hypermetropia (far-sightedness).

Q.0

(b) List two causes of this eye defect (hypermetropia).

Answer: Two causes of hypermetropia: (1) the focal length of the eye lens is too long (eye lens has too little converging power). (2) The eyeball has become too small (too short), so the retina is too close to the lens.

Explanation:

Hypermetropia arises from (1) a too-long focal length (low converging power) of the eye lens, or (2) a too-small eyeball;

either way the image forms behind the retina.

Q.0

(c) With the help of a diagram, show how this eye defect of vision (hypermetropia) is corrected.

Answer: Hypermetropia is corrected by using a convex (converging) lens of

suitable power. The convex lens converges the incoming rays slightly before they enter the eye, so that the eye lens can bring them to focus exactly on the retina instead of behind it. The diagram should show rays from a nearby object passing through a convex lens and then the eye lens, focussing on the retina.

Explanation:

A convex lens adds converging power, shifting the image from behind the retina onto the retina.

Diagram: rays from near object, then convex lens, then eye lens, focus on the retina.

Q.36 [5 marks]

(a) Name a device which is used to: (i) Maintain a constant potential difference in a circuit. (ii) Change the electric current in an electric circuit. (b) When the potential difference between the terminals of an electric heater is 110 V, a current of 5 A flows through it. What will be the value of current flowing through it when the potential difference is increased to 220 V?

Answer: (a)(i) A battery (or cell) is used to maintain a constant potential difference in a circuit. (a)(ii) A rheostat (variable resistance) is used to change the electric current in a circuit. (b) Resistance R = V/I = 110/5 = 22 ohm. When V = 220 V, current I = V/R = 220/22 = 10 A.

Explanation:

(a)(i) A battery/cell maintains a constant potential difference.

(a)(ii) A rheostat varies the current.

(b) By Ohm's law, R = 110 V / 5 A = 22 Ω (constant).

At 220 V, I = 220/22 = 10 A.

Section E

Case Study Based Questions (4 marks each)

Q.37 [4 marks]

Consider the given electric circuit (10 V battery; between R and S a 5 Ω resistor in parallel with the series pair 4 Ω and 1 Ω; between P and Q a 5 Ω

resistor in parallel with the series pair 2 Ω and 3 Ω; the two sections are in series with the battery) : Calculate the following : (a) Total resistance of the circuit (b) The electric current drawn from the battery (c) Potential difference between points P and Q

Answer: (a) The 4 Ω and 1 Ω resistors are in series: 4 + 1 = 5 Ω, which is in parallel with the 5 Ω between R and S: (5 × 5)/(5 + 5) = 2.5 Ω. Between P and Q, the 2 Ω and 3 Ω are in series: 5 Ω, in parallel with the 5 Ω between P and Q: 2.5 Ω. These two sections are in series with the 10 V battery, so total resistance = 2.5 + 2.5 = 5 Ω. (b) Current drawn from the battery I = V/R = 10/5 = 2 A. (c) Potential difference between P and Q = I × R(PQ) = 2 × 2.5 = 5 V.

Explanation:

Section R to S: (4 + 1) Ω in parallel with 5 Ω = 2.5 Ω.

Section P to Q: (2 + 3) Ω in parallel with 5 Ω = 2.5 Ω.

Series total = 5 Ω.

I = 10/5 = 2 A.

V(PQ) = 2 × 2.5 = 5 V.

Q.38 [4 marks]

The variation of image distance (v) with the object distance (u) for a convex lens is given in the observation table: S.No 1: u = -150, v = +30; 2: u = -75, v = +37.5; 3: u = -50, v = +50; 4: u = -37.5, v = +75; 5: u = -30, v = +150; 6: u = -15, v = +37.5 (all in cm). Analyse it and answer: (a) Without calculation, find out the focal length of the given convex lens. Justify your answer. (b) Which one of the observations given in the table is not correct and why? (c)(i) Find out the value of magnification for u = -30 cm. Write the nature of the image formed. Give reason for your answer.

Answer: (a) Focal length f = 25 cm. Justification: For observation 3, u = -50 cm gives v = +50 cm, i.e. object distance = image distance = 2f. Since 2f = 50 cm, f = 25 cm. (b) Observation 6 (u = -15 cm, v = +37.5 cm) is not correct. Reason: for a convex lens, when the object is placed between the lens and the focus (|u| = 15

cm is less than f = 25 cm), a virtual, erect image is formed on the same side as the object, so v should be negative (and no real image is formed on the far side). A positive real image distance of +37.5 cm is therefore impossible for u = -15 cm. (c)(i) For u = -30 cm, v = +150 cm. Magnification m = v/u = (+150)/(-30) = -5. The image is real and inverted (negative magnification) and magnified (|m| = 5 > 1, enlarged), formed on the opposite side of the lens.

Explanation:

(a) At u = -50, v = +50 the object and image are both at 2f, so 2f = 50 → f = 25 cm.
(b) With f = 25 cm, an object at 15 cm (inside the focus) gives a virtual erect image (v negative), so observation 6's +37.5 cm real image is impossible.
(c)(i) m = v/u = 150/(-30) = -5; negative sign →
real and inverted; |m| = 5 > 1 →
enlarged image.

Q.0

(c)(ii) [Alternative to Q38(c)(i)] Analyse the data given in the table above and draw the labelled ray diagram for u = -30 cm and v = 150 cm.

Answer: For a convex lens with focal length f = 25 cm, the object is at u = -30 cm, which lies between f (25 cm) and 2f (50 cm). The ray diagram should show: the object placed between F and 2F on one side; two rays from the top of the object — one parallel to the principal axis that refracts through the focus F on the other side, and one passing through the optical centre going straight — meeting on the far side at v = +150 cm (beyond 2F). The image formed is real, inverted and enlarged (magnified), formed beyond 2F on the opposite side of the lens. Label the object, image, lens, principal axis, F and 2F on both sides.

Explanation:

With f = 25 cm, object at 30 cm lies between F and 2F, so the image (v = 150 cm, beyond 2F) is real, inverted, and enlarged.
The labelled ray diagram uses the parallel ray (refracts through F) and the ray through the optical centre to locate the image.

Q.39 [4 marks]

Attempt (a): (i) What is a solenoid? Draw a diagram showing the magnetic field pattern due to a current-carrying solenoid (inside and outside). (ii) Name any two factors on which the magnitude of the magnetic field due to a current-carrying solenoid depends. (iii) A current-carrying solenoid is stretched and converted into a straight wire carrying current. Draw a diagram showing the magnetic field pattern around it and mark the direction of the magnetic field.

Answer: (i) A solenoid is a coil of many circular turns of insulated copper wire wound closely in the shape of a cylinder. Diagram: the magnetic field inside the solenoid is uniform and consists of straight, parallel field lines (like that of a bar magnet), while outside the field lines curve from the north pole (one end) round to the south pole (other end); one end acts as a north pole and the other as a south pole. (ii) The magnitude of the magnetic field of a current-carrying solenoid depends on: (1) the strength of the current flowing through it (more current → stronger field); and (2) the number of turns per unit length of the solenoid (more turns → stronger field). [It also depends on the nature of the core material.] (iii) When the solenoid is stretched into a straight current-carrying wire, the magnetic field around it consists of concentric circles in planes perpendicular to the wire; the direction of the field is given by the right-hand thumb rule / Maxwell's corkscrew rule (thumb points along the current, curled fingers give the field direction). The diagram should show the straight wire with concentric circular field lines around it, direction marked (e.g., anticlockwise when current flows towards the observer).

Explanation:

(i) A solenoid is a cylindrical coil of many turns;
its field is uniform inside (like a bar magnet) with defined N and S poles.
(ii) Field strength depends on the current and the number of turns per unit length (and core).
(iii) A straight current-carrying wire produces concentric circular field lines;
direction from the right-hand thumb rule.

OR

Q.39 [4 marks]

Attempt (b): (i) With the help of a diagram, show that a current-carrying conductor placed in an external magnetic field, experiences a force. Indicate the direction of the field, current and force clearly. (ii) The diagram given below shows an electron moving in a uniform magnetic field. (I) What will be the direction of the force acting on the electron? (II) What will happen to the direction of the force acting on the electron, if the direction of the magnetic field as well as the direction of motion of the electron, both are reversed?

Answer: (i) When a current-carrying conductor is placed in an external magnetic field, it experiences a force. The diagram should show a straight conductor carrying current placed between the poles (N and S) of a magnet; using Fleming's left-hand rule (forefinger = magnetic field, second finger = current, thumb = force), the conductor is pushed in a direction perpendicular to both the field and the current. The force is maximum when the current is perpendicular to the magnetic field. (ii)(I) The direction of the force on the electron is found using Fleming's left-hand rule, taking the conventional current in the direction OPPOSITE to the electron's motion (since the electron is negatively charged); the force acts perpendicular to both the field and the electron's velocity. In the figure the electron moves upward and the field points to the left; the equivalent conventional current is downward, so by Fleming's left-hand rule the force on the electron is perpendicular to the plane of the paper, directed into the page. (ii)(II) If BOTH the direction of the magnetic field and the direction of motion of the electron are reversed, the direction of the force acting on the electron remains UNCHANGED (the two reversals cancel each other, so the force direction stays the same).

Explanation:

(i) A current-carrying conductor in a magnetic field experiences a force given by Fleming's left-hand rule, perpendicular to both field and current (maximum when they are perpendicular).

(ii)(I) Force direction is from Fleming's left-hand rule, using conventional current

opposite to electron motion.

(ii)(II) Reversing both the field and the velocity reverses the force twice, so the net force direction is unchanged.

In the figure the force on the electron is into the plane of the paper.