CBSE 2025 Science — 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]

Consider the following chemical equation:

$pAl + qH_2O \rightarrow rAl_2O_3 + sH_2$

To balance this chemical equation, the values of p, q, r and s must be respectively:

(a) 3, 2, 2, 1

(b) 2, 3, 3, 1

(c) 2, 3, 1, 3 <<

(d) 3, 1, 2, 2

Explanation:

The balanced equation is $2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$. So p=2, q=3, r=1, s=3.

Q.2 [1 mark]

Which of the given option represents a family of salts?

(a) NaCl, Na_2SO_4, $CaSO_4$

(b) K_2SO_4, Na_2SO_4, $CaSO_4$ <<

(c) $NaNO_3$, $CaCO_3$, Na_2CO_3

(d) $MgSO_4$, $CuSO_4$, $MgCl_2$

Explanation:

K_2SO_4, Na_2SO_4 and $CaSO_4$ all contain the same anion (SO_4^{2-}), so they are a family of salts (sulphates).

Q.3 [1 mark]

The most common method of extraction of metals from their oxide ores is:

(a) Reduction with carbon <<

(b) Reduction with hydrogen

(c) Reduction with aluminium

(d) Electrolytic reduction

Explanation:

The most common method of extraction of metals from their oxide ores is reduction with carbon (coke).

This is used for metals of moderate reactivity like iron, zinc, etc.

Q.4 [1 mark]

Given below are the structures of some hydrocarbons. Select the two structures which are related to each other from the given options:

(i) $CH_3–CH_2–CH=CH_2$ (H–C–C–C=C–H, each carbon completed with H; C_4H_8)

(ii) $CH_3–CH_2–CH_2–CH_3$ (straight chain, C_4H_{10})

(iii) $(CH_3)_3CH$ (a central carbon bonded to three CH_3 groups, C_4H_{10})

(iv) $Cl–CH_2–CH_2–CH=CH_2$ (chlorine-substituted form of (i))

(a) (i) and (iv)

(b) (ii) and (iv)

(c) (ii) and (iii) <<

(d) (i) and (iii)

Explanation:

Structures (ii) and (iii) are both C_4H_{10} with different carbon skeletons (butane and 2-methylpropane), so they are structural isomers: option (C).

Note: this answer could not be confirmed against an official CBSE marking scheme.

Q.5 [1 mark]

Choose the incorrect statement about the common reaction used in hydrogenation of vegetable oils.

(a) It is an addition reaction.

(b) It takes place in the presence of nickel or palladium catalyst.

(c) The product contains only single bonds between carbon atoms.

(d) It is an addition reaction which occurs in the presence of an acid catalyst. <<

Explanation:

Hydrogenation of vegetable oils uses nickel or palladium as catalyst, not an acid catalyst.

It is an addition reaction where hydrogen is added across the double bonds, converting unsaturated fats to saturated fats with single bonds only.

Q.6 [1 mark]

Match Column-I with Column-II and select the correct option:

Column-I:

a. Site of fertilisation of egg with the sperm

b. Site of implantation of embryo

c. Site of entry of sperm into the female reproductive tract

d. Site through which the waste materials generated by the developing embryo are removed

Column-II:

(i) Vagina

(ii) Uterus

(iii) Oviduct

(iv) Placenta

(v) Cervix

(a) a-(ii), b-(i), c-(v), d-(iv)

(b) a-(iii), b-(i), c-(v), d-(iv)

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

(d) a-(iii), b-(ii), c-(i), d-(iv) <<

Explanation:

a.

Fertilisation occurs in the oviduct (iii).

b.

Embryo implants in the uterus (ii).

c.

Sperm enters through the vagina (i).

d.

Waste materials are removed through the placenta (iv).

Q.7 [1 mark]

The part of the brain that maintains the posture and balance of the body is:

(a) Pons

(b) Cerebrum

(c) Cerebellum <<

(d) Medulla

Explanation:

The cerebellum is responsible for maintaining posture, balance, and coordination of voluntary movements.

Q.8 [1 mark]

The plant hormone present in greater concentration in the areas of rapidly dividing cells is:

(a) Auxin

(b) Cytokinins <<

(c) Gibberelline

(d) Abscisic acid

Explanation:

Cytokinins are present in greater concentration in areas of rapid cell division.

They promote cell division (cytokinesis) and are found abundantly in regions like root tips, developing fruits, and seeds.

Q.9 [1 mark]

Select a pair of bisexual flowers from the following:

(a) Papaya and mustard

(b) Hibiscus and mustard <<

(c) Hibiscus and papaya

(d) Hibiscus and watermelon

Explanation:

Hibiscus and mustard are both bisexual flowers (containing both male and female reproductive organs).

Papaya and watermelon are unisexual flowers.

Q.10 [1 mark]

The gastric glands present in the wall of the stomach release:

(a) Mucus and Trypsin

(b) Pepsin and Trypsin

(c) Mucus and Pepsin <<

(d) Pepsin and Salivary amylase

Explanation:

The gastric glands in the stomach wall secrete mucus, pepsin (a protein-digesting enzyme), and hydrochloric acid.

Trypsin is secreted by the pancreas, and salivary amylase is secreted by salivary glands.

Q.11 [1 mark]

Absolute refractive index of water and glass is 4/3 and 3/2 respectively. If the speed of light in glass is 2×10^8 m/s, the speed of light in water is:

(a) 9/4 m/s <<

(b) 7/3 m/s

(c) 16/9 m/s

(d) 9/8 m/s

Explanation:

Speed of light in vacuum c = n_glass × v_glass = (3/2) × 2 × 10^8 = 3 × 10^8 m/s.

Speed in water = c / n_water = 3 × 10^8 / (4/3) = (9/4) × 10^8 m/s, which is option (A) (the paper prints 9/4 m/s without the 10^8 factor).

Q.12 [1 mark]

When a beam of white light passes through a region of very fine dust particles, the colour of light that scatters the most in that region is:

(a) red
(b) orange
(c) blue <<
(d) yellow

Explanation:
Blue light scatters the most because scattering is inversely proportional to the fourth power of wavelength (Rayleigh scattering).
Blue light has a shorter wavelength compared to red, orange, and yellow.

Q.13 [1 mark]

A wire of length 'l' is gradually stretched so that its length increases to 3l. If its original resistance is R, then its new resistance will be:

(a) 3R
(b) 6R
(c) 9R <<
(d) 27R

Explanation:
When a wire is stretched, its volume remains constant.
If length becomes 3l, area becomes A/3.
New resistance = $\rho(3l)/(A/3) = 9\rho l/A = 9R$.

Q.14 [1 mark]

Which one of the following statements is not true about a bar magnet?

(a) It sets itself in north-south direction when suspended freely.
(b) It has attractive power for iron filings.
(c) It produces magnetic field lines.
(d) The direction of magnetic field lines inside a bar magnet is from its north pole to its south pole. <<

Explanation:

Inside a bar magnet, the direction of magnetic field lines is from the south pole to the north pole (not north to south).

Outside the magnet, field lines go from north to south.

Q.15 [1 mark]

The strength of magnetic field produced inside a long straight current carrying solenoid does not depend upon:

(a) number of turns in the solenoid

(b) direction of current flowing through the solenoid

(c) material of the core filled inside the solenoid

(d) radius of the coil of the solenoid <<

Explanation:

The magnetic field inside a solenoid $B = \mu_0 nI$ depends on the number of turns per unit length (n), current (I), and the permeability of the core material (μ).

It does not depend on the radius of the coil.

Q.16 [1 mark]

Other than the abiotic components, which of the given biotic components are not required to make an aquarium with small herbivorous fishes a self-sustaining system?

(i) Aquatic plants and aquatic animals

(ii) Terrestrial plants and terrestrial animals

(iii) Decomposers as bacteria and fungi

(iv) Consumers as clown fishes and sea urchins

(a) (i) and (iv)

(b) (ii) and (iii)

(c) (i) and (iii)

(d) (ii) and (iv) <<

Explanation:

Terrestrial plants and terrestrial animals (ii) are not needed in an aquarium ecosystem.

Consumers like clown fishes and sea urchins (iv) are also not required for a self-sustaining system with small herbivorous fishes.

The system needs aquatic plants (producers), the herbivorous fish (consumers), and decomposers.

Q.17 [1 mark]

For Questions 17 to 20, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer from the codes (A), (B), (C) and (D).

Assertion (A): Hydrogen gas is not evolved when a metal reacts with nitric acid.

Reason (R): Nitric acid is a strong reducing agent and reduces the hydrogen produced in the reaction to water.

(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 true - hydrogen gas is not evolved when metals react with nitric acid because HNO_3 is a strong oxidising agent (not reducing agent).

It oxidises H_2 to water.

The Reason is false because it incorrectly calls nitric acid a 'reducing' agent instead of 'oxidising' agent.

Q.18 [1 mark]

Assertion (A): In our actions of writing or talking, our nervous system communicates with the muscles.

Reason (R): Cranial nerves and spinal nerves form the peripheral nervous system.

(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.

The nervous system does communicate with muscles for actions like writing and talking.

Cranial and spinal nerves do form the peripheral nervous system.

However, R does not directly explain A - the explanation would involve how motor neurons carry signals to muscles.

Q.19 [1 mark]

Assertion (A): Magnetic field lines around a bar magnet never intersect each other.

Reason (R): Magnetic field produced by a bar magnet is a quantity that has both magnitude and direction.

(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 are true.

Magnetic field lines never intersect because at any point, the magnetic field has a unique direction.

If they intersected, it would imply two different directions at one point, which is impossible.
R correctly explains A - because the field is a vector quantity with unique direction at each point, the lines cannot cross.

Q.20 [1 mark]

Assertion (A): Use of jute bags for shopping reduces pollution.
Reason (R): Jute is biodegradable and its bag may be reused as and when required.

(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 are true and R correctly explains A.
Jute bags reduce pollution because jute is biodegradable (decomposes naturally) and the bags can be reused, reducing waste compared to plastic bags.

Section B

Very Short Answer Questions (2 marks each)

Q.21 [2 marks]

(a) List the possible sources of energy required in decomposition reactions. Illustrate any one with a suitable example.

OR

(b) What is observed when hydrated ferrous sulphate crystals are heated in a dry boiling tube? Give balanced chemical equation(s) of the reaction(s) that occur(s).

Answer: (a) Sources of energy for decomposition: (1) Heat (thermal decomposition) e.g., $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$, (2) Electricity (electrolytic decomposition) e.g., $2H_2O \rightarrow 2H_2 + O_2$, (3) Sunlight (photolytic decomposition) e.g., $2AgCl \rightarrow 2Ag + Cl_2$.

OR

(b) Green colour of $FeSO_4 \cdot 7H_2O$ changes, crystals lose water and become white anhydrous $FeSO_4$, then decompose releasing SO_2, SO_3 gases and leaving behind Fe_2O_3 (reddish-brown). Equation: $2FeSO_4 \rightarrow Fe_2O_3 + SO_2 + SO_3$.

Explanation:

Decomposition reactions require energy input in the form of heat, electricity, or sunlight.

The OR part involves thermal decomposition of ferrous sulphate.

OR

Q.21 [2 marks]

(OR for Q21) What is observed when hydrated ferrous sulphate crystals are heated in a dry boiling tube? Give balanced chemical equation(s) of the reaction(s) that occur(s).

Answer: Green coloured $FeSO_4 \cdot 7H_2O$ crystals turn white (lose water of crystallisation) and then decompose to give reddish-brown Fe_2O_3, SO_2 and SO_3 gases. Equations: $FeSO_4 \cdot 7H_2O \rightarrow$(heat) $FeSO_4 + 7H_2O$; $2FeSO_4 \rightarrow$(heat) $Fe_2O_3 + SO_2 + SO_3$.

Explanation:

On heating, hydrated ferrous sulphate first loses water of crystallisation (turns from green to white), then decomposes to form ferric oxide, sulphur dioxide and sulphur trioxide.

Q.22 [2 marks]

(a) Write the formula of the ions which (i) acids, and (ii) bases generate in

water solutions.

(b) Dry HCl gas does not change the colour of dry litmus paper. Why?

Answer: (a) (i) Acids generate hydrogen ions H^+ (or H_3O^+, hydronium ions) in water solution. (ii) Bases generate hydroxide ions OH^- in water solution.

(b) Dry HCl gas does not change the colour of dry litmus paper because HCl can produce H^+ ions only in the presence of water. Without water, no ions are formed and hence no acidic behaviour is shown.

Explanation:

Acids produce $H^+(aq)$ ions and bases produce $OH^-(aq)$ ions in water.

Dry HCl cannot ionize without water, so it shows no acidic property.

Q.23 [2 marks]

State the main functions of veins in human circulatory system. Why do they not need thick walls?

Answer: Veins carry deoxygenated blood from body organs back to the heart (except pulmonary veins which carry oxygenated blood). They do not need thick walls because blood flows through veins at low pressure (unlike arteries where blood is under high pressure from the heart's pumping action). Veins also have valves to prevent backflow of blood.

Explanation:

Veins carry blood towards the heart at low pressure, so they have thin walls.

They have valves to ensure unidirectional flow.

Q.24 [2 marks]

(a) Explain how the proteins control the 'characteristics' in an organism with the help of an example of 'tallness' trait in pea plant.

(b) Name the section of DNA that controls the 'characteristics' in an organism.

Answer: (a) Genes (segments of DNA) code for proteins (enzymes). These proteins/enzymes control specific biochemical processes that determine traits. For

example, in pea plants, a gene produces a specific enzyme that leads to the synthesis of plant growth hormone. If the gene is efficient, more hormone is produced, leading to tall plants. If the gene is less efficient, less hormone is produced, leading to dwarf/short plants.

(b) The section of DNA that controls characteristics is called a 'gene'.

Explanation:

Genes code for proteins which act as enzymes controlling biochemical pathways.

The efficiency of these enzymes determines the expression of traits like tallness in pea plants.

Q.25 [2 marks]

(a) A student has difficulty in reading his textbooks but can read the blackboard clearly while sitting in the last row. Name the defect of vision the student is suffering from. List two reasons due to which this defect arises. Write the nature of the lenses required to correct this defect.

OR

(b) Draw a ray diagram to show the path of a ray of light falling obliquely on one of the refracting faces of a triangular glass prism and mark the angle of deviation on it.

Answer: (a) The student is suffering from hypermetropia (far-sightedness/long-sightedness). Reasons: (1) The focal length of the eye lens is too long. (2) The eyeball has become too short. Correction: Convex lens (converging lens) of suitable power is needed.

OR

(b) The ray diagram should show: incident ray hitting one face of the prism, refraction at entry (bending towards normal), travelling through the prism,

refraction at exit (bending away from normal), and the angle of deviation marked between the direction of the incident ray and the emergent ray.

Explanation:

The student can see distant objects (blackboard) clearly but not nearby objects (textbook), indicating hypermetropia.

It is corrected using convex lenses.

OR

Q.25 [2 marks]

(OR for Q25) Draw a ray diagram to show the path of a ray of light falling obliquely on one of the refracting faces of a triangular glass prism and mark the angle of deviation on it.

Answer: Ray diagram: incident ray bends towards the normal on entering the prism, bends away from the normal on emerging (towards the base); angle of deviation ∠D is marked between the incident ray produced forward and the emergent ray produced backward.

Explanation:

Steps for the diagram: (1) Draw a triangular glass prism ABC.

(2) Draw a ray PE falling obliquely on face AB and draw the normal at E.

(3) Inside the prism the refracted ray EF bends towards the normal (rarer → denser).

(4) At face AC draw the normal at F; the emergent ray FS bends away from the normal (denser →

rarer), so the ray deviates towards the base BC.

(5) Extend the incident ray PE forward and the emergent ray FS backward;

the angle between them is the angle of deviation ∠D.

Q.26 [2 marks]

An electric kettle is rated 230 V, 1000 W. Calculate the resistance of its heating element when in operation.

Answer: $R = V^2/P = (230)^2/1000 = 52900/1000 = 52.9\ \Omega$

Explanation:

Using the formula $P = V^2/R$, we get $R = V^2/P = (230)^2/1000 = 52900/1000 = 52.9\ \Omega$.

Section C

Short Answer Questions (3 marks each)

Q.27 [3 marks]

(a) What is a reactivity series of elements? How is it developed? Arrange the following elements as they are arranged in the reactivity series: Aluminium, Calcium, Copper, Lead.

(b) Write balanced chemical equation to show the reaction of iron (III) oxide (Fe_2O_3) with aluminium.

Answer: (a) A reactivity series is a list of metals arranged in the order of their decreasing reactivity. It is developed by studying the reactions of metals with water, acids, and displacement reactions with other metal salt solutions. Arrangement in decreasing reactivity: Calcium > Aluminium > Lead > Copper.

(b) $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$ (Thermite reaction)

Explanation:

The reactivity series arranges metals in decreasing order of reactivity.

Ca is most reactive, followed by Al, then Pb, then Cu.

The thermite reaction involves aluminium reducing iron oxide.

Q.28 [3 marks]

(a) Common salt is an important raw material for various chemicals of daily use. State in brief the method of preparation of (i) Sodium hydroxide, and (ii) Sodium hydrogen carbonate from common salt. Write balanced chemical equations of the reactions that occur.

OR

(b) Design an experimental set-up to demonstrate that 'Alcohol and glucose

contain hydrogen but are not categorised as acids'. Also give the reason to justify this fact.

Answer: (a) (i) Sodium hydroxide: By electrolysis of brine (concentrated NaCl solution). $2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$ (Chlor-alkali process).

(ii) Sodium hydrogen carbonate: By Solvay process - passing CO_2 through ammoniacal brine. $NaCl + H_2O + CO_2 + NH_3 \rightarrow NaHCO_3 + NH_4Cl$.

OR

(b) Set up a circuit with a battery, bulb, and two electrodes dipped in alcohol/glucose solution. The bulb does not glow, showing these solutions do not conduct electricity. Reason: Although alcohol and glucose contain hydrogen, they do not ionize in water to produce H^+ ions, hence they are not categorised as acids.

Explanation:

NaOH is prepared by chlor-alkali process (electrolysis of brine).

$NaHCO_3$ is prepared by passing CO_2 through ammoniacal brine.

OR

Q.28 [3 marks]

(OR for Q28) Design an experimental set-up to demonstrate that 'Alcohol and glucose contain hydrogen but are not categorised as acids'. Also give the reason to justify this fact.

Answer: Set up a circuit with a 6V battery, a bulb, and two nails (electrodes) dipped in solutions of alcohol and glucose separately. When current is passed, the bulb does not glow in either case. This shows that alcohol and glucose solutions do not conduct electricity, meaning they do not produce H^+ ions in solution. Reason: Although they contain hydrogen in their molecules, this hydrogen is not ionisable - it is bonded covalently and does not separate as $H^+(aq)$ ions in water. Only substances that produce H^+ ions in aqueous solution are classified as acids.

Explanation:

Acids must produce H^+ ions in aqueous solution.

Alcohol and glucose have hydrogen but it is covalently bonded and does not ionize in water.

Q.29 [3 marks]

On the basis of the characteristics of the processes given in the brackets in each case, differentiate between the following:

(a) Production or breakdown of pyruvate in aerobic and anaerobic respiration in human beings (product(s) of the processes)

(b) Respiration and photosynthesis in plants (gas released)

(c) Respiration in terrestrial animals and fishes (organs involved)

Answer: (a) Aerobic respiration: Pyruvate is broken down into CO_2 + H_2O + energy (in mitochondria with O_2). Anaerobic respiration in humans: Pyruvate is converted to lactic acid + energy (without O_2, in cytoplasm).

(b) Respiration releases CO_2. Photosynthesis releases O_2.

(c) Terrestrial animals respire using lungs. Fishes respire using gills.

Explanation:

Aerobic respiration produces CO_2 and water;

anaerobic respiration in humans produces lactic acid.

Respiration releases CO_2 while photosynthesis releases O_2.

Terrestrial animals use lungs while fishes use gills.

Q.30 [3 marks]

A pure pea plant having round (R), yellow (Y) seeds is crossed with another pure pea plant having wrinkled (r), green (y) seeds. Subsequently F_1 progeny is self-pollinated to obtain F_2 progeny.

(a) What do the seeds of F_1 generation look like?

(b) Give the possible combinations of traits in seeds of F_2 generation. Also give their ratio.

(c) State the reason of obtaining seeds of new combination of traits in F_2

generation.

Answer: (a) All F_1 seeds will be Round and Yellow (RrYy) as round is dominant over wrinkled and yellow is dominant over green.

(b) F_2 combinations: Round Yellow : Round Green : Wrinkled Yellow : Wrinkled Green in the ratio 9:3:3:1.

(c) New combinations (Round Green and Wrinkled Yellow) appear in F_2 because the genes for seed shape and seed colour are inherited independently of each other (Law of Independent Assortment). During gamete formation, the alleles of different genes segregate independently, producing new combinations.

Explanation:

This is a dihybrid cross.

F_1 is all RrYy (Round Yellow).

F_2 shows 9:3:3:1 ratio due to independent assortment of genes.

Q.31 [3 marks]

What is a rainbow? Draw a labelled diagram to show its formation.

Answer: A rainbow is a natural spectrum of sunlight in the sky, appearing as a band of colours (VIBGYOR) formed due to dispersion of white sunlight by tiny water droplets suspended in the atmosphere after rain. The diagram should show: sunlight entering a water droplet, undergoing refraction at entry, internal reflection at the back surface, and refraction again at exit, with the dispersed colours (violet to red) emerging at different angles.

Explanation:

A rainbow is formed by dispersion, refraction and internal reflection of sunlight by water droplets in the atmosphere.

It shows the spectrum VIBGYOR.

Q.32 [3 marks]

Consider a rectangular cardboard having two holes P and Q through which a current carrying circular loop has been inserted as shown in the diagram.

(a) Make this diagram on your answer sheet and draw three magnetic field lines, one each passing through the points 1 (near P), 2 (at the centre of the loop) and 3 (near Q).

(b) List two factors on which the intensity of the magnetic field produced at the centre of the loop depends.

(c) Name the rule you will apply to determine the direction of magnetic field produced due to a current carrying straight conductor.

Answer: (a) The diagram should show concentric circular field lines around the wire near points 1 and 3 (near the holes P and Q). At point 2 (centre of the loop), the field line should be a straight line perpendicular to the plane of the loop.

(b) Two factors: (1) The magnitude of current flowing through the loop. (2) The radius of the circular loop (field is inversely proportional to radius).

(c) Right-hand thumb rule (Maxwell's corkscrew rule): If you curl the fingers of the right hand in the direction of current flow, the thumb points in the direction of the magnetic field.

Explanation:

Magnetic field lines around a current-carrying circular loop are concentric circles near the wire and straight at the centre.

The field depends on current and radius.

Direction is determined by the right-hand thumb rule.

Q.33 [3 marks]

(a) "In a food chain energy flow is unidirectional." Give two reasons for the given statement.

(b) If 10,000 J energy is available at the producer level, how much energy will be available to the secondary consumers? Give reason to justify your answer.

Answer: (a) Two reasons why energy flow is unidirectional: (1) Energy captured by autotrophs (producers) does not revert back to the sun. (2) Energy transferred to herbivores does not go back to autotrophs. At each trophic level, a large

fraction of energy is lost as heat during metabolic activities and only 10% is transferred to the next level. Energy flows only in one direction: producers → primary consumers → secondary consumers → tertiary consumers.

(b) At producer level = 10,000 J. Primary consumers get 10% = 1,000 J. Secondary consumers get 10% of 1,000 = 100 J. This is based on the 10% law - only 10% of energy is transferred from one trophic level to the next.

Explanation:

Energy flow is unidirectional because energy is lost as heat at each trophic level and cannot be recycled.

By the 10% law, secondary consumers receive 100 J from 10,000 J at producer level.

Section D

Long Answer Questions (5 marks each)

Q.34 [5 marks]

(a) (i) Consider the following metals: K, Ca, Al, Cu, Ag, Fe. Select from the above metals, a metal which:

I. does not react with oxygen even at high temperature.

II. reacts at ordinary temperature and forms a protective oxide layer which prevents the metal from further oxidation.

III. catches fire when kept in the open.

IV. does not burn in oxygen but the hot metal is coated with a black coloured oxide layer.

(ii) What are amphoteric oxides? With the help of balanced chemical equations show that aluminium oxide is an amphoteric oxide.

(iii) What are alkalis? Give one example.

OR

(b) (i) With the help of balanced chemical equations state the process of extracting (I) mercury from its ore called cinnabar, and (II) copper from its

sulphide ore.

(ii) Silver and copper articles slowly lose their shiny surfaces when exposed to air. Name the compounds formed on (I) silver articles, and (II) copper articles in the form of coating.

Answer: (a) (i) I. Ag (Silver) - does not react with oxygen. II. Al (Aluminium) - forms protective Al_2O_3 layer. III. K (Potassium) - catches fire in open. IV. Cu (Copper) - forms black CuO layer when heated.

(ii) Amphoteric oxides react with both acids and bases. $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$; $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$.

(iii) Alkalis are bases that are soluble in water. Example: NaOH (sodium hydroxide).

OR

(b) (i) I. Mercury from cinnabar: $2HgS + 3O_2 \rightarrow 2HgO + 2SO_2$, then $2HgO \rightarrow 2Hg + O_2$. II. Copper from sulphide ore: $2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$, then $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$.

(ii) I. Silver articles: Silver sulphide (Ag_2S) - black coating. II. Copper articles: Copper carbonate/basic copper carbonate ($CuCO_3 \cdot Cu(OH)_2$) - green coating.

Explanation:

This question tests knowledge of reactivity of metals with oxygen, amphoteric oxides, alkalis, extraction of metals, and corrosion/tarnishing.

OR

Q.34 [5 marks]

(OR for Q34) (b) (i) With the help of balanced chemical equations state the process of extracting (I) mercury from its ore called cinnabar, and (II) copper from its sulphide ore.

(ii) Silver and copper articles slowly lose their shiny surfaces when exposed to air. Name the compounds formed on (I) silver articles, and (II) copper

articles in the form of coating.

Answer: (i) I. Mercury from cinnabar (HgS): First, roasting: $2HgS + 3O_2 \rightarrow 2HgO + 2SO_2$. Then reduction: $2HgO \rightarrow^{(heat)} 2Hg + O_2$.

II. Copper from Cu_2S: $2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$; then $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$.

(ii) I. Silver articles get coated with black silver sulphide (Ag_2S). II. Copper articles get coated with green basic copper carbonate ($CuCO_3 \cdot Cu(OH)_2$).

Explanation:

Mercury is extracted by roasting cinnabar then thermal decomposition of HgO.

Copper is extracted from Cu_2S by roasting and self-reduction.

Silver tarnishes to Ag_2S; copper forms green basic copper carbonate.

Q.35 [5 marks]

(a) (i) Identify the parts 'X' and 'Y' in the figure of a flower given below (showing petals, sepals, and reproductive parts marked X and Y).

(ii) Name the yellowish coloured structures produced by the part labelled as 'Y'.

(iii) Write the name of the process by which these are transferred to the part labelled as 'X'.

(iv) Explain the process of seed formation in a flowering plant.

OR

(b) (i) Name the type of asexual mode of reproduction shown in the given figure (showing organisms like Hydra with buds).

(ii) Identify the unicellular organism in the diagram.

(iii) List any two advantages of asexual reproduction over sexual reproduction.

(iv) Name and explain any one mode of asexual reproduction observed in Hydra.

Answer: (a) (i) X = Stigma, Y = Anther.

(ii) Pollen grains.

(iii) Pollination.

(iv) Seed formation: After pollination the pollen grain germinates on the stigma and grows a pollen tube through the style to the ovule. The male gamete fuses with the egg cell in the ovule (fertilisation) to form the zygote, which divides repeatedly to form the embryo. The ovule develops into the seed and the ovary into the fruit.

OR

(b) (i) Binary fission (longitudinal), as shown in the stages (a) to (f) of a flagellated cell dividing lengthwise.

(ii) Euglena (the flagellated single-celled organism with an eye-spot shown in every stage).

(iii) Advantages: (1) only one parent is needed; (2) rapid multiplication of many individuals; offspring are genetically identical to the parent.

(iv) Budding in Hydra: a bud grows as an outgrowth by repeated cell division at one site on the body, develops tentacles and mouth, and when mature detaches to live as a new independent Hydra. (Regeneration is the other mode seen in Hydra.)

Explanation:

Part (b): the figure shows a flagellated single-celled organism dividing lengthwise in stages (a)-(f), i.e.

binary fission in Euglena (not budding, not yeast).

OR

Q.35 [5 marks]

(OR for Q35) (b) (i) Name the type of asexual mode of reproduction shown in the given figure.

(ii) Identify the unicellular organism in the diagram.

(iii) List any two advantages of asexual reproduction over sexual reproduction.

(iv) Name and explain any one mode of asexual reproduction observed in Hydra.

Answer: (i) Binary fission (longitudinal), as shown in stages (a) to (f) of a flagellated cell dividing lengthwise.

(ii) Euglena.

(iii) Advantages: (1) only one parent is needed; (2) rapid multiplication; offspring are genetically identical to the parent.

(iv) Budding in Hydra: a bud grows as an outgrowth by repeated cell division at one site, develops tentacles and mouth, and when mature detaches from the parent to live as a new independent individual.

Explanation:

Part (b): the figure shows a flagellated single-celled organism dividing lengthwise in stages (a)-(f), i.e.

binary fission in Euglena (not budding, not yeast).

Q.36 [5 marks]

(a) (i) 'In refraction of light through a rectangular glass slab, the emergent ray is always parallel to the direction of the incident ray.' Why? Explain with the help of a ray diagram. What happens when a ray of light falls normally on one of the faces of a rectangular glass prism? Draw diagram.

(ii) An object is placed at a distance of 30 cm from the optical centre of a concave lens of focal length 20 cm. Use Lens formula to determine the position of the image formed in this case.

OR

(b) (i) A student wishes to study the image formation by a concave mirror using candle flame as object. State the type of image formed by the mirror

and mention the change in the image formed, if any, that he observes when the candle flame is gradually moved away from the pole of the mirror. Draw a ray diagram to show the image formation when the object distance is nearly equal to the radius of curvature of the mirror.

(ii) A convex mirror used for rear-view on an automobile has a focal length of 3.0 m. If a bus is located at 6.0 m from this mirror, use mirror formula to find the position of the image of the bus as seen in the mirror.

Answer: (a) (i) In a rectangular glass slab, the two refracting surfaces are parallel. The emergent ray is parallel to the incident ray because the refraction at the second surface exactly reverses the bending that occurred at the first surface (the angle of emergence equals the angle of incidence). When light falls normally, it passes through without any deviation.

(ii) Using lens formula: $1/v - 1/u = 1/f$. Here $u = -30$ cm, $f = -20$ cm (concave lens). $1/v = 1/f + 1/u = 1/(-20) + 1/(-30) = -3/60 - 2/60 = -5/60 = -1/12$. So $v = -12$ cm. The image is formed 12 cm from the lens on the same side as the object.

OR

(b) (i) When candle is close (within f), image is virtual, erect, magnified. As candle moves away: at C, image is real, inverted, same size at C. Beyond C, image is real, inverted, diminished. Ray diagram at C should show object at C, with rays converging to form image at C (same size, inverted).

(ii) Using mirror formula: $1/v + 1/u = 1/f$. Here $u = -6.0$ m, $f = +3.0$ m (convex mirror). $1/v = 1/f - 1/u = 1/3 - 1/(-6) = 1/3 + 1/6 = 3/6 = 1/2$. So $v = +2.0$ m. Image is formed 2.0 m behind the mirror (virtual, erect, diminished).

Explanation:

For the glass slab, parallel surfaces cause the emergent ray to be parallel to the incident ray.

The lens formula gives image position for concave lens.

For the OR part, mirror formula is applied for concave and convex mirrors.

OR

Q.36 [5 marks]

(OR for Q36) (b) (i) A student wishes to study the image formation by a concave mirror using candle flame as object. State the type of image formed by the mirror and mention the change in the image formed, if any, that he observes when the candle flame is gradually moved away from the pole of the mirror. Draw a ray diagram to show the image formation when the object distance is nearly equal to the radius of curvature of the mirror.

(ii) A convex mirror used for rear-view on an automobile has a focal length of 3.0 m. If a bus is located at 6.0 m from this mirror, use mirror formula to find the position of the image of the bus as seen in the mirror.

Answer: (i) When object is between P and F: virtual, erect, magnified image behind the mirror. As candle moves away from pole: At F - image at infinity. Between F and C - real, inverted, magnified, beyond C. At C - real, inverted, same size, at C. Beyond C - real, inverted, diminished, between F and C. At infinity - real, inverted, highly diminished, at F. Ray diagram at C: Two rays from tip of object at C - one parallel to axis reflects through F, another through F reflects parallel - they meet at C to form same-size inverted image.

(ii) 1/v + 1/u = 1/f; u = -6 m, f = +3 m. 1/v = 1/3 + 1/6 = 1/2. v = +2 m. Image is 2 m behind the mirror, virtual, erect, diminished.

Explanation:

Concave mirror forms different types of images depending on object position.

Convex mirror always forms virtual, erect, diminished images.

Q.37(a) [4 marks]

Case Study: 'A' and 'B' are two salts used for washing purposes. Salt 'A' is used for bathing also. Four test tubes I, II, III and IV as mentioned below are taken.

I. Rain water + solution of salt 'A'

II. Rain water + solution of salt 'B'

III. Tubewell water + solution of salt 'A'

IV. Tubewell water + solution of salt 'B'

The test tubes are shaken one by one almost identically for the same time and the lengths of foam formed in each test tube is noted.

(a) In which one of the four test tubes is the foam formed the minimum?

Answer: Test tube III. Salt A is a soap (it is also used for bathing) and salt B is a detergent. Soap forms insoluble scum with the Ca^{2+}/Mg^{2+} salts of hard (tubewell) water, so little foam forms in III, while the detergent B still lathers in hard water (IV) and both lather in rain water (I, II).

Explanation:

Rain water is soft, so both A and B lather (I, II).

Tubewell water is hard: soap A gives scum and very little foam (III), detergent B still foams (IV).

Minimum foam: III.

Q.37(b) [4 marks]

Case Study (continued):

(b) Differentiate between salt A and salt B.

Answer: Salt A is a soap: the sodium or potassium salt of a long-chain fatty (carboxylic) acid; it forms scum with the calcium and magnesium salts of hard water. Salt B is a detergent: generally the sodium salt of a sulphonic acid or an ammonium salt with a long hydrocarbon chain; its Ca/Mg salts are soluble, so it lathers even in hard water.

Explanation:

Soap (A) = sodium/potassium salt of a fatty acid, forms scum in hard water.

Detergent (B) = sulphonate/ammonium salt, works in hard water.

Q.37(c) [4 marks]

Case Study (continued):

(c) (i) What are esters? What happens when an ester reacts with an alkali (say sodium hydroxide)? Give the chemical equation for the reaction.

Answer: Esters are sweet-smelling (fruity) compounds formed when a carboxylic acid reacts with an alcohol in the presence of an acid catalyst. With an alkali such as NaOH an ester is hydrolysed to the sodium salt of the acid and the alcohol (saponification): $CH_3COOC_2H_5 + NaOH \rightarrow CH_3COONa + C_2H_5OH$.

Explanation:

Ester + NaOH gives the sodium salt of the carboxylic acid and an alcohol (saponification, used in soap making).

OR

Q.37(c) [4 marks]

Case Study (continued):

(c) (ii) What is the cause of hardness of water? Sometimes it is observed that while bathing foam is formed with difficulty and an insoluble substance is formed. Name this substance and write the cause of its formation.

Answer: Hardness of water is caused by dissolved calcium and magnesium salts (chlorides, sulphates, hydrogen carbonates). The insoluble substance is scum (calcium/magnesium salts of the fatty acids). It forms because soap reacts with the Ca^{2+} and Mg^{2+} ions of hard water: $2C_{17}H_{35}COONa + Ca^{2+} \rightarrow (C_{17}H_{35}COO)_2Ca\downarrow + 2Na^{+}$.

Explanation:

Ca^{2+}/Mg^{2+} salts make water hard;

soap reacts with them to form insoluble scum, so foam forms with difficulty.

Q.38(a) [4 marks]

Case Study: As shown in the diagram, an electric circuit consisting of an ammeter, a voltmeter, 4 cells of 1.5 V each, a plug key with a gap XY was set up. Voltmeter and ammeter readings were recorded in the observation table for four arrangements as given below:

Arrangement No. 1 - only resistor R_1 in gap XY
Arrangement No. 2 - only resistor R_2 in gap XY
Arrangement No. 3 - Resistors R_1 and R_2 in series in gap XY
Arrangement No. 4 - Resistors R_1 and R_2 in parallel in gap XY
Based on the observations, four V-I graphs A, B, C and D (I on the y-axis, V on the x-axis; D steepest, then C, B, A) were drawn. Study these graphs.

(a) Which one of the graphs represents the series combination of R_1 and R_2?

Answer: Graph A represents the series combination. In a V-I graph, slope = I/V = 1/R. Series combination has the highest total resistance ($R_1 + R_2$), so it has the least slope (flattest line). Graph A has the least slope, hence it represents the series combination.

Explanation:
In the I-V graph the slope is 1/R.
Series combination has the largest resistance (R_1+R_2), so the smallest slope: graph A.

Q.38(b) [4 marks]

Case Study (continued):
From the V-I graphs, which one of the graphs represents the parallel combination of R_1 and R_2?

Answer: Graph D represents the parallel combination. Parallel combination has the least total resistance ($R_1R_2/(R_1+R_2)$, which is less than either R_1 or R_2), so it has the highest slope in the V-I graph. Graph D has the steepest slope.

Explanation:
Parallel combination has minimum resistance, giving the highest slope in V-I graph.
Graph D (steepest) represents parallel combination.

Q.38(c) [4 marks]

Case Study (continued):
Show an arrangement of three resistors, each of resistance 10 Ω, so that the

combination has a resistance of 15 Ω. Give justification for your answer.

OR

A battery of 6 V is connected with a series combination of five resistors of 0.1 Ω, 0.2 Ω, 0.3 Ω, 0.4 Ω and 0.5 Ω. How much current would flow through the 0.3 Ω resistor? Justify your answer.

Answer: (i) Connect two resistors in parallel and the third in series with this combination. Two 10 Ω in parallel: R_p = (10×10)/(10+10) = 5 Ω. Then 5 Ω + 10 Ω (series) = 15 Ω.

OR

(ii) Total resistance in series = 0.1 + 0.2 + 0.3 + 0.4 + 0.5 = 1.5 Ω. Current I = V/R = 6/1.5 = 4 A. In a series circuit, the same current flows through all resistors. So current through 0.3 Ω resistor = 4 A.

Explanation:
For 15 Ω: two 10 Ω in parallel (5 Ω) + one 10 Ω in series = 15 Ω.
For the OR part, total series resistance = 1.5 Ω, I = 6/1.5 = 4 A through all resistors.

OR

Q.38(c) [4 marks]

Case Study (continued):
A battery of 6 V is connected with a series combination of five resistors of 0.1 Ω, 0.2 Ω, 0.3 Ω, 0.4 Ω and 0.5 Ω. How much current would flow through the 0.3 Ω resistor? Justify your answer.

Answer: Total resistance = 0.1 + 0.2 + 0.3 + 0.4 + 0.5 = 1.5 Ω. Current I = V/R = 6/1.5 = 4 A. In a series circuit, the same current flows through every component. Therefore, 4 A flows through the 0.3 Ω resistor.

Explanation:

In series, total R = sum of all resistances = 1.5 Ω.

I = V/R = 6/1.5 = 4 A.

Same current flows through all resistors in series.

Q.39(a) [4 marks]

Case Study: A person while climbing up a rocky hill comes into a panic state and fear. His body starts reacting in a 'fight-or-flight' condition to adjust to the dangerous and stressful situation. Based on the above facts, answer the questions that follow.

(a) (i) Name the hormone secreted in the blood of the person in this situation.

OR

(a) (ii) Name the source gland of the hormone secreted in this condition.

Answer: (i) The hormone is adrenaline (epinephrine).

OR

(ii) Its source gland is the adrenal gland (adrenal medulla), situated above the kidneys.

Explanation:

Adrenaline is the fight-or-flight hormone secreted by the adrenal glands (adrenal medulla) in response to stress or danger.

Q.39(b) [4 marks]

Case Study (continued):

(b) State any two responses in the body of the person as a result of the secretion of this hormone.

Answer: Two responses due to adrenaline: (1) the heart beats faster, increasing blood supply to the muscles; (2) the breathing rate increases to supply more oxygen. (Also: raised blood pressure, dilated pupils, blood diverted from digestion to skeletal muscles.)

Explanation:

Adrenaline increases heart rate, breathing rate, blood pressure and alertness.

OR

Q.39(b) [4 marks]

Case Study (continued):

(c) How does the action of the chemical signal in terms of hormones differ from the electrical impulses via nerve cells? (compulsory, not an OR)

Answer: Differences between hormonal and nervous control:

1. Hormones are transmitted through blood; nerve impulses travel through neurons (nerve fibres).
2. Hormones act slowly; nerve impulses are very fast.
3. Hormonal effects are long-lasting; nervous effects are short-lived.
4. Hormones have a widespread effect on target organs; nerve impulses have a precise, localised effect.
5. Hormones are chemical in nature; nerve impulses are electrochemical.

Explanation:

Hormonal control is slow, long-lasting, chemical-based via blood.

Nervous control is fast, short-lived, electrochemical via neurons.