

Science 2025, Set 31/3/1

Q.P. Code 31/3/1 · Series 3EGFH · 80 marks · 3 hours · March 2025. Questions are from the official CBSE paper. Step-by-step solutions are written by CogniGuru and checked against CBSE's published answer key. Where the key itself disagrees with the arithmetic, the solution says so.

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Section A: Multiple choice

20 questions, 1 mark each. MCQs (Q1 to Q16) and assertion-reason (Q17 to Q20).

Q1 · CHEMICAL REACTIONS AND EQUATIONS · 1 MARK

Consider the following chemical equation: $p \text{ Al} + q \text{ H}_2\text{O} \rightarrow r \text{ Al}_2\text{O}_3 + s \text{ H}_2$. The values of p , q , r and s respectively are:

(A) 3, 2, 2, 1

(B) 2, 3, 3, 1

(C) 2, 3, 1, 3

(D) 3, 1, 2, 2

SOLUTION

Balance aluminium: $r = 1$ gives 2 Al on the right, so $p = 2$. Balance oxygen: Al_2O_3 has 3 O, so $q = 3$. Then $3\text{H}_2\text{O}$ has 6 H, so $s = 3$.

$2\text{Al} + 3\text{H}_2\text{O} \rightarrow \text{Al}_2\text{O}_3 + 3\text{H}_2$, so $p, q, r, s = 2, 3, 1, 3$.

Answer: (C) 2, 3, 1, 3

Q2 · ACIDS, BASES AND SALTS · 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

SOLUTION

Salts belong to one family when they have the same negative ion (the same acid radical) or the same positive ion.

In option B all three are sulphates (they contain SO_4^{2-}), so they are the sulphate family.

Answer: (B) K_2SO_4 , Na_2SO_4 , CaSO_4

Q3 · METALS AND NON-METALS · 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

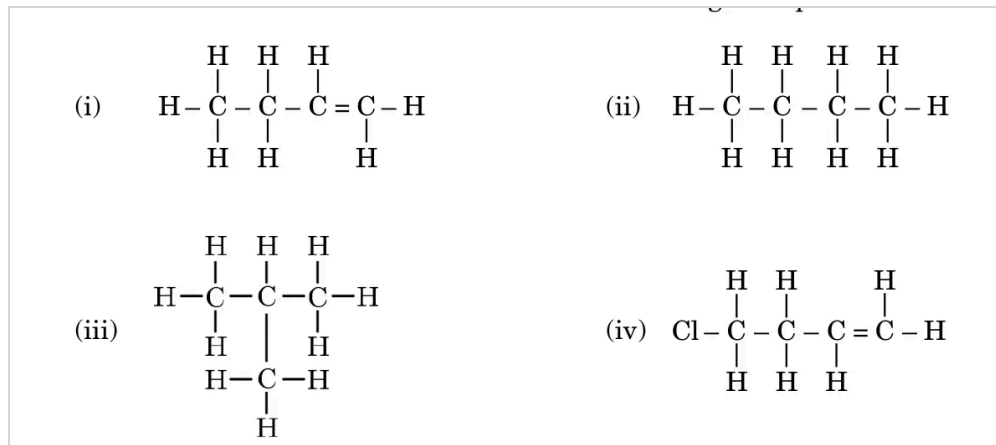
SOLUTION

Most metals in the middle of the reactivity series (zinc, iron, lead and so on) are obtained by heating their oxides with carbon (coke), which is cheap and takes the oxygen away.

Answer: (A) Reduction with carbon

Q4 · CARBON AND ITS COMPOUNDS · 1 MARK

Given below are the structures of some hydrocarbons: (i) but-1-ene, a four-carbon chain with one double bond; (ii) butane, a straight four-carbon chain with single bonds; (iii) 2-methylpropane, a branched four-carbon compound; (iv) a four-carbon chain with one chlorine and one double bond. Select the two structures which are related to each other from the given options:



(A) (i) and (iv)

(B) (ii) and (iv)

(C) (ii) and (iii)

(D) (i) and (iii)

SOLUTION

Related structures here means isomers: same molecular formula, different structure. (ii) is $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ and (iii) is $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_3$. Both are C_4H_{10} , one a straight chain and one branched.

(i) is C_4H_8 and (iv) contains chlorine, so neither is an isomer of the others.

Answer: (C) (ii) and (iii)

Q5 · CARBON AND ITS COMPOUNDS · 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.

SOLUTION

Hydrogenation adds hydrogen across the double bonds, so it is an addition reaction. It needs a nickel or palladium catalyst, and the product is saturated (only single C–C bonds).

An acid catalyst is not used, so statement D is the incorrect one.

Answer: (D) It is an addition reaction which occurs in the presence of an acid catalyst.

Q6 · HOW DO ORGANISMS REPRODUCE? · 1 MARK

Match Column-I with Column-II and select the correct option from the choices provided.

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)

SOLUTION

a. Fertilisation takes place in the oviduct: (iii). b. The embryo is implanted in the uterus: (ii). c. Sperm enter through the vagina: (i). d. Wastes of the embryo are removed through the placenta: (iv).

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

Q7 · CONTROL AND COORDINATION · 1 MARK

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

(A) Pons

(B) Cerebrum

(C) Cerebellum

(D) Medulla

SOLUTION

The cerebellum, part of the hind-brain, keeps the posture and balance of the body and coordinates voluntary movements.

Answer: (C) Cerebellum

Q8 · CONTROL AND COORDINATION · 1 MARK

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

(A) Auxin

(B) Cytokinins

(C) Gibberellins

(D) Absciscic acid

SOLUTION

Cytokinins promote cell division, so they are found in high concentration in fruits, seeds and other areas of rapid cell division.

Answer: (B) Cytokinins

Q9 · HOW DO ORGANISMS REPRODUCE? · 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

SOLUTION

A bisexual flower has both stamens and pistil. Hibiscus and mustard are bisexual. Papaya and watermelon have unisexual flowers.

Answer: (B) Hibiscus and mustard

Q10 · LIFE PROCESSES · 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

SOLUTION

Gastric glands release hydrochloric acid, the protein-digesting enzyme pepsin and mucus (which protects the stomach lining). Trypsin comes from the pancreas and amylase from the salivary glands.

Answer: (C) Mucus and Pepsin

Q11 · LIGHT: REFLECTION AND REFRACTION · 1 MARK

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

- (A) $\frac{9}{4}$ m/s (B) $\frac{7}{3}$ m/s
(C) $\frac{16}{9}$ m/s (D) $\frac{9}{8}$ m/s

SOLUTION

$n = \frac{c}{v}$, so $c = n_g v_g = \frac{3}{2} \times 2 \times 10^8 = 3 \times 10^8$ m/s. Then $v_w = \frac{c}{n_w} = \frac{3 \times 10^8}{4/3} = \frac{9}{4} \times 10^8$ m/s = 2.25×10^8 m/s.

The printed options leave out the factor 10^8 , so the question is faulty. CBSE's key awards the mark to all candidates. The nearest option to the correct digits is (A), $\frac{9}{4}$.

Answer: (A) $\frac{9}{4}$ (times 10^8 m/s); CBSE gave full credit to everyone

About CBSE's key: CBSE's marking scheme awards this mark to all candidates because the options omit the factor of 10^8 .

Q12 · HUMAN EYE AND THE COLOURFUL WORLD · 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

SOLUTION

Very fine particles scatter light of short wavelength the most. Blue has a shorter wavelength than red, orange and yellow, so it is scattered the most. (This is why the sky looks blue.)

Answer: (C) blue

Q13 · ELECTRICITY · 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) $27R$

SOLUTION

The volume stays the same: $A \times l = A' \times 3l$, so the area falls to $A' = \frac{A}{3}$.

$$R' = \rho \frac{3l}{A/3} = 9\rho \frac{l}{A} = 9R.$$

Answer: (C) $9R$

Common mistake: Answering $3R$. The wire is also thinner, which triples the resistance again.

Q14 · MAGNETIC EFFECTS OF ELECTRIC CURRENT · 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.

SOLUTION

Field lines are closed loops: outside the magnet they run from north to south, and inside the magnet they run from the south pole to the north pole. So statement D is not true.

Answer: (D) The direction of magnetic field lines inside a bar magnet is from its north pole to its south pole.

Q15 · MAGNETIC EFFECTS OF ELECTRIC CURRENT · 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

SOLUTION

The field inside a long solenoid depends on the current, the number of turns per unit length and the core material. It is uniform and does not depend on the radius of the coil. (The direction of the current only decides which end is north.)

Answer: (D) radius of the coil of the solenoid

Common mistake: Choosing B. Reversing the current reverses the direction of the field, but its strength is unchanged.

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?

- (A) (i) and (iv)
- (B) (ii) and (iii)
- (C) (i) and (iii)
- (D) (ii) and (iv)

A self-sustaining aquarium needs aquatic producers, the small herbivorous fish, and decomposers. Terrestrial plants and animals do not live in water, so (ii) is not needed.

Marine consumers such as clown fish and sea urchins are not required either, since the herbivorous fish are already the consumers: (iv) is not needed.

Q17 · ACIDS, BASES AND SALTS · 1 MARK

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 A and R are true and R is the correct explanation of A
- (B) Both A and R are true, but R is not the correct explanation of A
- (C) A is true, but R is false
- (D) A is false, but R is true

Assertion: true. Nitric acid is a strong oxidising agent, so hydrogen does not escape (except with very dilute acid and magnesium or manganese).

Reason: false. Nitric acid is a strong oxidising agent, not a reducing agent; it oxidises the hydrogen to water.

Q18 · CONTROL AND COORDINATION · 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 A and R are true and R is the correct explanation of A
- (B) Both A and R are true, but R is not the correct explanation of A
- (C) A is true, but R is false
- (D) A is false, but R is true

Assertion: true, the brain sends signals to the muscles through nerves. Reason: true, the nerves from the brain and spinal cord form the peripheral nervous system. But the reason only names parts of the system and does not explain why the nervous system works with the muscles.

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Q19 · MAGNETIC EFFECTS OF ELECTRIC CURRENT · 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 A and R are true and R is the correct explanation of A
(B) Both A and R are true, but R is not the correct explanation of A
(C) A is true, but R is false
(D) A is false, but R is true

SOLUTION

Both statements are true. But lines do not cross because at a point the field can have only one direction. Merely being a vector does not by itself explain this, so R is not the correct explanation.

Answer: (B) Both A and R are true, but R is not the correct explanation of A

Q20 · OUR ENVIRONMENT · 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 needed.

- (A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true, but R is not the correct explanation of A
(C) A is true, but R is false
(D) A is false, but R is true

SOLUTION

Jute breaks down by decomposers and the bag can be used again, so it does not pile up as non-biodegradable waste like plastic bags. The reason explains the assertion.

Answer: (A) Both A and R are true and R is the correct explanation of A

Section B: Very short answer

6 questions, 2 marks each (30 to 50 words).

Q21 · CHEMICAL REACTIONS AND EQUATIONS · 2 MARKS

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

OR

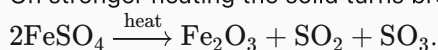
(b) What is observed when hydrated ferrous sulphate crystals are heated in a dry boiling tube? Give balanced chemical equation(s) of the reaction(s) that occur(s).

SOLUTION

(a) Heat, light and electricity. Example (light): $2\text{AgBr} \xrightarrow{\text{sunlight}} 2\text{Ag} + \text{Br}_2$.

(b) Green crystals first lose their water of crystallisation: water droplets appear on the cooler upper part of the tube and the colour changes from green to white. $\text{FeSO}_4 \cdot 7\text{H}_2\text{O} \rightarrow \text{FeSO}_4 + 7\text{H}_2\text{O}$.

On stronger heating the solid turns brown (iron(III) oxide) and gives off gases with the smell of burning sulphur:



Answer: (a) heat, light, electricity; e.g. $2\text{AgBr} \rightarrow 2\text{Ag} + \text{Br}_2$ (b) green $\rightarrow$ white, then brown; pungent SO_2

Q22 · ACIDS, BASES AND SALTS · 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?

SOLUTION

- (a) (i) Acids give hydrogen ions, H^+ (in water H_3O^+). (ii) Bases give hydroxide ions, OH^- .
- (b) Dry HCl does not form hydrogen ions in the absence of water. Only the H^+ ions change the colour of litmus, so dry HCl gas has no effect on dry litmus paper.

Answer: (a) H^+ and OH^- (b) no water, so no H^+ ions are released

Q23 · LIFE PROCESSES · 2 MARKS

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

SOLUTION

Veins carry deoxygenated blood from the different organs and bring it back to the heart (the pulmonary vein is the exception).

They do not need thick walls because the blood flows through them at low pressure.

Answer: Bring blood back to the heart; blood in veins is at low pressure

Q24 · HEREDITY · 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.

SOLUTION

(a) Tallness depends on the amount of a plant hormone (a growth hormone). Making this hormone depends on how efficiently an enzyme (a protein) works, and the enzyme is made from a specific section of DNA. A more efficient enzyme gives more hormone, so the plant is taller.

(b) A gene.

Answer: The gene makes the enzyme, which makes the growth hormone, which decides tallness; the section of DNA is a gene

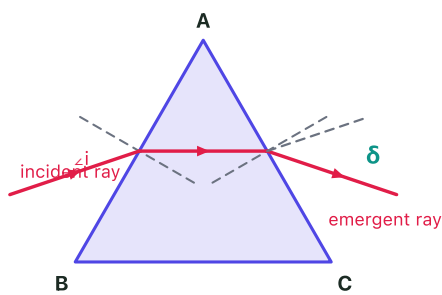
Q25 · HUMAN EYE AND THE COLOURFUL WORLD · 2 MARKS

- (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.

SOLUTION



δ = angle of deviation: between the original direction (dashed) and the emergent ray

(a) He sees far objects clearly but not near ones, so he has hypermetropia (far-sightedness). Reasons: the focal length of the eye lens is too long, or the eyeball has become too small. It is corrected with a convex (converging) lens.

(b) The ray bends towards the normal on entering the prism and away from the normal on leaving, so it is deviated towards the base. The angle between the original direction and the emergent ray is the angle of deviation (diagram above).

Answer: (a) hypermetropia; long focal length or small eyeball; convex lens (b) diagram

Q26 · ELECTRICITY · 2 MARKS

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

SOLUTION

$$P = \frac{V^2}{R}, \text{ so } R = \frac{V^2}{P} = \frac{230^2}{1000} = \frac{52900}{1000} = 52.9 \, \Omega.$$

Answer: 52.9 Ω

Section C: Short answer

7 questions, 3 marks each (50 to 80 words).

Q27 · METALS AND NON-METALS · 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.

SOLUTION

(a) The reactivity series is a list of metals arranged in decreasing order of their reactivity. It is developed by performing displacement reactions: a more reactive metal displaces a less reactive one from its salt solution.

In decreasing order of reactivity: calcium, aluminium, lead, copper.

(b) $\text{Fe}_2\text{O}_3 + 2\text{Al} \rightarrow \text{Al}_2\text{O}_3 + 2\text{Fe} + \text{heat}$ (the thermite reaction).

Answer: (a) Ca, Al, Pb, Cu (b) $\text{Fe}_2\text{O}_3 + 2\text{Al} \rightarrow \text{Al}_2\text{O}_3 + 2\text{Fe} + \text{heat}$

Q28 · ACIDS, BASES AND SALTS · 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.

SOLUTION

(a)(i) Electricity is passed through brine (aqueous sodium chloride), the chlor-alkali process:



(ii) Ammonia and carbon dioxide are passed through brine: $\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2 + \text{NH}_3 \rightarrow \text{NaHCO}_3 + \text{NH}_4\text{Cl}$.

(b) Set up a circuit with a bulb, a battery and two electrodes dipped in a beaker. Put solutions of glucose and alcohol in the beaker one at a time, and then dilute acid solutions (such as HCl). The bulb does not glow with glucose or alcohol, but glows with the acids.

Reason: acids release hydrogen ions in solution, so they conduct electricity. Glucose and alcohol contain hydrogen but do not release it as ions, so they are not acids.

Answer: (a) chlor-alkali process; brine + CO_2 + NH_3 (b) bulb glows only with acids because only acids give H^+ ions

Q29 · LIFE PROCESSES · 3 MARKS

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

- (a) Products of 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)

SOLUTION

(a) Aerobic respiration: pyruvate is broken down to carbon dioxide and water (with energy). Anaerobic respiration in humans (in muscle): pyruvate is changed to lactic acid.

(b) Respiration releases carbon dioxide; photosynthesis releases oxygen.

(c) Terrestrial animals breathe through lungs (or the skin in some); fishes breathe through gills.

Answer: (a) CO_2 + H_2O vs lactic acid (b) CO_2 vs O_2 (c) lungs vs gills

Q30 · HEREDITY · 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.

SOLUTION

(a) The parents are $RRYY$ and $rryy$. All F_1 plants are $RrYy$, and round and yellow are dominant, so all the seeds are round and yellow.

(b) F_2 : round yellow 9 : round green 3 : wrinkled yellow 3 : wrinkled green 1.

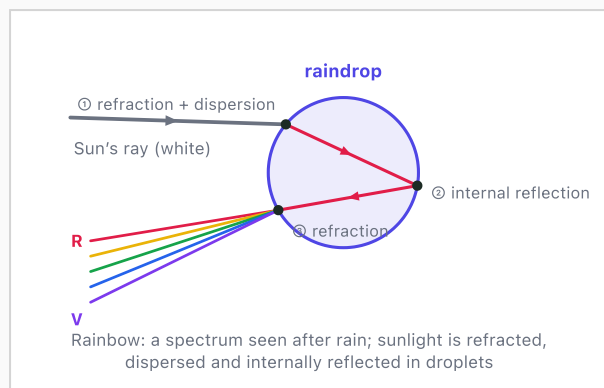
(c) The two traits are inherited independently of each other (independent assortment), so the genes recombine in the gametes and give the new combinations round green and wrinkled yellow.

Answer: (a) round and yellow (b) 9 : 3 : 3 : 1 (c) independent assortment of the traits

Q31 · HUMAN EYE AND THE COLOURFUL WORLD · 3 MARKS

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

SOLUTION



A rainbow is a natural spectrum (a band of colours) that appears in the sky after a rain shower, when the Sun is behind the observer.

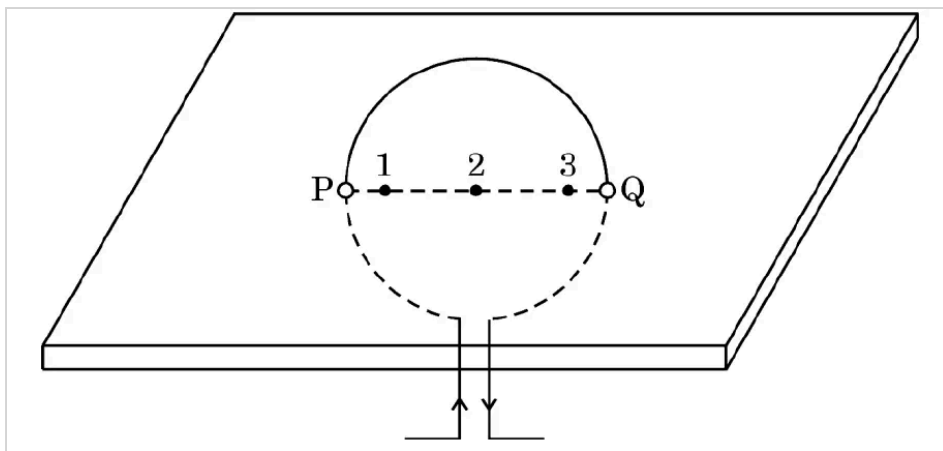
It forms by the dispersion of sunlight by tiny water droplets in the air. In each droplet the light is refracted and split into colours as it enters, reflected internally at the back of the drop, and refracted again as it leaves. Violet bends the most and red the least, so a band of seven colours reaches the eye (diagram above, with arrows).

Answer: A spectrum in the sky after rain, formed by refraction, dispersion and internal reflection in water droplets

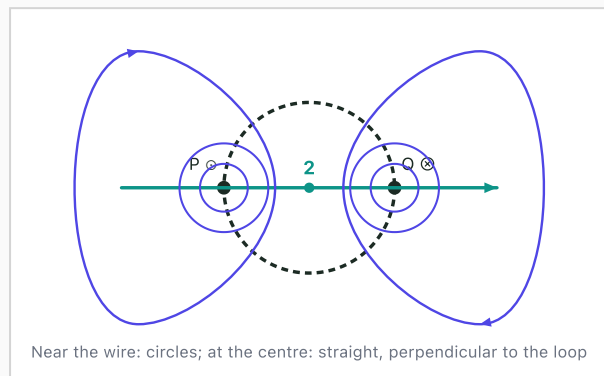
Q32 · MAGNETIC EFFECTS OF ELECTRIC CURRENT · 3 MARKS

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.



SOLUTION



Near the wire: circles; at the centre: straight, perpendicular to the loop

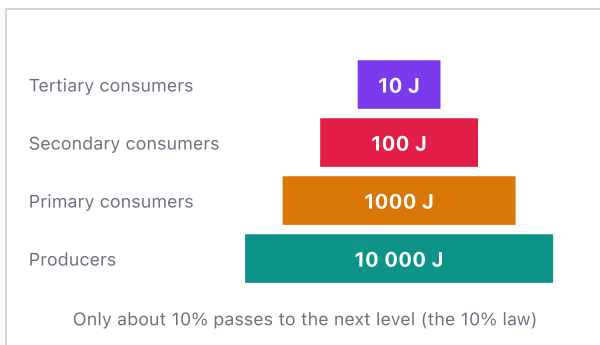
- (a) Near the wire (points 1 and 3) the field lines are circles around the wire, in the plane of the cardboard. At the centre of the loop (point 2) the field line is a straight line perpendicular to the plane of the loop.
- (b) The strength of the current in the loop, and the number of turns of the loop (the field also falls with the radius of the loop).
- (c) The right-hand thumb rule.

Answer: (a) circles near the wire, straight at the centre (b) current, number of turns (c) right-hand thumb rule

Q33 · OUR ENVIRONMENT · 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.

SOLUTION



(a) Reason 1: the energy captured by the plants never goes back to the Sun, and the energy passed to the herbivores does not go back to the producers. Reason 2: as energy moves from one trophic level to the next, it is no longer available to the previous level; a large part is lost at each level (as heat in respiration), so the energy cannot be passed backwards.

(b) Only about 10% of the energy passes on to the next level (the 10% law). Producers 10 000 J → primary consumers 1000 J → secondary consumers 100 J. So 100 J is available to the secondary consumers.

Answer: (a) energy is not returned to the Sun or the earlier level (b) 100 J (10% law)

Section D: Long answer

3 questions, 5 marks each (80 to 120 words).

Q34 · METALS AND NON-METALS · 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 with oxygen 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.

SOLUTION

(a)(i) I. Silver (Ag) does not react with oxygen even when hot. II. Aluminium (Al) forms a protective oxide layer. III. Potassium (K) catches fire in the open. IV. Copper (Cu) does not burn but gets a black coating of copper(II) oxide when heated.

(ii) Amphoteric oxides are metal oxides that react with both acids and bases to give salt and water.

$\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$ (acts as a base) and $\text{Al}_2\text{O}_3 + 2\text{NaOH} \rightarrow 2\text{NaAlO}_2 + \text{H}_2\text{O}$ (acts as an acid).

(iii) Alkalis are bases that dissolve in water, for example sodium hydroxide (NaOH) or potassium hydroxide (KOH).

(b)(i)(I) Cinnabar is heated in air: $2\text{HgS} + 3\text{O}_2 \xrightarrow{\text{heat}} 2\text{HgO} + 2\text{SO}_2$, and then mercury(II) oxide is heated: $2\text{HgO} \xrightarrow{\text{heat}} 2\text{Hg} + \text{O}_2$.

(II) Copper sulphide is heated in air: $2\text{Cu}_2\text{S} + 3\text{O}_2 \xrightarrow{\text{heat}} 2\text{Cu}_2\text{O} + 2\text{SO}_2$, and then $2\text{Cu}_2\text{O} + \text{Cu}_2\text{S} \xrightarrow{\text{heat}} 6\text{Cu} + \text{SO}_2$.

(ii) (I) Silver gets a coating of silver sulphide, Ag_2S (black). (II) Copper gets a green coating of basic copper carbonate, $\text{Cu}(\text{OH})_2 \cdot \text{CuCO}_3$.

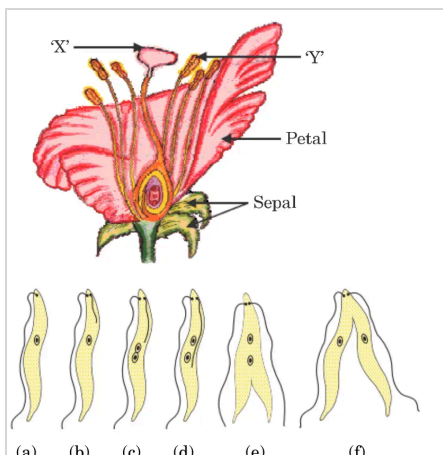
Answer: (a) Ag, Al, K, Cu; amphoteric oxides; NaOH (b) roasting of cinnabar and of Cu_2S ; Ag_2S and basic copper carbonate

Q35 · HOW DO ORGANISMS REPRODUCE? · 5 MARKS

(a) (i) Identify the parts 'X' and 'Y' in the figure given below. (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. (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.



SOLUTION

(a)(i) X is the stigma and Y is the anther. (ii) The anther produces yellowish pollen grains. (iii) The transfer of pollen from the anther to the stigma is pollination.

(iv) After pollination, a pollen tube grows out of the pollen grain, goes through the style and reaches the ovary. The male germ cell fuses with the female germ cell (the egg) in the ovule to form a zygote. The zygote divides again and again to form an embryo inside the ovule. The ovule develops a tough coat and changes into a seed.

(b)(i) Binary fission. (ii) The unicellular organism is Leishmania (it divides by binary fission along its long axis).

(iii) Advantages: many offspring are made in a short time; the offspring are genetically identical to the parent, so useful traits are kept; it needs no gametes or a mate; it helps organisms to survive in unfavourable conditions. (Any two.)

(iv) Budding: a bud forms as an outgrowth of the parent from repeated cell division at one site. It grows into a small individual, matures, and detaches to become a new independent Hydra.

Answer: (a) X stigma, Y anther; pollen; pollination; pollen tube and fertilisation make the seed (b) binary fission; Leishmania; two advantages; budding

Q36 · LIGHT: REFLECTION AND REFRACTION · 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.

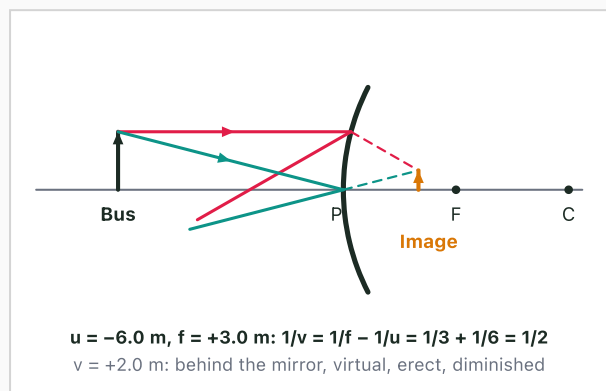
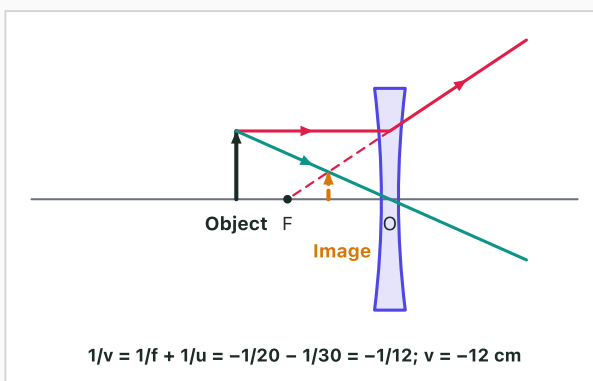
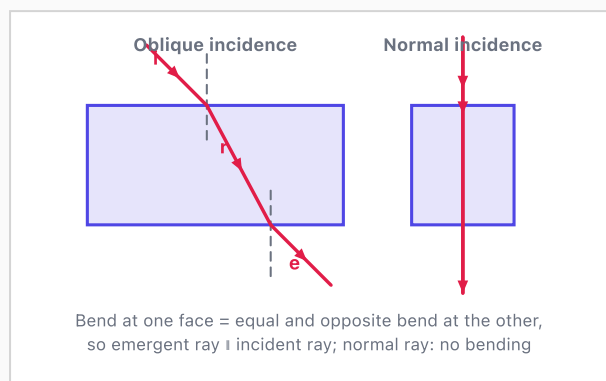
(ii) An object is placed at a distance of 30 cm from the optical centre of a concave lens of focal length 20 cm. Use Lens formula to determine the position of the image formed in this case.

OR

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

SOLUTION



(a)(i) At the first face the ray bends towards the normal by some angle, and at the opposite parallel face it bends away from the normal by the same angle. The two bends are equal and opposite, so the emergent ray is parallel to the incident ray (it is only shifted sideways). A ray falling normally on a face goes straight through without bending, as the angle of incidence is 0° .

(ii) $u = -30 \text{ cm}$ and $f = -20 \text{ cm}$ (concave lens). $\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = -\frac{1}{20} - \frac{1}{30} = -\frac{5}{60} = -\frac{1}{12}$, so $v = -12 \text{ cm}$. The image is 12 cm from the lens, on the same side as the object.

(b)(i) When the flame is beyond the focus, the image is real and inverted. When it is between the pole and the focus, the image is virtual and erect. As the flame is moved away from the pole the image gets smaller (diminished) and moves nearer the focus. When the object is nearly at the centre of curvature C, the image is also formed at C: real, inverted and the same size.

(ii) $u = -6.0 \text{ m}$ and $f = +3.0 \text{ m}$ (convex mirror). $\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{3} + \frac{1}{6} = \frac{1}{2}$, so $v = +2.0 \text{ m}$. The image is 2.0 m behind the mirror (virtual, erect and diminished).

Answer: (a) bends are equal and opposite; $v = -12\text{ cm}$ (b) real inverted then virtual erect, diminished as it moves away; $v = +2.0\text{ m}$

Section E: Case studies

3 case studies, 4 marks each.

Q37 · ACIDS, BASES AND SALTS · 4 MARKS

Case study 1. '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? [1]
(b) Differentiate between salt A and salt B. [1]
(c) (i) What are esters? What happens when an ester reacts with an alkali (say sodium hydroxide)? Give chemical equation for the reaction. [2]

OR

- (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. [2]

SOLUTION

- (a) Salt A is a soap (used for bathing) and salt B is a detergent. Tubewell water is usually hard. Soap does not lather in hard water, so the foam is the least in test tube III (tubewell water + salt A).
(b) Salt A (soap) is the sodium or potassium salt of long-chain carboxylic acids and does not form lather with hard water. Salt B (detergent) is a sodium salt of sulphonic acids (or an ammonium salt) and forms lather even with hard water.
(c)(i) Esters are sweet-smelling compounds, used in perfumes and flavourings, formed when an alcohol reacts with a carboxylic acid in the presence of an acid. With sodium hydroxide an ester is changed back to the alcohol and the sodium salt of the carboxylic acid (saponification): $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{NaOH} \rightarrow \text{C}_2\text{H}_5\text{OH} + \text{CH}_3\text{COONa}$.
(c)(ii) Hardness is caused by dissolved calcium and magnesium salts. The soap reacts with them to form an insoluble substance, scum, which is why foam forms with difficulty.

Answer: (a) test tube III (b) soap vs detergent (c) esters give alcohol + salt (OR) calcium and magnesium salts; scum

Q38 · CONTROL AND COORDINATION · 4 MARKS

Case study 2. A person while climbing up a rocky hill comes into a panic state and fear. His body starts reacting in a "flight-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. [2]

OR

- (a) (ii) Name the source gland of the hormone secreted in this condition. [2]
(b) State any two responses in the body of the person as a result of the secretion of this hormone. [1]
(c) How does the action of the chemical signal in terms of hormones differ from the electrical impulses via nerve cells? [1]

SOLUTION

(a)(i) Adrenaline. (ii) The adrenal gland (on top of the kidneys).

(b) The heart beats faster to supply more oxygen to the muscles; the breathing rate increases; blood is diverted to the skeletal muscles and its supply to the digestive system and the skin is reduced. (Any two.)

(c) A hormone, a chemical signal, travels through the bloodstream and reaches a wide range of target cells all over the body, while an electrical impulse travels along a nerve cell to a particular place, and is quicker.

Answer: (a) adrenaline (OR) adrenal gland (b) faster heartbeat, faster breathing (c) blood-borne and wide-ranging vs along nerves

Q39 · ELECTRICITY · 4 MARKS

Case study 3. 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: No. 1, only resistor R_1 in gap XY; No. 2, only resistor R_2 ; No. 3, R_1 and R_2 in series; No. 4, R_1 and R_2 in parallel. Based on the observations, four V–I graphs A, B, C and D as shown in figure were drawn (current I on the vertical axis, voltage V on the horizontal axis; D is the steepest line and A the least steep).

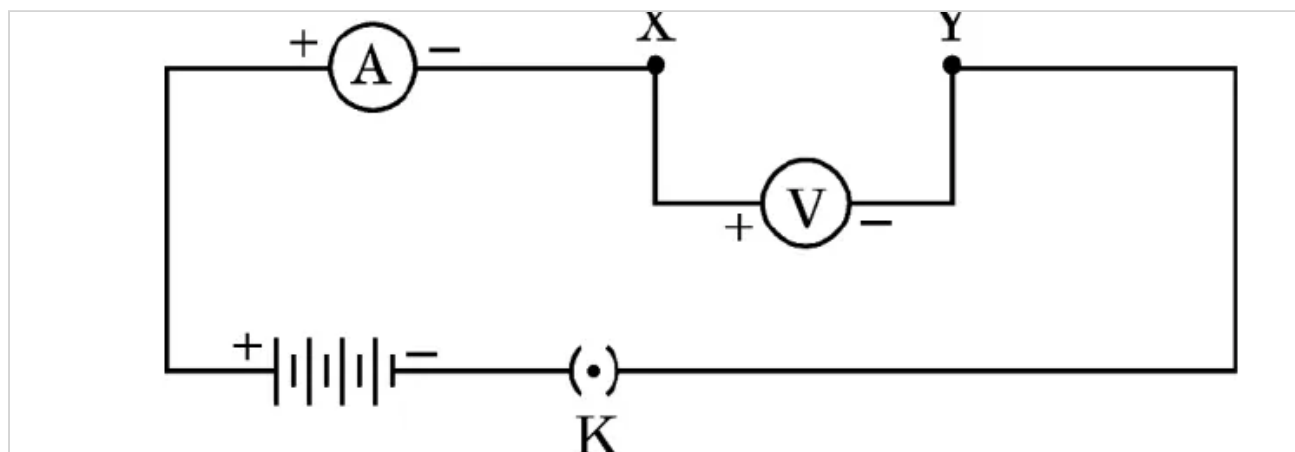
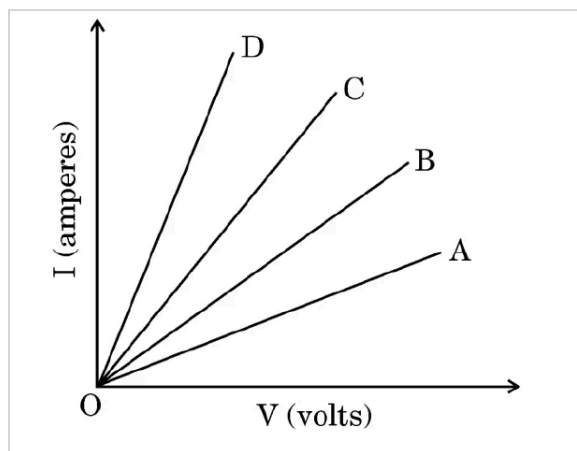
(a) Which one of the graphs represents the series combination of R_1 and R_2 ? [1]

(b) Which one of these graphs represents the parallel combination of R_1 and R_2 ? [1]

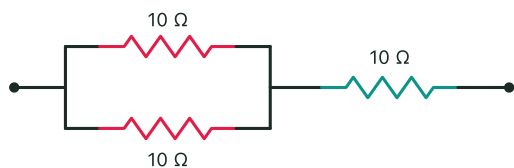
(c) (i) Show an arrangement of three resistors, each of resistance $10\ \Omega$, so that the combination has a resistance of $15\ \Omega$. Give justification for your answer. [2]

OR

(c) (ii) A battery of 6 V is connected with a series combination of five resistors of $0.1\ \Omega$, $0.2\ \Omega$, $0.3\ \Omega$, $0.4\ \Omega$ and $0.5\ \Omega$. How much current would flow through the $0.3\ \Omega$ resistor? Justify your answer. [2]



SOLUTION



parallel pair: $10 \times 10 / 20 = 5 \Omega$

total = $5 \Omega + 10 \Omega = 15 \Omega$

The graph of I against V is a straight line of slope $\frac{1}{R}$. A larger resistance gives a smaller slope.

(a) In series the total resistance is the greatest, so the slope is the least: graph A.

(b) In parallel the total resistance is the smallest, so the slope is the greatest: graph D.

(c)(i) Join two 10Ω resistors in parallel: $\frac{10 \times 10}{10 + 10} = 5 \Omega$. Join this pair in series with the third 10Ω resistor: $5 + 10 = 15 \Omega$ (diagram above).

(c)(ii) The total resistance in series is $0.1 + 0.2 + 0.3 + 0.4 + 0.5 = 1.5 \Omega$. $I = \frac{V}{R} = \frac{6}{1.5} = 4.0 \text{ A}$. The same current flows through every resistor in a series circuit, so 4.0 A flows through the 0.3Ω resistor.

Answer: (a) A (b) D (c) two 10Ω in parallel, in series with the third (OR) 4.0 A

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