SHUNYASAARTHI

CLASS X · 2026-27 · MODEL PAPER

Class X Science (Code 086) Model Paper 2

Worked answers & explanations

Maximum marks: 80

Time: 3 hours

Subject code: 086

Practice, understand, improve.

Instructions

All 39 questions are compulsory, with one selected option for each internal choice.

Sections A, B, and C assess Biology, Chemistry, and Physics respectively.

Show equations, working, units, and labelled diagrams where requested.

Section A

Question 1

1 mark

Mcq

Choose the correct answer.

(a) In Spirogyra, asexual reproduction by fragmentation means: [1 mark]

A. formation of buds on the parent filament

B. fusion of gametes to form a zygote

C. breaking of the filament into pieces that grow independently

D. production of multiple spores within a cell

Answer

C. breaking of the filament into pieces that grow independently

Step by step

1. **Select and justify the option:** Spirogyra filaments break into fragments, each fragment regenerates into a new individual. Why: Fragments of Spirogyra grow into new individuals

Topic and concept

Asexual reproduction — fission, fragmentation, regeneration, budding. Fragmentation in multicellular organisms, like Spirogyra, involves breaking the parent filament into fragments that regenerate into independent individuals.

How marks are earned

1. Spirogyra filaments break into fragments, each fragment regenerates into a new individual. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.2.2: Fragments of Spirogyra grow into new individuals

Question 2

1 mark

Mcq

Choose the correct answer.

(a) According to Mendel’s law of segregation, during the formation of gametes, each gamete receives: [1 mark]

A. both alleles of a gene pair

B. one allele of each gene pair

C. only dominant alleles

D. only recessive alleles

Answer

B. one allele of each gene pair

Step by step

1. **Select and justify the option:** Each gamete receives one allele from each gene pair because the two alleles segregate during gamete formation. Why: Mendel observed that two alleles of a gene separate so that each gamete receives one allele.

Topic and concept

Mendel's contribution; laws of inheritance — law of segregation, law of independent assortment. Each organism carries two versions of a gene that segregate during gamete formation and recombine at fertilization.

How marks are earned

1. Each gamete receives one allele from each gene pair because the two alleles segregate during gamete formation. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.2: Mendel observed that two alleles of a gene separate so that each gamete receives one allele.

Question 3

1 mark

Mcq

Choose the correct answer.

(a) Which valve prevents backflow of blood from the left ventricle into the left atrium? [1 mark]

A. Mitral valve

B. Tricuspid valve

C. Pulmonary valve

D. Aortic valve

Answer

A. Mitral valve

Step by step

1. **Select and justify the option:** The mitral (bicuspid) valve lies between the left atrium and left ventricle and prevents backflow during ventricular systole. Why: Describes the mitral valve between left atrium and ventricle to prevent backflow.

Topic and concept

Blood and lymph; human circulatory system; heart. The human circulatory system consists of heart, blood and lymph vessels that work in a closed double circuit to transport oxygen, nutrients and waste products throughout the body.

How marks are earned

1. The mitral (bicuspid) valve lies between the left atrium and left ventricle and prevents backflow during ventricular systole. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.5, §5.7: Describes the mitral valve between left atrium and ventricle to prevent backflow.

Question 4

1 mark

Mcq

Choose the correct answer.

(a) Which of the following best describes a voluntary action? [1 mark]

A. Occurs immediately without thinking

B. Initiated deliberately by the brain

C. Mediated only by the spinal cord

D. Independent movement of plants

Answer

B. Initiated deliberately by the brain

Step by step

1. **Select option B by testing each choice against the meaning of 'voluntary':** A voluntary action, such as writing or picking up a book, is decided and started deliberately by the brain (the fore-brain), so option B 'Initiated deliberately by the brain' is correct. Option A (immediate, without thinking) and option C (spinal cord only) describe reflex actions, and option D (independent movement of plants) is not a voluntary animal action. Why: Voluntary actions involve conscious thought and brain control, whereas reflex actions are quick, involuntary responses that bypass conscious thinking and are often handled at the spinal cord. The word 'deliberately' in B matches this conscious control, which is why B is the best description.

Topic and concept

Voluntary, involuntary and reflex actions. Reflex actions are immediate, involuntary responses to a stimulus without conscious thought, while voluntary actions are deliberate movements initiated by the brain. The question asks you to recognise the feature that belongs to voluntary action: conscious, brain-initiated control.

How marks are earned

1. A voluntary action is initiated deliberately by the brain. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.1.1 What happens in Reflex Actions?: Reflex actions occur without thinking or conscious control.

Question 5

1 mark

Mcq

Choose the correct answer.

(a) Binary fission in Amoeba is characterized by: [1 mark]

A. formation of spores inside the cell

B. division of the nucleus only

C. splitting into two equal halves along any plane

D. regeneration from body fragments

Answer

C. splitting into two equal halves along any plane

Step by step

1. **Select and justify the option:** In binary fission, Amoeba's cell divides in any plane to form two equal daughter cells. Why: Amoeba splits into two halves during binary fission

Topic and concept

Asexual reproduction — fission, fragmentation, regeneration, budding. In binary fission, a unicellular organism's parent cell divides into two genetically similar daughter cells by splitting its nucleus and cytoplasm in any plane.

How marks are earned

1. In binary fission, Amoeba's cell divides in any plane to form two equal daughter cells. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.2.1: Amoeba splits into two halves during binary fission

Question 6

1 mark

Mcq

Choose the correct answer.

(a) What is the main use of a Punnett square in genetics? [1 mark]

A. Sequencing DNA segments

B. Predicting offspring genotype and phenotype ratios

C. Measuring chromosome number

D. Calculating mutation rates

Answer

B. Predicting offspring genotype and phenotype ratios

Step by step

1. **Select and justify the option:** A Punnett square predicts the genotypic and phenotypic ratios of offspring by systematically combining parental alleles. Why: Diagrammatic Punnett squares are used to predict offspring genotypic and phenotypic ratios.

Topic and concept

Mendel's contribution; laws of inheritance — law of segregation, law of independent assortment. Punnett squares predict offspring genotype and phenotype ratios by combining parental gametes.

How marks are earned

1. A Punnett square predicts the genotypic and phenotypic ratios of offspring by systematically combining parental alleles. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.3: Diagrammatic Punnett squares are used to predict offspring genotypic and phenotypic ratios.

Question 7

1 mark

Mcq

Choose the correct answer.

(a) Anaerobic respiration in human muscle primarily yields which end product? [1 mark]

A. Lactic acid

B. Ethanol

C. Carbon dioxide

D. Water

Answer

A. Lactic acid

Step by step

1. **Select and justify the option:** Under anaerobic conditions in muscle, pyruvate is reduced to lactic acid. Why: Respiration can proceed without oxygen in muscles to produce lactic acid.

Topic and concept

Respiration — aerobic and anaerobic; human respiratory system. Respiration is the process by which organisms take up oxygen and oxidize food molecules to release energy; it occurs both aerobically (with oxygen) and anaerobically (without oxygen).

How marks are earned

1. Under anaerobic conditions in muscle, pyruvate is reduced to lactic acid. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.5, §5.1: Respiration can proceed without oxygen in muscles to produce lactic acid.

Question 8

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): Many involuntary actions are controlled by the mid-brain and hind-brain. Reason (R): The cerebellum is the main thinking part of the brain. [1 mark]

A. Both A and R true and R explains A

B. Both A and R true but R does not explain A

C. A true, R false

D. A false, R true

Answer

C. A true, R false

Step by step

1. **Judge Assertion and Reason separately, then choose C:** Assertion A is true: NCERT says many involuntary actions are controlled by the mid-brain and hind-brain. Reason R is false: the fore-brain is the main thinking part, while the cerebellum supports precise movement, posture and balance. Choose C: A true, R false. Why: A false reason cannot explain a true assertion; the other three assertion–reason combinations are ruled out.

Topic and concept

Human nervous system — brain, spinal cord, reflex arc. NCERT names the fore-brain as the main thinking part. It links many involuntary actions to the mid-brain and hind-brain; the medulla regulates specific involuntary functions and the cerebellum helps with precision, posture and balance.

How marks are earned

1. A is true because NCERT assigns many involuntary actions to the mid-brain and hind-brain; R is false because the fore-brain, not the cerebellum, is the main thinking part of the brain. (1 mark)

Source check: Check the reasoning against NCERT Class 10 Science, Ch. 6, §6.1.2 Human Brain, PDF pp. 4–5: Many involuntary actions are controlled by mid-brain and hind-brain; the fore-brain is the main thinking part, while the cerebellum supports precision, posture and balance.

Question 9

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): Pollination always requires insects. Reason (R): Pollination is the transfer of pollen grains from anther to stigma. [1 mark]

A. Both A and R true and R explains A

B. Both A and R true but R does not explain A

C. A true, R false

D. A false, R true

Answer

D. A false, R true

Step by step

1. **Select and justify the option:** Assertion is false because pollination can also be carried out by wind or water; Reason is true as it defines pollination. Why: Pollination is defined as pollen transfer, and it can be biotic or abiotic

Topic and concept

Sexual reproduction in flowering plants — pollination. Pollination is the transfer of pollen grains from anther to stigma and can be self-pollination or cross-pollination mediated by biotic or abiotic agents.

How marks are earned

1. Assertion is false because pollination can also be carried out by wind or water; Reason is true as it defines pollination. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.4: Pollination is defined as pollen transfer, and it can be biotic or abiotic

Question 10

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Differentiate between biodegradable and non-biodegradable substances. Provide one example for each category. [2 marks]

Answer

Biodegradable substances are those that can be decomposed by biological organisms over time; for example, vegetable peels. Non-biodegradable substances persist under ambient conditions and require physical or chemical methods to break down; for example, plastic bottles.

Step by step

1. **Define biodegradable substances and give an example:** Biodegradable substances are those that biological organisms such as bacteria and fungi can decompose over time, so they are broken down into simpler materials. Example: vegetable peels. Why: Decomposers use enzymes to break down organic matter, so the material is recycled into the environment instead of accumulating. This is why a biological agent is the key part of the definition.
2. **Define non-biodegradable substances and give an example:** Non-biodegradable substances persist under ambient conditions because biological organisms cannot break them down, and they need physical or chemical methods to be broken down. Example: plastic bottles. They remain in the environment and can accumulate there. Why: Materials such as plastics resist enzymatic breakdown, so they stay unchanged for long periods. The contrast with step 1 is the deciding factor: biological decomposition for one group and persistence for the other.

Topic and concept

Biodegradable and non-biodegradable substances. Substances are classed as biodegradable if biological organisms can decompose them, and as non-biodegradable if they resist this and persist in the environment. The question asks for this contrast with one example of each.

How marks are earned

1. Biodegradable substances are those that can be decomposed by biological organisms over time; for example, vegetable peels. (1 mark)
2. Non-biodegradable substances persist under ambient conditions and require physical or chemical methods to break down; for example, plastic bottles. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 13, §13.2.2 Managing the Garbage we Produce: Biodegradable materials change form by biological action while non-biodegradable ones remain unchanged under ambient conditions.

Question 11

2 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

(a) Describe saprotrophic nutrition with an example. [2 marks]

Answer

In saprotrophic nutrition, organisms secrete digestive enzymes onto dead or decaying organic matter and absorb the resulting soluble nutrients. Fungi such as bread moulds and mushrooms exhibit saprotrophic nutrition by decomposing and absorbing material from their substrates.

Step by step

1. **Describe the process of saprotrophic nutrition:** In saprotrophic nutrition, the organism secretes digestive enzymes onto dead or decaying organic matter outside its body. The enzymes break the complex molecules down into simpler soluble nutrients, and the organism then absorbs these nutrients. Why: A saprotroph cannot make its own food, so it digests externally and absorbs the products. The sequence of secreting enzymes, breaking down matter and absorbing nutrients is what separates it from holozoic nutrition (ingestion and internal digestion) and parasitic nutrition (feeding on a living host).
2. **Give a suitable example:** Fungi such as bread moulds and mushrooms are saprotrophs. They grow on dead or decaying material, decompose it with secreted enzymes and absorb the resulting nutrients. Why: Fungi are typical decomposers, which links the example back to the definition in step 1. Because they feed on dead matter, they also act as decomposers in nature.

Topic and concept

Heterotrophic nutrition — saprotrophic, holozoic, parasitic. Heterotrophs depend directly or indirectly on autotrophs and use enzymes to break down complex organic substances. Saprotrophs are the heterotrophs that digest dead and decaying matter outside the body and then absorb it.

How marks are earned

1. In saprotrophic nutrition, organisms secrete digestive enzymes onto dead or decaying organic matter and absorb the resulting soluble nutrients. (1 mark)
2. Fungi such as bread moulds and mushrooms exhibit saprotrophic nutrition by decomposing and absorbing material from their substrates. (1 mark)

Source check: Check the reasoning against NCERT Science X, Chapter 5, §5.2.2 Heterotrophic Nutrition: Heterotrophic organisms cannot synthesise their own food and therefore break down complex molecules externally or internally, adopting strategies like decomposition (saprotrophy), ingestion (holozoic) or deriving nutrients from a host (parasitic).

OR

Option B

Answer the question with working and reasons where needed.

(a) Define life processes and list the main processes involved. [2 marks]

Answer

Life processes are the set of maintenance functions that sustain the internal order and prevent breakdown in living organisms. These processes include nutrition, respiration, transport and excretion, which together enable growth and survival.

Step by step

1. **Work through marking point 1:** Life processes are the set of maintenance functions that sustain the internal order and prevent breakdown in living organisms. Why: Even at rest or during sleep, organisms must continuously perform maintenance functions—nutrition, respiration, transport and excretion—to prevent breakdown, and these collectively are called life processes.
2. **Work through marking point 2:** These processes include nutrition, respiration, transport and excretion, which together enable growth and survival. Why: Even at rest or during sleep, organisms must continuously perform maintenance functions—nutrition, respiration, transport and excretion—to prevent breakdown, and these collectively are called life processes.

Topic and concept

Living beings; basic concept of nutrition, respiration, transport and excretion. Life processes are the integrated set of functions—nutrition, respiration, transport and excretion—that sustain the internal order and enable growth in all living organisms.

How marks are earned

1. Life processes are the set of maintenance functions that sustain the internal order and prevent breakdown in living organisms. (1 mark)
2. These processes include nutrition, respiration, transport and excretion, which together enable growth and survival. (1 mark)

Source check: Check the reasoning against NCERT Science X, Chapter 5, §5.1 WHAT ARE LIFE PROCESSES?: Even at rest or during sleep, organisms must continuously perform maintenance functions—nutrition, respiration, transport and excretion—to prevent breakdown, and these collectively are called life processes.

Question 12

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) State two structural features that protect the brain and spinal cord. [2 marks]

Answer

The brain is enclosed within the skull, a bony box that shields it from mechanical injury. The spinal cord is protected by the vertebral column and cushioned by cerebrospinal fluid inside membranes.

Step by step

1. **State the protection of the brain by the skull:** The brain is enclosed within the skull, a bony box that shields it from mechanical injury. This is the first structural feature. Why: The brain is soft tissue that is easily damaged, so a rigid bony case spreads the force of a blow and keeps the organ safe.
2. **State the protection of the spinal cord by the vertebral column and CSF:** The spinal cord lies inside the vertebral column (backbone), which protects it. It is also cushioned by cerebrospinal fluid held inside protective membranes (meninges), which is the second feature. Why: The vertebral column gives a bony cover along the length of the cord. The fluid-filled membranes act as a shock absorber, so a jolt reaches the central nervous system in a weaker form.

Topic and concept

Human nervous system — brain, spinal cord, reflex arc. The brain and spinal cord form the central nervous system, which controls the body, so the body protects them with bony covers and a fluid cushion. The skull covers the brain, and the vertebral column covers the spinal cord.

How marks are earned

1. The brain is enclosed within the skull, a bony box that shields it from mechanical injury. (1 mark)
2. The spinal cord is protected by the vertebral column and cushioned by cerebrospinal fluid inside membranes. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.1.3: The brain sits in a bony skull and is surrounded by fluid for shock absorption, while the spinal cord lies inside the vertebral column.

Question 13

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) If 2×10^5 J of solar energy falls on the leaves of green plants, calculate the amount of energy stored as chemical energy by producers, given that they capture about 1% of incident sunlight. Also state why this stored energy is important. [3 marks]

Answer

Using 1% capture, stored energy = 1/100 × 2×10^5 J = 2×10^3 J. Thus, producers store 2000 J of chemical energy from the incident sunlight. This stored energy supports the nutritional needs of heterotrophs in the ecosystem.

Step by step

1. **Apply the 1% capture rule to the incident energy:** Stored energy = (1/100) × 2×10^5 J = 0.01 × 200000 J = 2000 J = 2×10^3 J. Why: Green plants capture only about 1% of the sunlight falling on them, so the stored energy is found by multiplying the incident energy by this fraction. Check: 1% of 200000 is 2000, and 2000 is much smaller than 200000, as it should be.
2. **State the result with its unit:** Producers store 2000 J of chemical energy (2×10^3 J) from the incident sunlight, and this amount is what is available at the first trophic level. Why: The answer is energy, so it needs the unit joule. Writing it in chemical form shows that it is converted sunlight now held in food made by photosynthesis.
3. **Explain why the stored energy is important:** This stored chemical energy is passed along the food chain and supports the nutritional needs of heterotrophs, the consumers that cannot make their own food. Why: Producers are the first trophic level and the only entry point of energy into the food chain. All consumers depend directly or indirectly on this energy, so the ecosystem is sustained by it.

Topic and concept

Ecosystem and its components. In a food chain, producers are the first trophic level and they convert about 1% of incident sunlight into chemical energy through photosynthesis. This stored energy is the source for all the consumers in the chain.

How marks are earned

1. Using 1% capture, stored energy = 1/100 × 2×10^5 J = 2×10^3 J. (1 mark)
2. Thus, producers store 2000 J of chemical energy from the incident sunlight. (1 mark)
3. This stored energy supports the nutritional needs of heterotrophs in the ecosystem. (1 mark)

> **Source check:** Check the reasoning against NCERT Class 10 science, Ch. 13, §13.1.1: Green plants capture about 1% of sunlight energy to convert into food.

Question 14

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Describe Mendel's law of independent assortment and illustrate it using a dihybrid cross of seed shape and seed colour. [3 marks]

Answer

Mendel's law of independent assortment states that alleles of two different genes segregate independently during gamete formation if they are on different chromosomes. In a dihybrid cross between RrYy plants, the alleles for seed shape (R, r) and seed colour (Y, y) distribute independently, producing four types of gametes in equal proportions. The F2 generation exhibits a 9:3:3:1 phenotypic ratio for round-yellow, round-green, wrinkled-yellow, and wrinkled-green seeds, confirming the law.

Step by step

1. **State the law in Class X words:** Mendel's law of independent assortment says that when two pairs of contrasting traits are followed together, the alleles of one gene pair separate into gametes independently of the alleles of the other pair, so the inheritance of seed shape does not depend on the inheritance of seed colour. Why: This follows from Mendel's finding (NCERT Ch. 8, §8.2.2) that paired factors separate so each gamete gets one allele; with two traits, each pair separates on its own, which is what 'independent' means.
2. **Set up the dihybrid cross and list the gametes:** Cross round-yellow RRYY with wrinkled-green rryy: the F1 plants are all RrYy and show round-yellow seeds. On self-pollination an F1 plant forms four gamete types, RY, Ry, rY and ry, in equal proportions (1/4 each), because R can pair with either Y or y and r can pair with either Y or y. Why: Equal numbers of all four gamete types, including the new combinations Ry and rY, show that shape alleles and colour alleles were not tied together as in the parents. This is the core evidence for independence.
3. **Combine gametes in a Punnett square and read the F2 ratio:** Four male gametes × four female gametes give 4 × 4 = 16 combinations. Counting phenotypes: round-yellow 9, round-green 3, wrinkled-yellow 3, wrinkled-green 1, so the F2 ratio is 9:3:3:1. Check: 9 + 3 + 3 + 1 = 16. Round-green and wrinkled-yellow are new combinations not seen in either parent. Why: The 9:3:3:1 ratio of the dihybrid cross (NCERT Ch. 8, §8.2.3) is what you get when each trait on its own still gives 3:1 and the two traits combine at random. The new combinations confirm independent assortment.

Topic and concept

Mendel's contribution; laws of inheritance — law of segregation, law of independent assortment. Mendel found that each organism carries two versions (alleles) of a gene, and that these separate during gamete formation and join again at fertilisation. In a dihybrid cross two such gene pairs, seed shape (R, r) and seed colour (Y, y), are followed together. Because each pair

separates independently, an RrYy plant makes four gamete types in equal numbers, and random fertilisation gives the 9:3:3:1 F2 ratio.

How marks are earned

1. Mendel's law of independent assortment states that alleles of two different genes segregate independently during gamete formation if they are on different chromosomes. (1 mark)
2. In a dihybrid cross between RrYy plants, the alleles for seed shape (R, r) and seed colour (Y, y) distribute independently, producing four types of gametes in equal proportions. (1 mark)
3. The F2 generation exhibits a 9:3:3:1 phenotypic ratio for round-yellow, round-green, wrinkled-yellow, and wrinkled-green seeds, confirming the law. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.3: Dihybrid crosses showing a 9:3:3:1 ratio illustrate independent segregation of different gene pairs.

Question 15

4 marks

Case Based

Arjun accidentally touches a hot iron plate and immediately withdraws his hand, without thinking. The next morning he notices his potted plant bending toward the window light and wonders how organisms coordinate such responses.

(a) Read the following scenario and answer the question. Case: Arjun accidentally touches a hot iron plate and immediately withdraws his hand, without thinking. Question: What type of action does Arjun's withdrawal of his hand represent? [1 mark]

Answer

Arjun's hand withdrawal is a reflex action because it is an immediate, involuntary response to a harmful stimulus without conscious thought.

Step by step

1. **Work through marking point 1:** Arjun's hand withdrawal is a reflex action because it is an immediate, involuntary response to a harmful stimulus without conscious thought. Why: Reflex actions are immediate, involuntary responses to environmental stimuli without conscious thought.

Topic and concept

Voluntary, involuntary and reflex actions. Reflex actions are immediate, involuntary responses to stimuli without conscious thought, while voluntary actions are deliberate movements initiated by the brain.

How marks are earned

1. Arjun's hand withdrawal is a reflex action because it is an immediate, involuntary response to a harmful stimulus without conscious thought. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.1.1 What happens in Reflex Actions?: Reflex actions are immediate, involuntary responses to environmental stimuli without conscious thought.

(b) Based on the case passage, identify which part of the central nervous system primarily mediates the hand-withdrawal reflex. [1 mark]

Answer

The spinal cord mediates the hand-withdrawal reflex by receiving sensory impulses and sending motor impulses without involving conscious brain processing.

Step by step

1. **Trace the reflex arc to find the controlling centre:** The hot plate stimulates the heat receptor in the skin. A sensory neuron carries the impulse to the spinal cord. There it passes to a motor neuron, which carries the impulse to the effector, the arm muscle, and the hand is pulled away. The spinal cord is therefore the part of the central nervous system that mediates the reflex. The signal reaches the brain only afterwards, which is why Arjun feels the pain after he has withdrawn his hand. Why: A reflex action is immediate and involuntary (NCERT Ch. 6, §6.1.1). The spinal cord, part of the central nervous system, passes information quickly between receptors and effectors (§6.1.2). Skipping the brain's decision-making step makes the response fast. The nearest wrong answer, the brain, applies to voluntary actions, not this one.

Topic and concept

Human nervous system — brain, spinal cord, reflex arc. The central nervous system is the brain and spinal cord. In a reflex action the path is receptor, sensory neuron, spinal cord, motor neuron, effector, and no conscious thought is involved. The brain is informed afterwards, so the response comes before the sensation of pain.

How marks are earned

1. The spinal cord mediates the hand-withdrawal reflex by receiving sensory impulses and sending motor impulses without involving conscious brain processing. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.1.2 Human Brain: Spinal cord is part of the central nervous system that conveys information rapidly between receptors and effectors in reflex actions.

Attempt one of the final two-mark options.

Option A

(c) (i) From the same scenario, what term describes the plant's growth toward the window light? (ii) Which plant hormone accumulates on the shaded side of the stem to cause bending toward light? [2 marks]

Answer

The plant's growth toward the window light is called phototropism, a directional growth response toward light. Auxin accumulates on the shaded side of the stem, promoting cell elongation that bends the plant toward light.

Step by step

1. **Name the plant response (part i):** The plant's directional growth toward the window light is called phototropism, a tropic movement in which the stem bends toward the light source. Why: Tropic movements are directional growth responses of plants toward or away from a stimulus (NCERT Ch. 6, §6.2). When the stimulus is light the response is called phototropism, and the stem growing toward light is the positive case.
2. **Identify the hormone and explain the bending (part ii):** The hormone is auxin. Auxin collects on the shaded side of the stem, away from the light. Cells on the shaded side elongate more than cells on the lit side, so the stem bends toward the light. Why: Auxin promotes cell elongation in stems and directs phototropic bending (NCERT Ch. 6, §6.2.2). Unequal elongation on the two sides is what turns the stem toward the light. The nearest wrong idea is that auxin collects on the lit side. If it did, the stem would bend away from the light.

Topic and concept

Tropic movements in plants. Phototropism is the directional growth of a plant part in response to light. Auxin is a plant hormone that makes stem cells elongate. When light falls from one side, auxin gathers on the shaded side, those cells grow longer, and the stem curves toward the light.

How marks are earned

1. The plant's growth toward the window light is called phototropism, a directional growth response toward light. (1 mark)
2. Auxin accumulates on the shaded side of the stem, promoting cell elongation that bends the plant toward light. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.2 Coordination in Plants: Tropic movements are directional growth responses of plants toward or away from stimuli such as light. Check the reasoning against NCERT Class 10 science, Ch. 6, §6.2.2 Plant Hormones: Auxin is a plant hormone that promotes cell elongation in stems, directing phototropic bending.

OR

Option B

(c) Trace the nerve impulse from Arjun's hand to the muscle that withdraws it, and explain why the response is rapid. [2 marks]

Answer

A receptor in the skin sends an impulse along a sensory neuron to the spinal cord, where it is relayed to a motor neuron. The motor neuron carries the impulse to an arm muscle, causing withdrawal through a spinal reflex without waiting for conscious brain processing.

Step by step

1. **Read the given facts:** A receptor in the skin sends an impulse along a sensory neuron to the spinal cord, where it is relayed to a motor neuron. Why: A reflex arc carries an impulse from a receptor through a sensory neuron and spinal cord to a motor neuron and effector muscle.
2. **Apply the concept and check the result:** The motor neuron carries the impulse to an arm muscle, causing withdrawal through a spinal reflex without waiting for conscious brain processing. Why: A reflex arc carries an impulse from a receptor through a sensory neuron and spinal cord to a motor neuron and effector muscle.

Topic and concept

Tropic movements in plants. A reflex arc carries an impulse from a receptor through a sensory neuron and spinal cord to a motor neuron and effector muscle.

How marks are earned

1. A receptor in the skin sends an impulse along a sensory neuron to the spinal cord, where it is relayed to a motor neuron. (1 mark)
2. The motor neuron carries the impulse to an arm muscle, causing withdrawal through a spinal reflex without waiting for conscious brain processing. (1 mark)

Source check: Check the passage facts and NCERT Class 10 science, Ch. 6, §6.1.1 What happens in Reflex Actions? against both steps.

Question 16

5 marks

Long Answer

Attempt one option.

Option A

Answer both connected parts. Show the required method, explanation and units.

(a) Which part of the brain maintains posture and equilibrium? [2 marks]

Answer

The cerebellum, a part of the hind-brain, maintains posture and equilibrium. It coordinates the precision of voluntary muscle movements needed for balance.

Step by step

1. **Name the precise brain part:** The cerebellum, which is part of the hind-brain, maintains posture and equilibrium. Why: NCERT identifies the cerebellum rather than the whole hind-brain as the region responsible for precision and balance.
2. **Explain its role:** The cerebellum coordinates voluntary muscle movements such as walking straight or riding a bicycle, helping the body stay balanced. Why: Coordinated timing and precision of muscle action make controlled movement and stable posture possible.

Topic and concept

Human nervous system — brain, spinal cord, reflex arc. The cerebellum is a part of the hind-brain. It coordinates precise voluntary movement and helps maintain posture and balance.

How marks are earned

1. Name the cerebellum, a part of the hind-brain, as the structure that maintains posture and equilibrium. (1 mark)
2. Explain that the cerebellum coordinates precise voluntary movements and balance. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.1.2: The hind-brain controls posture and equilibrium.

(b) Describe the three major regions of the human brain and their primary functions. [3 marks]

Answer

The fore-brain is the main thinking and sensory-interpretation region and helps direct voluntary action. The mid-brain and hind-brain control many involuntary actions. Within the hind-brain, the medulla regulates actions such as blood pressure and salivation, while the cerebellum coordinates precise voluntary movement and maintains posture and balance.

Step by step

1. **Describe the fore-brain:** The fore-brain receives sensory information, supports thinking and memory, and controls voluntary actions after interpreting those inputs. Why: NCERT identifies the fore-brain as the main thinking part with sensory and motor areas.
2. **Describe the mid-brain role within involuntary control:** The mid-brain, together with the hind-brain, controls many involuntary actions that do not require conscious thought. Why: NCERT groups mid-brain and hind-brain for involuntary control; it does not describe the mid-brain here as a relay station.
3. **Name the important hind-brain parts:** The medulla in the hind-brain controls actions such as blood pressure, salivation and vomiting; the cerebellum coordinates precise voluntary movement and maintains posture and balance. Why: Naming the parts avoids attributing every hind-brain function to one undifferentiated region.

Topic and concept

Human nervous system — brain, spinal cord, reflex arc. NCERT divides the brain into fore-brain, mid-brain and hind-brain. The fore-brain interprets sensory input and controls voluntary action; mid- and hind-brain help control involuntary actions, while the medulla and cerebellum have specific roles within the hind-brain.

How marks are earned

1. Describe the fore-brain as the main thinking and sensory-interpretation region that directs voluntary actions. (1 mark)
2. State that the mid-brain, together with the hind-brain, controls many involuntary actions. (1 mark)
3. Name the medulla for involuntary functions and the cerebellum for precision, posture and balance within the hind-brain. (1 mark)

Source check: Checked against downloaded NCERT Science X Ch. 6, Control and Coordination pp. 103–104: fore-brain thinking/sensory role; mid- and hind-brain involuntary control; medulla and cerebellum functions.

OR

Option B

Answer both connected parts. Show the required method, explanation and units.

(a) Based on the NCERT description, define a reflex action and give one example. [2 marks]

Answer

A reflex action is an immediate, involuntary response to a stimulus that occurs without conscious thought. An example of a reflex action is quickly withdrawing the hand upon touching a hot object.

Step by step

1. **Work through marking point 1:** A reflex action is an immediate, involuntary response to a stimulus that occurs without conscious thought. Why: Reflex actions are responses to environmental changes that occur without conscious thought.
2. **Work through marking point 2:** An example of a reflex action is quickly withdrawing the hand upon touching a hot object. Why: Reflex actions are responses to environmental changes that occur without conscious thought.

Topic and concept

Voluntary, involuntary and reflex actions. Reflex actions are immediate, involuntary responses to stimuli without conscious thought, while voluntary actions are deliberate movements initiated by the brain.

How marks are earned

1. A reflex action is an immediate, involuntary response to a stimulus that occurs without conscious thought. (1 mark)
2. An example of a reflex action is quickly withdrawing the hand upon touching a hot object. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.1.1: Reflex actions are responses to environmental changes that occur without conscious thought.

(b) Describe the role of gibberellins in seed germination. [3 marks]

Answer

Gibberellins break seed dormancy by stimulating the synthesis of enzymes such as amylase. The amylase converts stored starch in the endosperm into sugars, providing energy for the growing embryo. Gibberellins also promote the elongation of the embryo and growth of the seedling.

Step by step

1. **Work through marking point 1:** Gibberellins break seed dormancy by stimulating the synthesis of enzymes such as amylase. Why: Gibberellins stimulate seed germination by promoting enzyme production and growth.
2. **Work through marking point 2:** The amylase converts stored starch in the endosperm into sugars, providing energy for the growing embryo. Why: Gibberellins stimulate seed germination by promoting enzyme production and growth.
3. **Work through marking point 3:** Gibberellins also promote the elongation of the embryo and growth of the seedling. Why: Gibberellins stimulate seed germination by promoting enzyme production and growth.

Topic and concept

plant hormones — auxin, gibberellin, cytokinin, abscisic acid. Gibberellins stimulate seed germination and stem elongation; cytokinins promote cell division; abscisic acid induces seed dormancy and helps plants respond to stress.

How marks are earned

1. Gibberellins break seed dormancy by stimulating the synthesis of enzymes such as amylase. (1 mark)
2. The amylase converts stored starch in the endosperm into sugars, providing energy for the growing embryo. (1 mark)
3. Gibberellins also promote the elongation of the embryo and growth of the seedling. (1 mark)

Source check: Check the reasoning against Concept CH6-C07: Gibberellins stimulate seed germination by promoting enzyme production and growth.

Section B

Question 17

1 mark

Mcq

Choose the correct answer.

(a) Which of the following best explains why metals exhibit a shiny metallic lustre? [1 mark]

A. Presence of tightly bound core electrons

B. Delocalised electrons on the surface reflecting light uniformly

C. Mobile ions oscillating under incident light

D. Arrangement of atoms in cubic lattices

Answer

B. Delocalised electrons on the surface reflecting light uniformly

Step by step

1. **Select and justify the option:** Metals have delocalised (free) electrons at their surface which reflect incident light uniformly, producing a shiny lustre. Why: Pure metals have a shining surface called metallic lustre due to their free electrons.

Topic and concept

Physical properties of metals and non-metals. Pure metals exhibit a lustrous appearance because their free electrons reflect light uniformly.

How marks are earned

1. Metals have delocalised (free) electrons at their surface which reflect incident light uniformly, producing a shiny lustre. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 3, §3.1.1: Pure metals have a shining surface called metallic lustre due to their free electrons.

Question 18

1 mark

Mcq

Choose the correct answer.

(a) Which of the following reactions is most likely with ethene (C_2H_4)? [1 mark]

A. Addition of bromine across the C=C bond

B. Substitution of a hydrogen atom by chlorine

C. Formation of a ring structure without breaking bonds

D. Decomposition into methane

Answer

A. Addition of bromine across the C=C bond

Step by step

1. **Select and justify the option:** Ethene, being unsaturated with a C=C bond, readily undergoes addition reactions such as bromine addition. Why: Unsaturated compounds with double bonds undergo addition reactions.

Topic and concept

Saturated and unsaturated carbon compounds; chain, branch and ring structures. Compounds with only single C–C bonds are saturated and relatively unreactive, while those with double or triple bonds are unsaturated and more prone to addition reactions; chains can also branch or form rings.

How marks are earned

1. Ethene, being unsaturated with a C=C bond, readily undergoes addition reactions such as bromine addition. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.2.1: Unsaturated compounds with double bonds undergo addition reactions.

Question 19

1 mark

Mcq

Choose the correct answer.

(a) Rancidity in edible oils is primarily caused by: [1 mark]

A. oxidation of unsaturated fatty acids

B. reduction of triglycerides

C. polymerization of glycerol

D. precipitation of free fatty acids

Answer

A. oxidation of unsaturated fatty acids

Step by step

1. **Select and justify the option:** Rancidity occurs when unsaturated fatty acids in oils react with oxygen, producing compounds with bad odor and taste. Why: Rancidity is the oxidation of fats or oils resulting in unpleasant odors and flavors.

Topic and concept

Rancidity and corrosion. Rancidity is the oxidation of fats or oils leading to unpleasant odors and flavors.

How marks are earned

1. Rancidity occurs when unsaturated fatty acids in oils react with oxygen, producing compounds with bad odor and taste. (1 mark)

Source check: Check the reasoning against NCERT Chemistry Class X, Ch.1, §1.2.5: Rancidity is the oxidation of fats or oils resulting in unpleasant odors and flavors.

Question 20

1 mark

Mcq

Choose the correct answer.

(a) When sodium carbonate reacts with dilute hydrochloric acid, which gas is evolved that turns lime water milky? [1 mark]

A. Oxygen

B. Hydrogen

C. Carbon dioxide

D. Nitrogen

Answer

C. Carbon dioxide

Step by step

1. **Select and justify the option:** Sodium carbonate reacts with dilute HCl to evolve carbon dioxide, which turns lime water milky. Why: metal carbonates react with acid to give CO_2 which turns lime water milky

Topic and concept

Reaction of metal carbonates and metal hydrogencarbonates with acids. Metal carbonates and hydrogencarbonates react with acids to liberate carbon dioxide, water and a salt.

How marks are earned

1. Sodium carbonate reacts with dilute HCl to evolve carbon dioxide, which turns lime water milky. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 2, §2.1.3: metal carbonates react with acid to give CO_2 which turns lime water milky

Question 21

1 mark

Mcq

Choose the correct answer.

(a) Which metal reacts most vigorously with cold water to produce hydroxide and hydrogen gas? [1 mark]

A. Magnesium

B. Calcium

C. Sodium

D. Silver

Answer

C. Sodium

Step by step

1. **Select and justify the option:** Sodium reacts vigorously with cold water to form sodium hydroxide and hydrogen gas. Why: Alkali metals like sodium react violently with cold water to form hydroxide and hydrogen gas.

Topic and concept

Chemical properties — reaction with oxygen, water, acids and other metal salts. Metals react with water to give metal hydroxides and hydrogen; the vigour increases down the reactivity series.

How marks are earned

1. Sodium reacts vigorously with cold water to form sodium hydroxide and hydrogen gas. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 3, §3.2.2: Alkali metals like sodium react violently with cold water to form hydroxide and hydrogen gas.

Question 22

1 mark

Mcq

Choose the correct answer.

(a) What is the term for the unique ability of carbon to form long chains of carbon atoms? [1 mark]

A. Polymerisation

B. Catenation

C. Isomerisation

D. Coordination

Answer

B. Catenation

Step by step

1. **Select and justify the option:** The property of carbon atoms bonding with each other to form long chains is called catenation. Why: Carbon exhibits catenation by forming bonds with other carbon atoms to make long chains, branches, or rings.

Topic and concept

Covalent bonding in carbon compounds; versatile nature of carbon. Carbon's ability to bond to other carbon atoms (catenation) and its valency of four enable formation of diverse stable structures such as long chains, branches, and rings.

How marks are earned

1. The property of carbon atoms bonding with each other to form long chains is called catenation. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.2: Carbon exhibits catenation by forming bonds with other carbon atoms to make long chains, branches, or rings.

Question 23

1 mark

Mcq

Choose the correct answer.

(a) Which metal is protected from corrosion by the formation of a thin, adherent oxide layer? [1 mark]

A. Aluminium

B. Iron

C. Copper

D. Sodium

Answer

A. Aluminium

Step by step

1. **Select and justify the option:** Aluminium forms a thin, protective Al2O3 layer on its surface that inhibits further corrosion. Why: Corrosion is the oxidative deterioration of metals, and protective oxide layers slow it down.

Topic and concept

Rancidity and corrosion. Corrosion is the oxidative deterioration of metals that can be slowed by protective coatings.

How marks are earned

1. Aluminium forms a thin, protective Al2O3 layer on its surface that inhibits further corrosion. (1 mark)

Source check: Check the reasoning against NCERT Chemistry Class X, Ch.1, §1.2.6: Corrosion is the oxidative deterioration of metals, and protective oxide layers slow it down.

Question 24

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): A solution of NaOH when diluted to ten times its original volume changes its pH by 1 unit. Reason (R): Diluting a base decreases [OH^-] by the same factor and pOH increases by 1. [1 mark]

A. Both A and R true and R explains A

B. Both A and R true but R does not explain A

C. A true, R false

D. A false, R true

Answer

A. Both A and R true and R explains A

Step by step

1. **Check A and R and decide how they are related:** Take NaOH of concentration 0.1 M. [OH^-] = 0.1 M = 10^{-1} M, so pOH = 1 and pH = 14 − 1 = 13. After tenfold dilution [OH^-] = 10^{-2} M, so pOH = 2 and pH = 12. The pH has changed by 1 unit, so A is true. In R, [OH^-] falls by a factor of 10 and pOH rises by 1, so R is also true. R gives the reason for A: pH + pOH = 14, so when pOH rises by 1, pH must fall by 1. The key is A. Why: pH is a logarithmic scale (NCERT Ch. 2, §2.2), so a change in concentration by a factor of 10 shifts the value by exactly 1 unit. Option B is the nearest wrong choice, because R is not an unrelated fact but the direct reason for A. This holds for moderate concentrations. Extremely dilute solutions are not considered, because pH would then be limited by the water itself, which is outside the question's assumption.

Topic and concept

pH scale; importance of pH in everyday life. The pH scale measures how acidic or basic a solution is, and it is logarithmic. For a base, pH + pOH = 14. A tenfold change in [OH^-] shifts pOH by 1 and so shifts pH by 1 in the opposite direction, so diluting a base lowers its pH by 1.

How marks are earned

1. Tenfold dilution reduces [OH^-] by ten times, so pOH increases by 1 and pH decreases by 1. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 2, §2.2: Logarithmic nature of pH/pOH means tenfold change shifts scale by 1 unit.

Question 25

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Explain how (i) painting or oiling and (ii) galvanising help prevent corrosion of iron. [2 marks]

Answer

Painting or oiling blocks contact between iron and air/moisture. Galvanising adds a protective zinc coating that helps stop the iron from rusting.

Step by step

1. **Explain protective coating:** Painting or oiling covers the metal surface so air and moisture do not contact the metal and corrosion is slowed. Why: A barrier blocks the contact needed for rusting or similar corrosion.
2. **Explain galvanising:** Galvanising coats iron or steel with zinc, which protects the underlying metal from corrosion. Why: The zinc layer separates iron from the air and moisture responsible for rusting.

Topic and concept

Corrosion and its prevention. Corrosion can be prevented by isolating metal from air and water: painting, oiling or greasing provide a barrier, while galvanising adds a protective zinc coating.

How marks are earned

1. Explain that paint or oil forms a barrier between iron and air or moisture, slowing corrosion. (1 mark)
2. Explain that galvanising coats iron with zinc, helping prevent contact with air or moisture and rusting. (1 mark)

Source check: Downloaded NCERT Science X, Ch. 3, corrosion prevention: painting or oiling makes a barrier, and galvanising applies a zinc coating.

Question 26

3 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

(a) Provide the IUPAC name and structural formula of the compound CH3–CH(OH)–CH3, and identify its functional group. [3 marks]

Answer

The IUPAC name of CH3–CH(OH)–CH3 is propan-2-ol. Its structural formula is CH3–CHOH–CH3 with the –OH group attached to the middle carbon. The functional group present is the hydroxyl group (–OH), characteristic of alcohols.

Step by step

1. **Derive the IUPAC name stepwise:** The longest carbon chain has 3 carbons, so the parent is propane. The functional group is –OH, so the 'e' is dropped and 'ol' is added, giving propanol. Numbering from either end puts –OH on carbon 2, which gives the locant 2. The name is propan-2-ol. Why: Naming follows the rule that the functional group sets the suffix, and the chain is numbered to give the group the lowest possible locant (NCERT Ch. 4, §4.2.3). The locant 2 shows that –OH is on the middle carbon and not on an end carbon. The nearest wrong name, propan-1-ol, would place the –OH on an end carbon.
2. **Write the full structural formula:** The three carbons are joined in a chain, C–C–C. The middle carbon carries the –OH group and one H. Each end carbon carries three H atoms. In the condensed form this is CH3–CH(OH)–CH3. The count is 3 carbons, 8 hydrogens and 1 oxygen, which is C3H8O. Why: A structural formula shows every atom and bond, and each carbon must form four bonds. The middle carbon has two C–C bonds, one C–O bond and one C–H bond, which makes four. This confirms the –OH really is on the middle carbon.
3. **Identify the functional group:** The group –OH (hydroxyl) is attached to a carbon of the chain, so the compound is an alcohol and the functional group is the hydroxyl group. Why: A functional group is an atom or group of atoms that defines a class of carbon compounds and determines their chemical behaviour (NCERT Ch. 4, Table 4.3). The –OH group is what makes this compound an alcohol and gives it the suffix 'ol'.

Topic and concept

Nomenclature of carbon compounds; functional groups. A functional group such as –OH replaces a hydrogen in a hydrocarbon chain and sets the compound's class, name and properties. For CH3–CH(OH)–CH3, the 3-carbon chain gives 'propane', the –OH gives the suffix 'ol', and its position on carbon 2 gives propan-2-ol.

How marks are earned

1. The IUPAC name of CH3–CH(OH)–CH3 is propan-2-ol. (1 mark)
2. Its structural formula is CH3–CHOH–CH3 with the –OH group attached to the middle carbon. (1 mark)
3. The functional group present is the hydroxyl group (–OH), characteristic of alcohols. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, Table 4.3: Alcohols contain the –OH functional group, as seen in propan-2-ol.

OR

Option B

Answer the question with working and reasons where needed.

(a) Give the IUPAC name of CH3COOH, write its displayed structural formula, and identify its functional group. [3 marks]

Answer

CH3COOH is named ethanoic acid because it has two carbon atoms and the carboxylic acid ending -oic acid. Its displayed structure is CH3–C(=O)–OH, with the carbonyl oxygen double-bonded to the second carbon. The functional group is the carboxyl group –COOH, which identifies the compound as a carboxylic acid.

Step by step

1. **Explain marking point 1:** CH3COOH is named ethanoic acid because it has two carbon atoms and the carboxylic acid ending -oic acid. Why: A functional group such as –OH replaces a hydrogen in a hydrocarbon chain and sets the compound's class, name and properties. For CH3–CH(OH)–CH3, the 3-carbon chain gives 'propane', the –OH gives the suffix 'ol', and its position on carbon 2 gives propan-2-ol.
2. **Explain marking point 2:** Its displayed structure is CH3–C(=O)–OH, with the carbonyl oxygen double-bonded to the second carbon. Why: A functional group such as –OH replaces a hydrogen in a hydrocarbon chain and sets the compound's class, name and properties. For CH3–CH(OH)–CH3, the 3-carbon chain gives 'propane', the –OH gives the suffix 'ol', and its position on carbon 2 gives propan-2-ol.
3. **Explain marking point 3:** The functional group is the carboxyl group –COOH, which identifies the compound as a carboxylic acid. Why: A functional group such as –OH replaces a hydrogen in a hydrocarbon chain and sets the compound's class, name and properties. For CH3–CH(OH)–CH3, the 3-carbon chain gives 'propane', the –OH gives the suffix 'ol', and its position on carbon 2 gives propan-2-ol.

Topic and concept

Nomenclature of carbon compounds; functional groups. A functional group such as –OH replaces a hydrogen in a hydrocarbon chain and sets the compound's class, name and properties. For CH3–CH(OH)–CH3, the 3-carbon chain gives 'propane', the –OH gives the suffix 'ol', and its position on carbon 2 gives propan-2-ol.

How marks are earned

1. CH3COOH is named ethanoic acid because it has two carbon atoms and the carboxylic acid ending -oic acid. (1 mark)
2. Its displayed structure is CH3–C(=O)–OH, with the carbonyl oxygen double-bonded to the second carbon. (1 mark)

3. The functional group is the carboxyl group –COOH, which identifies the compound as a carboxylic acid. (1 mark)

Source check: Check the name, displayed formula and functional group against NCERT Class 10 science, Ch. 4, Table 4.3.

Question 27

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Define a double displacement reaction and write two balanced chemical equations with state symbols for such reactions. [3 marks]

Answer

A double displacement reaction involves the exchange of ions between two reactant compounds to form two new products. $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$. $BaCl_2(aq) + K_2SO_4(aq) \rightarrow BaSO_4(s) + 2KCl(aq)$.

Step by step

1. **Define a double displacement reaction:** A double displacement reaction is one in which two compounds react and exchange their ions (cation and anion partners) to form two new compounds. It is often recognised by the formation of a precipitate, so the pattern is AB + CD → AD + CB. Why: NCERT Ch. 1, §1.2.4 describes the cations and anions swapping between the reactant compounds. This distinguishes it from a displacement reaction, in which one element replaces another element in a compound.
2. **Write and balance the first equation with state symbols:** $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$. Balance check: Ag 1 = 1, N 1 = 1, O 3 = 3, Na 1 = 1, Cl 1 = 1. The ions Ag^+ and Na^+ exchange partners, and the insoluble white AgCl forms as a precipitate. Why: The equation is already balanced when atoms of each element are equal on both sides. State symbols show that the reactants are dissolved in water (aq) and the precipitate is a solid (s). The solid product is the usual signal of double displacement. The marks go to any valid balanced example with state symbols.
3. **Write and balance the second equation with state symbols:** $BaCl_2(aq) + K_2SO_4(aq) \rightarrow BaSO_4(s) + 2KCl(aq)$. Balance check: Ba 1 = 1, S 1 = 1, O 4 = 4, K 2 = 2, Cl 2 = 2. The coefficient 2 in front of KCl is needed to balance both K and Cl. Here Ba^{2+} and K^+ exchange partners, and white $BaSO_4$ precipitates. Why: Balancing obeys conservation of mass: the number of atoms of each element must not change. Without the 2 before KCl, K and Cl would each be 1 on the right and 2 on the left. The exchange of partners and the formation of a precipitate show it is a double displacement reaction.

Topic and concept

Types of chemical reactions — displacement and double displacement. In a double displacement reaction, two compounds in solution exchange ions to form two new compounds. One product is often an insoluble precipitate. Equations must be balanced so that atoms of each element are equal on both sides, and state symbols (aq), (s) show the physical state of each substance.

How marks are earned

1. A double displacement reaction involves the exchange of ions between two reactant compounds to form two new products. (1 mark)
2. $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$. (1 mark)
3. $BaCl_2(aq) + K_2SO_4(aq) \rightarrow BaSO_4(s) + 2KCl(aq)$. (1 mark)

Source check: Check the reasoning against NCERT Chemistry, Ch. 1, §1.2.3: Double displacement reactions involve ion exchange between two compounds.

Question 28

4 marks

Case Based

A group of students investigated four organic compounds: Compound A is C_2H_6 with only single bonds; Compound B is C_2H_4 containing one C=C bond; Compound C is CH_3CH_2OH featuring an –OH group; and Compound D is CH_3COOH with a –COOH group. They observed that Compound A and B are non-conductors, Compound B underwent addition reaction with hydrogen to yield ethane, Compound C dehydrated to ethene on heating with acid, and Compound D formed an ester when reacted with ethanol.

(a) Based on the passage, which compound is unsaturated? [1 mark]

Answer

Compound B (C_2H_4) contains a C=C double bond and hence is unsaturated.

Step by step

1. **Work through marking point 1:** Compound B (C_2H_4) contains a C=C double bond and hence is unsaturated. Why: Unsaturated carbon compounds have double or triple bonds and undergo addition reactions.

Topic and concept

Saturated and unsaturated carbon compounds; chain, branch and ring structures. Compounds with only single C–C bonds are saturated and relatively unreactive, while those with double or triple bonds are unsaturated and more prone to addition reactions; chains can also branch or form rings.

How marks are earned

1. Compound B (C_2H_4) contains a C=C double bond and hence is unsaturated. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.2.1 Saturated and Unsaturated Carbon Compounds: Unsaturated carbon compounds have double or triple bonds and undergo addition reactions.

(b) Which structural feature shared by the four compounds illustrates carbon’s catenation? [1 mark]

Answer

Each compound has two carbon atoms directly bonded (C–C or C=C), showing carbon's ability to bond with carbon.

Step by step

1. **Identify carbon-carbon bonding:** Each listed compound has two carbon atoms directly bonded to one another; the C–C or C=C link is an example of catenation. Why: Catenation means carbon atoms bonding to other carbon atoms, so ethane is one clear example but is not the only valid one.

Topic and concept

Covalent bonding in carbon compounds; versatile nature of carbon. Catenation is the ability of carbon to bond to carbon. Ethane, ethene, ethanol and ethanoic acid in the passage each contain a direct carbon-carbon link.

How marks are earned

1. Identify the carbon-carbon bond shared by all four compounds as the structural feature illustrating catenation. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.2 Versatile Nature of Carbon: Carbon atoms can bond to other carbon atoms (catenation) forming chains, branches, or rings.

Attempt one of the final two-mark options.

Option A

(c) (i) Which functional group is present in Compound C as per the passage? (ii) According to the passage, which reaction type does Compound B undergo? [2 marks]

Answer

Compound C has the –OH group, indicating it is an alcohol. Compound B undergoes an addition reaction, where hydrogen adds across the C=C bond to form ethane.

Step by step

1. **Identify the functional group in Compound C (CH3CH2OH) from the passage:** Compound C is written as CH3CH2OH, so its heteroatom-containing group is –OH (hydroxyl), which places it in the alcohol class (ethanol). Why: A functional group is a heteroatom or group that replaces hydrogen in a hydrocarbon chain, and the –OH group defines the alcohol class and its behaviour.
2. **Identify the reaction type of Compound B (C2H4) from the passage:** Compound B has a C=C double bond and reacts with hydrogen to give ethane, C2H4 + H2 → C2H6 (usually with a nickel catalyst). Hydrogen adds across the double bond, so the reaction is an addition reaction (hydrogenation). Why: An unsaturated compound has a double bond that can open so that new atoms attach to both carbons. The product has only single bonds, which is the pattern of addition, not substitution.

Topic and concept

Nomenclature of carbon compounds; functional groups. Functional groups such as –OH decide the class and behaviour of a carbon compound. Unsaturated compounds with a C=C bond undergo addition reactions, whereas saturated ones such as ethane are comparatively unreactive. Here the passage is read for two things: the group in CH3CH2OH and the reaction that turns ethene into ethane.

How marks are earned

1. Compound C has the –OH group, indicating it is an alcohol. (1 mark)
2. Compound B undergoes an addition reaction, where hydrogen adds across the C=C bond to form ethane. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.2.3 Will you be my Friend?: The –OH group defines the alcohol class in carbon compounds. Check the reasoning against NCERT Class 10 science, Ch. 4, §4.2.1 Saturated and Unsaturated Carbon Compounds: Unsaturated compounds undergo addition reactions across their double bonds.

OR

Option B

(c) Write the reaction of Compound B with hydrogen to form Compound A, and explain the change in bonding. [2 marks]

Answer

$C_2H_4 + H_2 \rightarrow C_2H_6$ is the addition (hydrogenation) reaction described in the passage. Hydrogen adds across the C=C double bond of unsaturated ethene, producing saturated ethane with only single bonds.

Step by step

1. **Read the given facts:** $C_2H_4 + H_2 \rightarrow C_2H_6$ is the addition (hydrogenation) reaction described in the passage. Why: Hydrogenation adds hydrogen across the double bond of an unsaturated hydrocarbon, replacing the C=C bond with a saturated C–C bond.
2. **Apply the concept and check the result:** Hydrogen adds across the C=C double bond of unsaturated ethene, producing saturated ethane with only single bonds. Why: Hydrogenation adds hydrogen across the double bond of an unsaturated hydrocarbon, replacing the C=C bond with a saturated C–C bond.

Topic and concept

Nomenclature of carbon compounds; functional groups. Hydrogenation adds hydrogen across the double bond of an unsaturated hydrocarbon, replacing the C=C bond with a saturated C–C bond.

How marks are earned

1. $C_2H_4 + H_2 \rightarrow C_2H_6$ is the addition (hydrogenation) reaction described in the passage. (1 mark)
2. Hydrogen adds across the C=C double bond of unsaturated ethene, producing saturated ethane with only single bonds. (1 mark)

Source check: Check the passage facts and NCERT Class 10 science, Ch. 4, §4.2.1 Saturated and Unsaturated Carbon Compounds against both steps.

Question 29

5 marks

Long Answer

Attempt one option.

Option A

Answer both connected parts. Show the required method, explanation and units.

(a) Define metallic lustre. [2 marks]

Answer

Metallic lustre is the property of pure metals that gives them a shiny appearance when their surface is cleaned. This lustrous appearance arises because the free electrons on the metal surface reflect light uniformly.

Step by step

1. **State the definition of metallic lustre:** Metallic lustre is the shining surface that a pure metal shows. It appears when the metal is cleaned, because the tarnish or dirt layer is removed. Why: The shine belongs to the pure metal itself. A dull layer on the surface hides it, so the surface must be clean for the property to be seen.
2. **Give the reason for the shine:** The free electrons in the metal reflect the light falling on the surface uniformly, so the metal looks bright and shiny. Why: The cited concept links lustre to free electrons reflecting light uniformly. Because the electrons reflect the incident light rather than absorbing it, a clean metal surface appears shiny.

Topic and concept

Physical properties of metals and non-metals. Pure metals are lustrous: when cleaned, they show a shining surface called metallic lustre. The concept statement attributes this to free electrons reflecting light uniformly.

How marks are earned

1. Metallic lustre is the property of pure metals that gives them a shiny appearance when their surface is cleaned. (1 mark)
2. This lustrous appearance arises because the free electrons on the metal surface reflect light uniformly. (1 mark)

Source check: Check the reasoning against NCERT Science, Ch. 3 §3.1.1 Metals: Pure metals exhibit a shining surface, called metallic lustre, when cleaned.

(b) Compare metals and non-metals in terms of lustre, malleability and electrical conductivity. Give one difference for each. [3 marks]

Answer

Metals exhibit metallic lustre and have a shiny surface when cleaned, whereas non-metals are generally dull in appearance. Metals are malleable and can be beaten into thin sheets; non-metals are brittle and break when hammered. Metals conduct electricity in solid form due to free electrons, whereas non-metals do not conduct electricity when solid.

Step by step

1. **Compare lustre:** Metals, when clean, show metallic lustre and look shiny. Non-metals are generally dull in appearance. Why: Lustre depends on how the surface reflects light, and metals reflect it strongly. The word 'generally' matters because iodine and graphite are non-metal exceptions that are shiny.
2. **Compare malleability:** Metals are malleable and can be beaten into thin sheets. Non-metals are brittle and break into pieces when hammered. Why: Non-metals generally lack malleability, so they cannot be shaped by hammering. Metals can be beaten into sheets without breaking.
3. **Compare electrical conductivity:** Metals conduct electricity in the solid state because they have free electrons. Non-metals are generally poor conductors and do not conduct when solid. Graphite, a non-metal, is a well-known exception. Why: Conduction needs charge carriers that can move. Free electrons in metals provide them, while non-metals usually lack them. Graphite is the exception to the general rule.

Topic and concept

Physical properties of metals and non-metals. Metals are lustrous, malleable and good conductors, whereas non-metals are generally dull, brittle and poor conductors. The comparison is general, and graphite and iodine are named exceptions.

How marks are earned

1. Metals exhibit metallic lustre and have a shiny surface when cleaned, whereas non-metals are generally dull in appearance. (1 mark)
2. Metals are malleable and can be beaten into thin sheets; non-metals are brittle and break when hammered. (1 mark)
3. Metals conduct electricity in solid form due to free electrons, whereas non-metals do not conduct electricity when solid. (1 mark)

Source check: Check the reasoning against NCERT Science, Ch. 3 §3.1.1 Metals: Metals are lustrous, malleable, and conduct electricity.

OR

Option B

Answer both connected parts. Show the required method, explanation and units.

(a) State any two physical properties that distinguish non-metals from metals. [2 marks]

Answer

Non-metals generally lack malleability and cannot be beaten into thin sheets, unlike metals. Non-metals do not conduct electricity in solid form, whereas metals are good conductors of electricity.

Step by step

1. **Work through marking point 1:** Non-metals generally lack malleability and cannot be beaten into thin sheets, unlike metals. Why: Non-metals generally lack malleability, ductility, and electrical conductivity.
2. **Work through marking point 2:** Non-metals do not conduct electricity in solid form, whereas metals are good conductors of electricity. Why: Non-metals generally lack malleability, ductility, and electrical conductivity.

Topic and concept

Physical properties of metals and non-metals. Pure metals exhibit a lustrous appearance because their free electrons reflect light uniformly.

How marks are earned

1. Non-metals generally lack malleability and cannot be beaten into thin sheets, unlike metals. (1 mark)
2. Non-metals do not conduct electricity in solid form, whereas metals are good conductors of electricity. (1 mark)

Source check: Check the reasoning against NCERT Science, Ch. 3 §3.1.2 Non-metals: Non-metals generally lack malleability, ductility, and electrical conductivity.

(b) Describe what happens when an iron nail is placed in copper(II) sulfate solution. Write the balanced equation, the observation, and explain the reaction using the reactivity series. [3 marks]

Answer

$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$. Observation: A brown deposit of copper forms on the iron nail and the blue color of the solution fades. Explanation: Iron is higher than copper in the reactivity series, so it displaces copper from its salt solution.

Step by step

1. **Work through marking point 1:** Fe + $CuSO_4$ → $FeSO_4$ + Cu. Why: A metal higher in the reactivity series displaces a less reactive metal from its salt solution.
2. **Work through marking point 2:** Observation: A brown deposit of copper forms on the iron nail and the blue color of the solution fades. Why: A metal higher in the reactivity series displaces a less reactive metal from its salt solution.
3. **Work through marking point 3:** Explanation: Iron is higher than copper in the reactivity series, so it displaces copper from its salt solution. Why: A metal higher in the reactivity series displaces a less reactive metal from its salt solution.

Topic and concept

Reactivity series. The reactivity series arranges metals by their tendency to be oxidized, predicting displacement reactions.

How marks are earned

1. Fe + $CuSO_4$ → $FeSO_4$ + Cu. (1 mark)
2. Observation: A brown deposit of copper forms on the iron nail and the blue color of the solution fades. (1 mark)
3. Explanation: Iron is higher than copper in the reactivity series, so it displaces copper from its salt solution. (1 mark)

Source check: Check the reasoning against NCERT Science, Ch. 3 §3.2.4 Metals react with acids and salts: A metal higher in the reactivity series displaces a less reactive metal from its salt solution.

Section C

Question 30

1 mark

Mcq

Choose the correct answer.

(a) Tyndall effect can be observed in which of the following? [1 mark]

A. Clear sugar solution

B. Salt solution

C. Colloidal suspension of milk in water

D. Pure distilled water

Answer

C. Colloidal suspension of milk in water

Step by step

1. **Select and justify the option:** Colloidal suspensions have particle sizes comparable to the wavelength of light and scatter it, exhibiting the Tyndall effect. Why: Scattering of light by colloidal particles makes beams visible in a colloidal medium.

Topic and concept

Scattering of light — Tyndall effect, Rayleigh scattering; colour of sky and sunset. The Tyndall effect is the scattering of light by colloidal particles, making light beams visible in media such as fog or milk.

How marks are earned

1. Colloidal suspensions have particle sizes comparable to the wavelength of light and scatter it, exhibiting the Tyndall effect. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.4: Scattering of light by colloidal particles makes beams visible in a colloidal medium.

Question 31

1 mark

Mcq

Choose the correct answer.

(a) Which type of lens is used to correct myopia? [1 mark]

A. Convex lens

B. Concave lens

C. Cylindrical lens

D. Convex bifocal lens

Answer

B. Concave lens

Step by step

1. **Select and justify the option:** Myopia is corrected by a concave lens which diverges incoming rays so that the image is formed on the retina. Why: Correction of myopia is done using a concave lens of suitable power.

Topic and concept

Defects of vision — myopia, hypermetropia, presbyopia; correction with lenses. Myopia is the defect in which distant objects form images in front of the retina, making them appear blurred.

How marks are earned

1. Myopia is corrected by a concave lens which diverges incoming rays so that the image is formed on the retina. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.2: Correction of myopia is done using a concave lens of suitable power.

Question 32

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): In a metallic wire, conventional current is taken opposite to the direction of electron drift. Reason (R): Conventional current is defined as the direction of positive-charge flow, while electrons carry negative charge. [1 mark]

A. Both A and R true and R explains A

B. Both A and R true but R does not explain A

C. A true, R false

D. A false, R true

Answer

A. Both statements are true, and the positive-charge current convention explains why electron drift is opposite to conventional current.

Step by step

1. **Read the current convention:** The direction of current is defined as the direction in which positive charge would flow. Electrons are negative, so their drift is opposite; both assertion and reason are true and R explains A. Why: The revised assertion and reason directly match the Class X explanation, giving unambiguous option A.

Topic and concept

Electric potential difference and electric current; Ohm's law. The conventional direction of current is the direction of positive-charge flow. Electrons carry negative charge in metallic wires, so their drift is opposite to the assigned current direction.

How marks are earned

1. Select A: conventional current is positive-charge-flow direction and electrons are negative, explaining their opposite drift direction. (1 mark)

Source check: Downloaded NCERT Science X, Ch. 11, electric current: positive-charge-flow convention makes current direction opposite to electron drift.

Question 33

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Explain dispersion of white light through a glass prism and why violet light deviates more than red. [2 marks]

Answer

Dispersion occurs because the prism's refractive index varies with wavelength, so different colours refract at different angles. Violet light has a shorter wavelength and higher refractive index in glass, so it bends more than red light which has a longer wavelength.

Step by step

1. **Explain why white light disperses in a prism:** White light is a mixture of colours. At the prism faces each colour has a different refractive index, so each is bent through a different angle and the colours separate into a spectrum. Why: Dispersion happens because the refractive index depends on wavelength. If every colour bent equally, white light would pass through without splitting.
2. **Explain why violet deviates more than red:** Violet has a shorter wavelength and a higher refractive index in glass, so it slows more in glass and bends more. Red has a longer wavelength and lower refractive index, so it bends least. In the spectrum, red is deviated least and violet most. Why: A higher refractive index means a larger bending at each face. Violet therefore has the greatest deviation and red the smallest.

Topic and concept

Refraction of light through a prism; dispersion. Dispersion in a prism occurs because different wavelengths refract by different amounts. Violet light deviates more than red, so white light splits into its constituent colours.

How marks are earned

1. Dispersion occurs because the prism's refractive index varies with wavelength, so different colours refract at different angles. (1 mark)
2. Violet light has a shorter wavelength and higher refractive index in glass, so it bends more than red light which has a longer wavelength. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.3.2 Dispersion of Light: Different wavelengths refract by different amounts in a prism, causing white light to split into colours

Question 34

2 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

(a) State Ohm’s law for a conductor at constant temperature. [2 marks]

Answer

At constant temperature, the current through a conductor is directly proportional to the potential difference across its ends. This relationship is expressed by the formula V = IR according to Ohm’s law.

Step by step

1. **Work through marking point 1:** At constant temperature, the current through a conductor is directly proportional to the potential difference across its ends. Why: Ohm’s law states that at constant temperature current through a conductor is directly proportional to the potential difference across it.
2. **Work through marking point 2:** This relationship is expressed by the formula V = IR according to Ohm’s law. Why: Ohm’s law states that at constant temperature current through a conductor is directly proportional to the potential difference across it.

Topic and concept

Electric potential difference and electric current; Ohm’s law. Ohm’s law states that at constant temperature the current through a conductor is directly proportional to the potential difference across it.

How marks are earned

1. At constant temperature, the current through a conductor is directly proportional to the potential difference across its ends. (1 mark)
2. This relationship is expressed by the formula V = IR according to Ohm’s law. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, §11.2 Circuit for studying Ohm's law: Ohm’s law states that at constant temperature current through a conductor is directly proportional to the potential difference across it.

OR

Option B

Answer the question with working and reasons where needed.

(a) Define electric current and state its SI unit. [2 marks]

Answer

Electric current is the rate of flow of electric charge through a conductor in the direction of positive charge movement. Its SI unit is ampere, defined as one coulomb of charge passing a point in one second.

Step by step

1. **Work through marking point 1:** Electric current is the rate of flow of electric charge through a conductor in the direction of positive charge movement. Why: Electric current is defined as the amount of charge flowing per unit time through a conductor.
2. **Work through marking point 2:** Its SI unit is ampere, defined as one coulomb of charge passing a point in one second. Why: Electric current is defined as the amount of charge flowing per unit time through a conductor.

Topic and concept

Electric potential difference and electric current; Ohm's law. Potential difference between two points is the work done per unit charge to move the charge from one point to the other.

How marks are earned

1. Electric current is the rate of flow of electric charge through a conductor in the direction of positive charge movement. (1 mark)
2. Its SI unit is ampere, defined as one coulomb of charge passing a point in one second. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, §11.1 Electric current and circuit: Electric current is defined as the amount of charge flowing per unit time through a conductor.

Question 35

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Explain with ray interpretation how a convex lens produces an image when the object is placed between the lens and its principal focus, and state the nature of the image. [3 marks]

Answer

A ray parallel to the principal axis refracts through the focal point on the opposite side of the convex lens; trace the emergent ray backward to locate the virtual image. A ray passing through the optical centre continues undeviated through the lens. Their backward extensions meet on the object side, forming a virtual, erect and enlarged image.

Step by step

1. **Work through marking point 1:** A ray parallel to the principal axis refracts through the focal point on the opposite side of the convex lens; trace the emergent ray backward to locate the virtual image. Why: Convex lens produces virtual, erect, enlarged image for object within focal length
2. **Work through marking point 2:** A ray passing through the optical centre continues undeviated through the lens. Why: Convex lens produces virtual, erect, enlarged image for object within focal length
3. **Work through marking point 3:** Their backward extensions meet on the object side, forming a virtual, erect and enlarged image. Why: Convex lens produces virtual, erect, enlarged image for object within focal length

Topic and concept

Refraction at spherical surfaces; lenses; lens formula. The thin-lens equation relates object distance u, image distance v and focal length f as $1/v - 1/u = 1/f$, with sign conventions for converging and diverging lenses.

How marks are earned

1. A ray parallel to the principal axis refracts through the focal point on the opposite side of the convex lens; trace the emergent ray backward to locate the virtual image. (1 mark)
2. A ray passing through the optical centre continues undeviated through the lens. (1 mark)
3. Their backward extensions meet on the object side, forming a virtual, erect and enlarged image. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 9, §9.3.5: Convex lens produces virtual, erect, enlarged image for object within focal length

Question 36

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) A copper wire of length 2 m and cross-sectional area 1.0×10^{-6} m² has a resistivity of 1.7×10^{-8} Ω·m. Calculate its resistance. [3 marks]

Answer

Using the relation $R = \rho l/A$ (where ρ is resistivity, l is length and A is cross-sectional area). Substituting $\rho = 1.7 \times 10^{-8}$ Ω·m, $l = 2$ m and $A = 1.0 \times 10^{-6}$ m² gives $R = (1.7 \times 10^{-8} \times 2) / (1.0 \times 10^{-6})$ Ω. Calculating this value yields $R = 0.034$ Ω.

Step by step

1. **Write the given data and the formula:** Given $\rho = 1.7 \times 10^{-8}$ Ω·m, $l = 2$ m and $A = 1.0 \times 10^{-6}$ m². The formula is $R = \rho l/A$. Why: Resistance varies directly with length and inversely with cross-sectional area, and ρ is the material property. This formula joins all the given quantities.
2. **Substitute the values into the formula:** $R = (1.7 \times 10^{-8}$ Ω·m $\times$ 2 m$) / (1.0 \times 10^{-6}$ m²$) = (3.4 \times 10^{-8}) / (1.0 \times 10^{-6})$ Ω. Why: The numerator multiplies resistivity by length. The area in the denominator is in m², so all quantities are in SI units.
3. **Evaluate and check the unit:** $3.4 \times 10^{-8} \div 10^{-6} = 3.4 \times 10^{-2}$ Ω $= 0.034$ Ω. The unit check is (Ω·m × m)/m² = Ω. Why: Subtracting powers of ten $(-8 - (-6) = -2)$ gives 3.4×10^{-2}. The unit reducing to Ω confirms that the setup is dimensionally correct.

Topic and concept

Resistance of a conductor; factors affecting resistance; resistivity. The resistance of a conductor depends on its length, cross-sectional area and the resistivity of its material, as $R = \rho l/A$. A long, thin wire has more resistance. Copper has a very small resistivity, so this 2 m wire has a small resistance.

How marks are earned

1. Using the relation $R = \rho l/A$ (where ρ is resistivity, l is length and A is cross-sectional area). (1 mark)
2. Substituting $\rho = 1.7 \times 10^{-8}$ Ω·m, $l = 2$ m and $A = 1.0 \times 10^{-6}$ m² gives $R = (1.7 \times 10^{-8} \times 2) / (1.0 \times 10^{-6})$ Ω. (1 mark)
3. Calculating this value yields $R = 0.034$ Ω. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, §11.5 Factors affecting resistance: Resistance of a conductor is given by $R = \rho l/A$ where ρ is resistivity.

Question 37

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Describe the function of a fuse in a domestic electric circuit. Why is choosing the correct fuse rating important? [3 marks]

Answer

A fuse is a protective device that contains a thin wire which melts when the current exceeds its specified value, breaking the circuit. The melting of the fuse wire prevents excessive current from flowing, protecting appliances and wiring from damage and fire hazards. Selecting the correct fuse rating ensures that the fuse will blow under fault conditions but will not interrupt the normal operating current of the circuit.

Step by step

1. **State what a fuse is and how it acts in the circuit:** A fuse is a safety device containing a thin wire of low melting point, connected in series with the live wire. When the current exceeds its rated value, the wire heats up, melts, and breaks the circuit. Why: Current produces heat in a conductor (heating effect, $H = I^2Rt$), so a thin wire heats fastest. Because the fuse is in series, all the circuit current passes through it, and its melting stops the current.
2. **Explain how the broken circuit protects appliances and wiring:** Once the fuse wire melts, the circuit is open and the current falls to zero. This stops excess current from overheating the wires and appliances, which prevents damage and fire. This happens during a short circuit or overloading. Why: Excess current in a short circuit or overload would keep heating the wires, whose insulation could burn. Opening the circuit removes the heating at its source, as in NCERT §12.7 (fuses melt under high current to break the circuit).
3. **Justify the importance of the correct fuse rating with an example:** The rating should be slightly above the normal current. For a 1000 W appliance on 220 V, $I = P/V = 1000/220 \approx 4.5$ A, so a 5 A fuse is suitable. A 2 A fuse would blow on normal use. A 20 A fuse would not melt at a harmful current such as 10 A, so the wire could overheat unprotected. Why: A fuse protects only if its rated current lies just above the normal load current. Too low a rating causes false trips, and too high a rating gives no protection. Check: $4.5 \text{ A} < 5 \text{ A}$, so normal use is safe.

Topic and concept

Domestic electric circuits; earthing; fuse; MCB. A fuse works on the heating effect of current. A thin, low-melting wire is placed in series with the live wire. It melts when the current exceeds its rating and breaks the circuit. The rating must therefore match the normal load: just above the normal current, but well below the current that would harm the wiring.

How marks are earned

1. A fuse is a protective device that contains a thin wire which melts when the current exceeds its specified value, breaking the circuit. (1 mark)

2. The melting of the fuse wire prevents excessive current from flowing, protecting appliances and wiring from damage and fire hazards. (1 mark)
3. Selecting the correct fuse rating ensures that the fuse will blow under fault conditions but will not interrupt the normal operating current of the circuit. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.12, §12.9: A fuse wire melts under excessive current to break the circuit, and its rating must suit the normal load to avoid false trips.

Question 38

4 marks

Case Based

A student sets up a circuit with a 6 V battery, variable resistor, ammeter in series and voltmeter across the resistor. At a 100 Ω setting, the voltmeter reads 6.0 V and ammeter 0.06 A; at 200 Ω, they read 6.0 V and 0.03 A. Separately, the student compares two test wires of the same material and length. The second wire has twice the cross-sectional area of the first.

(a) What is the function of the voltmeter in the student's experimental setup? [1 mark]

Answer

The voltmeter measures the potential difference across the resistor.

Step by step

1. **Work through marking point 1:** The voltmeter measures the potential difference across the resistor. Why: A voltmeter is used to measure the potential difference across a component in a circuit.

Topic and concept

Electric potential difference and electric current; Ohm's law. Ohm's law states that at constant temperature the current through a conductor is directly proportional to the potential difference across it.

How marks are earned

1. The voltmeter measures the potential difference across the resistor. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, §11.3 Circuit diagram: A voltmeter is used to measure the potential difference across a component in a circuit.

(b) Calculate the resistance setting corresponding to a current of 0.04 A in the experiment. [1 mark]

Answer

Using Ohm's law R = V/I, the resistance is 6.0 V ÷ 0.04 A = 150 Ω.

Step by step

1. **Work through marking point 1:** Using Ohm’s law R = V/I, the resistance is 6.0 V ÷ 0.04 A = 150 Ω. Why: Potential difference between two points is work done per unit charge and is related to current by Ohm’s law V = IR.

Topic and concept

Electric potential difference and electric current; Ohm’s law. Ohm’s law states that at constant temperature the current through a conductor is directly proportional to the potential difference across it.

How marks are earned

1. Using Ohm’s law R = V/I, the resistance is 6.0 V ÷ 0.04 A = 150 Ω. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, §11.2 Electric potential and potential difference: Potential difference between two points is work done per unit charge and is related to current by Ohm’s law V = IR.

Attempt one of the final two-mark options.

Option A

(c) (i) Which property differs between the two test wires? (ii) What is the ratio of the second wire's resistance to the first wire's resistance? [2 marks]

> **Answer**
>
> **The cross-sectional area is doubled. Since R=ρl/A at fixed material and length, the second wire has half the resistance of the first, so their resistance ratio is 1:2.**
>
> **Step by step**
>
> 1. **Identify the changed property:** The replacement test wire has twice the cross-sectional area while its length and material are unchanged. Why: Cross-sectional area is the property varied in the separate wire comparison.
> 2. **Use the resistance formula:** With resistivity ρ and length l fixed, R=ρl/A. Doubling A gives R_new=R_original/2, so R_new:R_original=1:2. Why: The relationship is inverse for the wire resistance alone; it does not assert that a connecting wire doubles the total circuit current.
>
> **Topic and concept**
>
> **Resistance of a conductor; factors affecting resistance; resistivity.** For a uniform wire, R=ρl/A. When material and length stay fixed, doubling the cross-sectional area halves that wire's resistance.
>
> **How marks are earned**
>
> 1. Identify the changed test-wire property as cross-sectional area, which is twice as large for the second wire. (1 mark)
> 2. Apply R=ρl/A at fixed material and length to show the second wire has half the resistance, giving ratio 1:2. (1 mark)
>
> **Source check:** Downloaded NCERT Science X, Ch. 11, resistance of a wire: R=ρl/A, so twice the area at fixed length and material halves the wire resistance.

OR

Option B

(c) Use the two 6 V readings to calculate both resistance settings and explain the effect of doubling resistance on current. [2 marks]

Answer

By Ohm's law, R=V/I: 6 V ÷ 0.06 A = 100 Ω and 6 V ÷ 0.03 A = 200 Ω. At fixed 6 V, doubling resistance from 100 Ω to 200 Ω halves the current from 0.06 A to 0.03 A.

Step by step

1. **Read the given facts:** By Ohm's law, R=V/I: 6 V ÷ 0.06 A = 100 Ω and 6 V ÷ 0.03 A = 200 Ω. Why: Ohm's law gives R=V/I; when voltage stays fixed, current is inversely proportional to resistance.
2. **Apply the concept and check the result:** At fixed 6 V, doubling resistance from 100 Ω to 200 Ω halves the current from 0.06 A to 0.03 A. Why: Ohm's law gives R=V/I; when voltage stays fixed, current is inversely proportional to resistance.

Topic and concept

Resistance of a conductor; factors affecting resistance; resistivity. Ohm's law gives R=V/I; when voltage stays fixed, current is inversely proportional to resistance.

How marks are earned

1. By Ohm's law, R=V/I: 6 V ÷ 0.06 A = 100 Ω and 6 V ÷ 0.03 A = 200 Ω. (1 mark)
2. At fixed 6 V, doubling resistance from 100 Ω to 200 Ω halves the current from 0.06 A to 0.03 A. (1 mark)

Source check: Check the passage facts and NCERT Class 10 science, Ch. 11, §11.3 Circuit diagram against both steps.

Question 39

5 marks

Long Answer

Attempt one option.

Option A

Answer both connected parts. Show the required method, explanation and units.

(a) Define accommodation of the human eye and briefly describe how it adjusts to focus on near and distant objects. [2 marks]

Answer

Accommodation is the ability of the eye lens to change its focal length by altering its curvature through the action of ciliary muscles. For near objects, ciliary muscles contract, making the lens thicker and decreasing its focal length, and for distant objects the muscles relax, making the lens thinner and increasing its focal length.

Step by step

1. **Define accommodation:** Accommodation is the ability of the eye lens to change its focal length by changing its curvature, through the action of the ciliary muscles. This lets the eye focus objects at different distances on the retina. Why: The lens-to-retina distance is fixed, so the eye must change the lens's focal length to focus objects at different distances. The ciliary muscles change the curvature of the lens, and with it the focal length.
2. **Describe the adjustment for near and distant objects:** For a near object (as close as the near point, 25 cm), the ciliary muscles contract, the lens becomes thicker and its focal length decreases. For a distant object (up to infinity), the muscles relax, the lens becomes thinner and its focal length increases. Why: A more curved lens bends light more strongly and so has a shorter focal length. A flatter lens bends light less and has a longer one. This is how the image stays on the retina, as in NCERT §10.1.1.

Topic and concept

Human eye; far point, near point; accommodation. Accommodation is the eye's way of keeping the image on the retina, a fixed distance from the lens. Contraction of the ciliary muscles thickens the lens for near vision, and relaxation flattens it for distant vision. The eye can focus from the near point (25 cm) to the far point (infinity).

How marks are earned

1. Accommodation is the ability of the eye lens to change its focal length by altering its curvature through the action of ciliary muscles. (1 mark)
2. For near objects, ciliary muscles contract, making the lens thicker and decreasing its focal length, and for distant objects the muscles relax, making the lens thinner and increasing its focal length. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.1.1: ciliary muscles change lens curvature to adjust focal length

(b) Explain how the eye adjusts its focal length to focus on (a) a near object, and (b) a distant object. Give three points in your answer. [3 marks]

Answer

When viewing a near object, ciliary muscles contract and zonular fibres relax, allowing the lens to become thicker and more convex, which reduces its focal length by increasing curvature. When viewing a distant object, ciliary muscles relax and zonular fibres pull the lens into a thinner shape, decreasing its curvature and increasing its focal length. This dynamic change in focal length enables the eye to form a sharp image on the retina for objects from 25 cm to infinity.

Step by step

1. **Explain near-object focusing:** For a near object, the ciliary muscles contract and the lens becomes thicker and more convex. Its curvature increases and its focal length decreases, so the diverging rays from the close object are focused on the retina. (The key also mentions relaxed zonular fibres, a detail beyond Class X.) Why: A greater curvature gives a stronger converging lens, so its focal length is shorter. A shorter focal length is needed because rays from a near object diverge more. Without this change, the image would form behind the retina.
2. **Explain distant-object focusing:** For a distant object, the ciliary muscles relax and the lens becomes thinner, with less curvature. Its focal length increases, so the nearly parallel rays are focused on the retina. (The key explains this through the zonular fibres pulling the lens thinner, again beyond Class X.) Why: Nearly parallel rays need only a weak converging lens. A flatter lens has a longer focal length and bends light less. This puts the image on the retina rather than in front of it, as in NCERT §10.1.1.
3. **State the overall effect and range:** By changing the focal length in this way, the eye keeps a sharp image on the retina, a fixed distance behind the lens, for objects from the near point (25 cm) to infinity. Why: The image distance cannot change, so only the focal length can. Since lens power P = 1/f, a shorter f means greater power for near objects and a longer f means less power for distant ones.

Topic and concept

Human eye; far point, near point; accommodation. Accommodation changes the curvature of the eye lens by the action of the ciliary muscles. The lens is thicker with a shorter focal length for near objects, and thinner with a longer focal length for distant objects. The image therefore stays on the retina for objects from 25 cm to infinity.

How marks are earned

1. When viewing a near object, ciliary muscles contract and zonular fibres relax, allowing the lens to become thicker and more convex, which reduces its focal length by increasing curvature. (1 mark)

2. When viewing a distant object, ciliary muscles relax and zonular fibres pull the lens into a thinner shape, decreasing its curvature and increasing its focal length. (1 mark)
3. This dynamic change in focal length enables the eye to form a sharp image on the retina for objects from 25 cm to infinity. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.1.1: ciliary muscle contraction makes lens thicker for near focus and relaxation makes it thinner for distant focus

OR

Option B

Answer both connected parts. Show the required method, explanation and units.

(a) State the near point and far point of a normal human eye and give their values. [2 marks]

Answer

The near point of a normal eye is the minimum distance at which an object can be seen distinctly without strain, called the least distance of distinct vision. For a young adult with normal vision, the near point is about 25 cm and the far point is at infinity.

Step by step

1. **Work through marking point 1:** The near point of a normal eye is the minimum distance at which an object can be seen distinctly without strain, called the least distance of distinct vision. Why: definition and values of near point (25 cm) and far point (infinity) for a normal eye
2. **Work through marking point 2:** For a young adult with normal vision, the near point is about 25 cm and the far point is at infinity. Why: definition and values of near point (25 cm) and far point (infinity) for a normal eye

Topic and concept

Human eye; far point, near point; accommodation. The near point of a normal eye is 25 cm, and the far point is at infinity, defining the range over which objects are seen distinctly without strain.

How marks are earned

1. The near point of a normal eye is the minimum distance at which an object can be seen distinctly without strain, called the least distance of distinct vision. (1 mark)
2. For a young adult with normal vision, the near point is about 25 cm and the far point is at infinity. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.1.1: definition and values of near point (25 cm) and far point (infinity) for a normal eye

(b) Describe the causes of myopia and explain how it is corrected. Provide three points. [3 marks]

Answer

Myopia occurs when the eyeball is too long or the eye lens has excessive curvature, causing parallel rays from distant objects to converge before reaching the retina. As a result, distant objects appear blurred because their image forms in front of the retina rather

than on it. A concave lens of suitable power diverges incoming parallel rays so that they are focused by the eye's lens exactly on the retina, restoring clear distance vision.

Step by step

1. **Work through marking point 1:** Myopia occurs when the eyeball is too long or the eye lens has excessive curvature, causing parallel rays from distant objects to converge before reaching the retina. Why: myopia arises from elongated eyeball or high lens curvature; corrected by concave lens
2. **Work through marking point 2:** As a result, distant objects appear blurred because their image forms in front of the retina rather than on it. Why: myopia arises from elongated eyeball or high lens curvature; corrected by concave lens
3. **Work through marking point 3:** A concave lens of suitable power diverges incoming parallel rays so that they are focused by the eye's lens exactly on the retina, restoring clear distance vision. Why: myopia arises from elongated eyeball or high lens curvature; corrected by concave lens

Topic and concept

Defects of vision — myopia, hypermetropia, presbyopia; correction with lenses. Myopia is corrected by a concave lens whose power causes incoming rays to diverge so that they focus precisely on the retina.

How marks are earned

1. Myopia occurs when the eyeball is too long or the eye lens has excessive curvature, causing parallel rays from distant objects to converge before reaching the retina. (1 mark)
2. As a result, distant objects appear blurred because their image forms in front of the retina rather than on it. (1 mark)
3. A concave lens of suitable power diverges incoming parallel rays so that they are focused by the eye's lens exactly on the retina, restoring clear distance vision. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.2(a): myopia arises from elongated eyeball or high lens curvature; corrected by concave lens