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CLASS X · 2026-27 · MODEL PAPER

Class X Science (Code 086) Model Paper 4

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) Which form of heterotrophic nutrition involves secreting enzymes onto the food source outside the organism? [1 mark]

A. Saprotrophic

B. Holozoic

C. Parasitic

D. Autotrophic

Answer

A. Saprotrophic

Step by step

1. **Select and justify the option:** Saprotrophic organisms (e.g., fungi) secrete digestive enzymes onto dead organic matter and then absorb the products. Why: Saprotrophs release enzymes externally to digest and then absorb nutrients.

Topic and concept

Heterotrophic nutrition — saprotrophic, holozoic, parasitic. Heterotrophs rely directly or indirectly on autotrophs, ingest complex organic substances and use enzymes to break them down; they may be saprotrophic, holozoic or parasitic.

How marks are earned

1. Saprotrophic organisms (e.g., fungi) secrete digestive enzymes onto dead organic matter and then absorb the products. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.5, §5.2.2: Saprotrophs release enzymes externally to digest and then absorb nutrients.

Question 2

1 mark

Mcq

Choose the correct answer.

(a) Which part of the brain maintains posture and equilibrium of the body? [1 mark]

A. Fore-brain

B. Mid-brain

C. Hind-brain

D. Cerebral cortex

Answer

C. Hind-brain

Step by step

1. **Identify the brain region that controls posture and balance, and eliminate the other options:** Posture and equilibrium are regulated by the cerebellum, which lies in the hind-brain, so option C (Hind-brain) is correct. The fore-brain handles thinking, memory and voluntary action, and the mid-brain handles reflex responses to sight and sound, so options A and B do not fit. The cerebral cortex (D) is part of the fore-brain and does not coordinate balance. Why: The brain is divided into regions with different roles, and the hind-brain (cerebellum, with the medulla and pons) is the region that coordinates muscle activity for balance. Matching the function to its region shows why the keyed choice follows and the others do not.

Topic and concept

Human nervous system — brain, spinal cord, reflex arc. The human brain is part of the central nervous system and is divided into the fore-brain, mid-brain and hind-brain. Each region has a main role. The hind-brain, through the cerebellum, controls posture and balance, while the fore-brain is concerned with thinking and voluntary action.

How marks are earned

1. The hind-brain is responsible for posture and equilibrium. (1 mark)

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

Question 3

1 mark

Mcq

Choose the correct answer.

(a) Regeneration differs from simple reproduction because it [1 mark]

A. always uses spores

B. requires fertilisation

C. rebuilds missing body parts to form a whole organism

D. only occurs in plants

Answer

C. rebuilds missing body parts to form a whole organism

Step by step

1. **Select and justify the option:** Regeneration involves specialised cells proliferating and differentiating to rebuild entire organisms from body fragments. Why: Specialised cells regenerate missing parts to form complete organisms

Topic and concept

Asexual reproduction — fission, fragmentation, regeneration, budding. Regeneration, exemplified by Planaria and Hydra, uses specialized cells to rebuild missing body parts, allowing complete organisms to form from fragments.

How marks are earned

1. Regeneration involves specialised cells proliferating and differentiating to rebuild entire organisms from body fragments. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.2.3: Specialised cells regenerate missing parts to form complete organisms

Question 4

1 mark

Mcq

Choose the correct answer.

(a) A woman carrier for an X-linked recessive trait marries a normal man. What proportion of their sons is expected to express the trait? [1 mark]

A. 0%

B. 25%

C. 50%

D. 100%

Answer

C. 50%

Step by step

1. **Write the genotypes of the parents, make the cross and read off the sons:** Let X^A be the normal allele and X^a the recessive allele. The carrier mother is X^A X^a and the normal father is X^A Y. The mother's eggs are X^A or X^a in equal numbers. The sons get Y from the father, so they are X^A Y (normal) or X^a Y (express the trait) in a 1 : 1 ratio. So 1/2 = 50% of sons express the trait, which is option C. Daughters get X^A from the father, so they are X^A X^A or X^A X^a and none express the trait. Why: A son gets his only X chromosome from his mother and his Y from his father. The recessive allele has no matching allele on the Y chromosome to mask it, so any son who receives X^a expresses the trait. Each egg carries X^A or X^a with equal chance, which gives 50%. This is why 0% (A) and 100% (D) are wrong. Option B (25%) is the proportion of all children, not of sons.

Topic and concept

Sex determination in human beings; sex-linked traits (qualitative). Genes on the X chromosome that are absent from the Y chromosome show sex-linked inheritance. A male has only one X chromosome, which he inherits from his mother. A recessive X-linked allele therefore shows in a male whenever he inherits it, because the Y chromosome carries no matching allele to mask it.

How marks are earned

1. Sons have a 50% chance to inherit the mother’s recessive X-linked allele and express the trait. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.4: Males inherit their X chromosome from the mother, so a carrier mother passes the allele to half her sons.

Question 5

1 mark

Mcq

Choose the correct answer.

(a) Which gas do green plants take in from the air to make carbohydrates during photosynthesis? [1 mark]

A. Oxygen

B. Carbon dioxide

C. Hydrogen

D. Nitrogen

Answer

B. Green plants take in carbon dioxide from the air during photosynthesis.

Step by step

1. **Identify the gas taken from air:** Green plants take carbon dioxide from the surrounding air for photosynthesis, so option B is correct. Why: Carbon dioxide supplies carbon used to make carbohydrates; water and light are also needed but are not gases taken in from air in this question.

Topic and concept

Autotrophic nutrition; photosynthesis — raw materials, process, outcomes. In photosynthesis, plants take in carbon dioxide and water and use light energy to make carbohydrates, releasing oxygen. Carbon dioxide is the gas taken from air for making food.

How marks are earned

1. Select B because carbon dioxide is the gas taken from air and used to make carbohydrates in photosynthesis. (1 mark)

Source check: Downloaded NCERT Science X, Ch. 5, photosynthesis: carbon dioxide is taken from air and used with water and light to make carbohydrates.

Question 6

1 mark

Mcq

Choose the correct answer.

(a) When you unknowingly jerk your hand away upon touching a hot object, this action is an example of: [1 mark]

A. voluntary action

B. reflex action

C. learned response

D. conditioned reflex

Answer

B. reflex action

Step by step

1. **Select and justify the option:** It is a reflex action because it occurs immediately without conscious thought. Why: Reflex actions occur without thinking or conscious control.

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. It is a reflex action because it occurs immediately 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 occur without thinking or conscious control.

Question 7

1 mark

Mcq

Choose the correct answer.

(a) Why is variation in DNA copies advantageous for a population? [1 mark]

A. It guarantees all offspring survive

B. It produces individuals that may adapt to changing environments

C. It prevents any mutations

D. It speeds up cell division

Answer

B. It produces individuals that may adapt to changing environments

Step by step

1. **Select and justify the option:** Variation generates diverse traits in offspring, increasing the likelihood that some individuals will survive environmental changes. Why: Variations allow some individuals to survive when environmental conditions change

Topic and concept

Basic principles of DNA copying and variation. Accurate DNA copying during cell reproduction ensures the preservation of body designs across generations while occasional copying errors generate variation essential for species adaptability.

How marks are earned

1. Variation generates diverse traits in offspring, increasing the likelihood that some individuals will survive environmental changes. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.1.1: Variations allow some individuals to survive when environmental conditions change

Question 8

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): A gene is a section of DNA that provides information for making a protein affecting a trait. Reason (R): A germ cell carries only one set of genes from its parent. [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

B. Both statements are true, but the number of gene sets in a germ cell does not explain what a gene is or how its information makes a protein.

Step by step

1. **Judge the two statements and their link:** A is true because a gene is a DNA section giving information for a protein. R is true because a germ cell has one gene set. R concerns inheritance, not the gene definition, so choose B. Why: A true biological fact does not necessarily explain a different true biological fact.

Topic and concept

Mendel's contribution; laws of inheritance — law of segregation, law of independent assortment. Genes are sections of DNA that carry information for proteins affecting traits. Germ cells carry one set of genes for inheritance; that fact is separate from the definition of a gene.

How marks are earned

1. Select B: a gene carries information for a protein, and a germ cell has one gene set, but the latter fact does not explain the gene definition. (1 mark)

Source check: Downloaded NCERT Science X, Ch. 8, heredity: a gene is a DNA section with protein information, while a germ cell carries one gene set.

Question 9

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): Hydrochloric acid in the stomach helps the digestion of proteins. Reason (R): Hydrochloric acid creates an acidic medium that facilitates the action of pepsin. [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 are true, and R explains A.

Step by step

1. **Relate stomach acid to the enzyme:** The stomach releases hydrochloric acid, which creates the acidic medium needed for pepsin to act on proteins. Thus both the assertion and reason are true, and the reason explains the assertion. Why: The revised statements follow the NCERT Class X account directly and avoid requiring pepsinogen activation details.

Topic and concept

Human digestive system. Gastric glands release hydrochloric acid and pepsin. Hydrochloric acid creates an acidic medium that facilitates pepsin's digestion of proteins.

How marks are earned

1. Select A: stomach hydrochloric acid creates the acidic medium in which pepsin acts on proteins, explaining the assertion. (1 mark)

Source check: Downloaded NCERT Science X, Ch. 5, digestion in the stomach: hydrochloric acid creates an acidic medium that helps pepsin act.

Question 10

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Differentiate between biotic and abiotic components of an ecosystem with one example each.
[2 marks]

Answer

Biotic components are living organisms such as plants, animals or microorganisms in an ecosystem. Abiotic components are non-living physical factors such as temperature, soil or rainfall.

Step by step

1. **Define biotic components and give an example:** Biotic components are the living organisms of an ecosystem, such as plants, animals and microorganisms. Example: green plants, which make food, and bacteria and fungi, which decompose dead matter. (1 mark) Why: An ecosystem is made of all the organisms in an area interacting with each other and with non-living factors. The living part is called biotic, and an example is needed to show that the term is understood.
2. **Define abiotic components and give an example, then state the difference:** Abiotic components are the non-living physical factors of the ecosystem, such as temperature, soil, water, sunlight and rainfall. Example: sunlight or soil. The difference is that biotic components are living and grow, reproduce and respond, while abiotic components are non-living physical factors that these organisms depend on. (1 mark) Why: The other part of the ecosystem is the physical environment. The two marks need a clear contrast, living versus non-living, and an example for each. A bare list of examples without the contrast would not show the difference.

Topic and concept

Ecosystem and its components. An ecosystem has interacting biotic components (living organisms) and abiotic components (the physical environment). Organisms depend on factors such as temperature, soil and water, and the living and non-living parts act together.

How marks are earned

1. Biotic components are living organisms such as plants, animals or microorganisms in an ecosystem. (1 mark)
2. Abiotic components are non-living physical factors such as temperature, soil or rainfall. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 13, §13.1: An ecosystem consists of living organisms and physical factors.

Question 11

2 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

(a) Describe the process of budding in Hydra in two steps. [2 marks]

Answer

A bud appears as an outgrowth at a specific site due to repeated cell division of regenerative cells (1 mark). The bud grows into a miniature Hydra and detaches when mature to become an independent individual (1 mark).

Step by step

1. **Describe step 1: formation of the bud:** In Hydra, repeated cell division of regenerative cells at one specific site on the body wall forms an outgrowth, the bud. (1 mark) Why: Hydra has regenerative cells that divide repeatedly. Dividing at a fixed site makes a protrusion, which is how a bud begins. Mitotic division makes the new individual a copy of the parent, so budding is asexual reproduction.
2. **Describe step 2: growth and detachment of the bud:** The bud grows and develops into a miniature Hydra with a mouth and tentacles. When it is mature it detaches from the parent and lives as an independent individual. (1 mark) Why: The bud stays attached and is fed by the parent while it develops. It separates only when it can survive alone, so budding ends with a new, separate organism.

Topic and concept

Asexual reproduction — fission, fragmentation, regeneration, budding. Budding is a form of asexual reproduction in which a new individual grows as an outgrowth from the parent body. In Hydra, repeated division of regenerative cells at a specific site forms the bud. The bud matures and then detaches as an independent organism.

How marks are earned

1. A bud appears as an outgrowth at a specific site due to repeated cell division of regenerative cells (1 mark). (1 mark)
2. The bud grows into a miniature Hydra and detaches when mature to become an independent individual (1 mark). (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.2.4: Hydra forms buds by repeated cell division

OR

Option B

Answer the question with working and reasons where needed.

(a) Define budding and give one example of an organism that reproduces by budding. [2 marks]

Answer

Budding is an asexual reproduction process in which a new individual develops from an outgrowth or bud due to repeated cell division at a specific site on the parent, contributing 1 mark. An example of budding is observed in Hydra, where buds form on the parent's body and, upon maturation, detach as independent individuals, contributing 1 mark.

Step by step

1. **Work through marking point 1:** Budding is an asexual reproduction process in which a new individual develops from an outgrowth or bud due to repeated cell division at a specific site on the parent, contributing 1 mark. Why: Hydra reproduces by budding where a bud forms and detaches.
2. **Work through marking point 2:** An example of budding is observed in Hydra, where buds form on the parent's body and, upon maturation, detach as independent individuals, contributing 1 mark. Why: Hydra reproduces by budding where a bud forms and detaches.

Topic and concept

Asexual reproduction — vegetative propagation, spore formation. Spore formation in fungi and some plants involves producing resistant reproductive spores that can germinate into new individuals under favorable conditions.

How marks are earned

1. Budding is an asexual reproduction process in which a new individual develops from an outgrowth or bud due to repeated cell division at a specific site on the parent, contributing 1 mark. (1 mark)
2. An example of budding is observed in Hydra, where buds form on the parent's body and, upon maturation, detach as independent individuals, contributing 1 mark. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.2.4: Hydra reproduces by budding where a bud forms and detaches.

Question 12

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Explain how the sex of a human child is determined genetically. [2 marks]

Answer

Human females have two X chromosomes (XX) and males have one X and one Y chromosome (XY). All children inherit an X chromosome from their mother, and the father's X or Y chromosome determines the child's sex.

Step by step

1. **State the sex chromosomes of females and males:** Human females have two X chromosomes (XX). Human males have one X and one Y chromosome (XY). (1 mark) Why: Sex in humans is decided by the X and Y chromosomes. The pairs differ between the sexes, so the combination a child inherits decides the sex.
2. **Show the cross and state who decides the sex:** Cross: mother XX × father XY. All eggs carry X. Sperms are X or Y in equal numbers. An X sperm gives XX (girl) and a Y sperm gives XY (boy), so each child has a 50 : 50 chance of being a girl or a boy. The father's X or Y chromosome decides the sex of the child. (1 mark) Why: The mother can pass on only an X chromosome, so she cannot change the outcome. The father makes two kinds of sperm, X or Y, so which sperm fertilises the egg decides the sex. This is why the mother is not responsible for the sex of the child.

Topic and concept

Sex determination in human beings; sex-linked traits (qualitative). Human sex is determined by the X and Y chromosomes inherited from the parents. Females are XX and males are XY. Every egg carries an X, while a sperm carries either X or Y, so the father's sperm decides the sex.

How marks are earned

1. Human females have two X chromosomes (XX) and males have one X and one Y chromosome (XY). (1 mark)
2. All children inherit an X chromosome from their mother, and the father's X or Y chromosome determines the child's sex. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.4: Human sex is determined genetically by inheriting XX for females or XY for males, with the father's contribution deciding the outcome.

Question 13

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) A community generates 500 kg of daily waste, of which 60% is biodegradable. Calculate the mass of biodegradable and non-biodegradable waste, and suggest appropriate disposal methods for each.
[3 marks]

Answer

Biodegradable waste mass = 60/100 × 500 kg = 300 kg. Non-biodegradable waste mass = 500 kg − 300 kg = 200 kg. The 300 kg biodegradable portion can be composted, and the 200 kg non-biodegradable part should be sent for recycling or safe landfill disposal.

Step by step

1. **Calculate the biodegradable waste using the percentage:** Mass of biodegradable waste = (60/100) × 500 kg = 0.60 × 500 kg = 300 kg. (1 mark) Why: 60% of the total waste is biodegradable, so the mass is found by multiplying the percentage fraction by the total. Biodegradable waste, such as kitchen scraps and vegetable peels, is broken down by microorganisms.
2. **Calculate the non-biodegradable waste by subtraction:** Non-biodegradable waste = total − biodegradable = 500 kg − 300 kg = 200 kg. Check: 40% of 500 kg = 0.40 × 500 kg = 200 kg, and 300 kg + 200 kg = 500 kg. (1 mark) Why: The rest of the waste, 100% − 60% = 40%, cannot be broken down by microorganisms. It is non-biodegradable, such as plastic and glass. The two masses must add up to the total, which gives a check.
3. **Suggest a disposal method for each type of waste:** The 300 kg of biodegradable waste can be composted into manure. The 200 kg of non-biodegradable waste, such as plastics and metals, should be recycled or sent to safe landfill disposal. (1 mark) Why: Biodegradable waste decomposes into compost, so composting returns nutrients to the soil. Non-biodegradable waste persists in the environment, so it is recycled to reduce landfill or disposed of safely to avoid pollution.

Topic and concept

Waste and its management; recycling and reuse. Waste is divided into biodegradable waste, which microorganisms break down, and non-biodegradable waste, which persists. Segregating the two lets each be handled suitably: composting for biodegradable waste, and recycling, reuse or safe landfill for non-biodegradable waste.

How marks are earned

1. Biodegradable waste mass = 60/100 × 500 kg = 300 kg. (1 mark)
2. Non-biodegradable waste mass = 500 kg − 300 kg = 200 kg. (1 mark)
3. The 300 kg biodegradable portion can be composted, and the 200 kg non-biodegradable part should be sent for recycling or safe landfill disposal. (1 mark)

> **Source check:** Check the reasoning against NCERT Class 10 science, Ch. 13, §13.2.2: Materials that change form are biodegradable and can be composted, while others persist and require different disposal.

Question 14

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) 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. **State how gibberellins end dormancy by triggering enzyme synthesis:** Gibberellins act on the dormant seed and stimulate the synthesis of enzymes such as amylase, so the seed moves from a resting state to an active, germinating state. Why: Abscisic acid keeps seeds dormant, while gibberellins act against this dormancy; the hormone signal therefore works first by switching on enzyme production, which is the governing idea of CH6-C07.
2. **Trace the enzyme action from starch to sugar to energy:** Amylase breaks down the stored starch in the endosperm into simple sugars, and these sugars are respired to supply energy to the growing embryo. Why: Stored starch is a large insoluble reserve that the embryo cannot use directly; digesting it to sugars makes fuel available, which links the hormone to the energy needs of germination.
3. **Link the energy supply to embryo elongation and seedling growth:** With energy available, gibberellins also promote elongation of the embryo, so the embryo grows into a seedling with an elongating stem. Why: Gibberellins are growth-promoting hormones that stimulate stem elongation, so the sequence ends in visible growth: hormone, then enzyme, then starch to sugar, then energy, then elongation.

Topic and concept

plant hormones — auxin, gibberellin, cytokinin, abscisic acid. Gibberellins stimulate seed germination and stem elongation, whereas abscisic acid induces dormancy. For this question the sequence is: gibberellin signal, amylase synthesis, starch turned to sugars, energy for the embryo, then elongation and seedling growth. Detail on the enzyme mechanism goes slightly beyond the core Class X text, so answer at the level of this sequence.

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.

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. **Identify the spinal cord as the reflex centre by following the reflex arc:** On touching the hot plate, the receptor in the skin sends a sensory impulse along the sensory neuron to the spinal cord, where it passes to a relay neuron and then to a motor neuron that reaches the muscle (effector) of the hand, so the hand withdraws without the brain's conscious thought.
   Why: A reflex is an immediate, involuntary response without conscious thought (CH6-C01); the spinal cord, part of the central nervous system (CH6-C02), is the shortcut centre that links sensory input to motor output rapidly, so it mediates the reflex.

Topic and concept

Human nervous system — brain, spinal cord, reflex arc. Reflex actions are immediate and involuntary, unlike voluntary actions started by the brain. The reflex arc runs receptor, sensory neuron, spinal cord, motor neuron, effector. The spinal cord is part of the central nervous system and handles the response without conscious processing.

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 response of the plant to light:** The plant bends toward the window light, which is a directional growth response to light, so the term is phototropism. Why: Tropic movements are directional growth responses toward or away from a stimulus (CH6-C05); because the stimulus here is light and the growth is directed toward it, the movement is phototropism.
2. **Identify auxin and explain the shaded-side bending:** Auxin moves away from the light and accumulates on the shaded side of the stem, where it promotes more cell elongation, so the shaded side grows longer than the lit side and the stem bends toward the light. Why: Auxin promotes cell elongation in stems and directs phototropic bending (CH6-C06); uneven elongation between the two sides, with the longer shaded side on the outside, is what turns the stem toward the light.

Topic and concept

Tropic movements in plants. Phototropism is directional growth of a plant toward light. The hormone auxin collects on the shaded side of the stem and makes those cells elongate faster. The unequal growth bends the stem toward the light source.

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) Define the term allele as used in genetics. [2 marks]

Answer

Alleles are alternative forms of a gene present at the same locus on homologous chromosomes. These alternative forms may exhibit dominant or recessive behaviour in determining a trait.

Step by step

1. **Define allele as an alternative form of a gene:** An allele is one of the alternative forms of the same gene, found at the same position on a pair of homologous chromosomes, such as the T and t forms of the gene for plant height. Why: A gene is a DNA section that codes for a protein influencing a trait, so different versions of that gene are alleles; each organism carries two versions, one from each parent (CH8-C01).
2. **State that alleles can be dominant or recessive, using T and t:** The alleles can behave as dominant or recessive: in a pea plant, T (tallness) is dominant and t (shortness) is recessive, so Tt gives a tall plant while tt gives a short plant. Why: The trait that shows in a plant with two different alleles is decided by dominance, so naming the dominant and recessive behaviour shows how alleles determine a trait.

Topic and concept

Mendel's contribution; laws of inheritance — law of segregation, law of independent assortment. Each organism carries two versions of a gene, called alleles, which separate during gamete formation and recombine at fertilisation. Alleles may be dominant or recessive. The T and t alleles for height in pea plants are a standard example.

How marks are earned

1. Alleles are alternative forms of a gene present at the same locus on homologous chromosomes. (1 mark)
2. These alternative forms may exhibit dominant or recessive behaviour in determining a trait. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.3: A gene is a DNA section that codes for a protein influencing a trait, and different forms of a gene are called alleles.

(b) A pea plant heterozygous for tallness (Tt) is crossed with a homozygous short plant (tt). Use a Punnett square to determine the genotypic and phenotypic ratios of their offspring. [3 marks]

Answer

The parental gametes are T and t from the heterozygous parent and t from the homozygous recessive parent. The Punnett square shows genotypes Tt and tt in a 1:1 ratio. Phenotypically, half the offspring are tall (Tt) and half are short (tt), giving a 1:1 ratio.

Step by step

1. **Write the gametes of each parent:** The Tt parent forms two kinds of gametes, T and t, while the tt parent can form only one kind, t; since T is dominant over t, this is a test cross of a heterozygous tall plant with a short plant. Why: Alleles separate during gamete formation so each gamete receives only one allele (CH8-C01); the gametes are therefore the starting inputs for the Punnett square.
2. **Complete the Punnett square and read the genotypes:** Put T and t along the top and t, t down the side. The four boxes are Tt, tt, Tt, tt. The genotypes are 2 Tt : 2 tt, which simplifies to 1 Tt : 1 tt. Why: A Punnett square combines every male gamete with every female gamete (CH8-C07), so each box is an equally likely offspring and counting the boxes gives the genotypic ratio.
3. **Convert genotypes to phenotypes:** Tt shows the dominant trait, so it is tall, while tt shows the recessive trait, so it is short. Half the offspring (2 of 4) are tall and half (2 of 4) are short, a phenotypic ratio of 1 tall : 1 short. Why: Dominance means one T allele is enough to give tallness, while shortness appears only with tt; the phenotypic ratio equals the genotypic ratio here because Tt and tt each map to one distinct phenotype.

Topic and concept

Mendel's contribution; laws of inheritance — law of segregation, law of independent assortment. A Punnett square predicts offspring ratios by combining the gametes of the two parents. In this test cross, a Tt parent gives T and t gametes and a tt parent gives only t. The offspring are 1 Tt : 1 tt, giving 1 tall : 1 short, with T dominant over t.

How marks are earned

1. The parental gametes are T and t from the heterozygous parent and t from the homozygous recessive parent. (1 mark)
2. The Punnett square shows genotypes Tt and tt in a 1:1 ratio. (1 mark)
3. Phenotypically, half the offspring are tall (Tt) and half are short (tt), giving a 1:1 ratio. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.3: Punnett square method combines parental gametes to predict offspring genotype and phenotype ratios.

OR

Option B

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

(a) State Mendel's law of independent assortment. [2 marks]

Answer

Mendel's law of independent assortment states that alleles of different genes located on different chromosomes assort independently into gametes. This results in the formation of gametes with various combinations of alleles from the parental genes.

Step by step

1. **Work through marking point 1:** Mendel's law of independent assortment states that alleles of different genes located on different chromosomes assort independently into gametes. Why: Mendel's dihybrid cross shows that different gene pairs segregate independently, producing new trait combinations.
2. **Work through marking point 2:** This results in the formation of gametes with various combinations of alleles from the parental genes. Why: Mendel's dihybrid cross shows that different gene pairs segregate independently, producing new trait combinations.

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. Mendel's law of independent assortment states that alleles of different genes located on different chromosomes assort independently into gametes. (1 mark)
2. This results in the formation of gametes with various combinations of alleles from the parental genes. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.3: Mendel's dihybrid cross shows that different gene pairs segregate independently, producing new trait combinations.

(b) A woman with normal vision, who is a carrier for red-green colour blindness, marries a man with normal vision. Determine the probability that their son will be colour blind. [3 marks]

Answer

Let X^C represent the normal allele and X^c represent the colour-blind allele; the mother's genotype is X^C X^c and the father's is X^C Y. The possible male offspring genotypes are

X^C Y and X^c Y, each with a probability of 1/2. Therefore, there is a 50% probability that a son will inherit the X^c allele and be colour blind.

Step by step

1. **Work through marking point 1:** Let X^C represent the normal allele and X^c represent the colour-blind allele; the mother's genotype is X^C X^c and the father's is X^C Y. Why: Sex-linked traits on the X chromosome show inheritance patterns that differ between males and females.
2. **Work through marking point 2:** The possible male offspring genotypes are X^C Y and X^c Y, each with a probability of 1/2. Why: Sex-linked traits on the X chromosome show inheritance patterns that differ between males and females.
3. **Work through marking point 3:** Therefore, there is a 50% probability that a son will inherit the X^c allele and be colour blind. Why: Sex-linked traits on the X chromosome show inheritance patterns that differ between males and females.

Topic and concept

Sex determination in human beings; sex-linked traits (qualitative). Human sex is determined by the combination of X and Y chromosomes inherited from parents.

How marks are earned

1. Let X^C represent the normal allele and X^c represent the colour-blind allele; the mother's genotype is X^C X^c and the father's is X^C Y. (1 mark)
2. The possible male offspring genotypes are X^C Y and X^c Y, each with a probability of 1/2. (1 mark)
3. Therefore, there is a 50% probability that a son will inherit the X^c allele and be colour blind. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.4: Sex-linked traits on the X chromosome show inheritance patterns that differ between males and females.

Section B

Question 17

1 mark

Mcq

Choose the correct answer.

(a) Which term describes the loss of electrons in a chemical reaction? [1 mark]

A. Oxidation

B. Reduction

C. Hydrolysis

D. Neutralization

Answer

A. Oxidation

Step by step

1. **Select and justify the option:** Oxidation is defined as the loss of electrons by a substance during a chemical reaction. Why: Oxidation is loss of electrons and reduction is gain of electrons.

Topic and concept

Oxidation and reduction; effects of oxidation in everyday life. Oxidation is the loss of electrons and reduction is the gain of electrons by a substance.

How marks are earned

1. Oxidation is defined as the loss of electrons by a substance during a chemical reaction. (1 mark)

Source check: Check the reasoning against NCERT Chemistry Class X, Ch.1, §1.2.3: Oxidation is loss of electrons and reduction is gain of electrons.

Question 18

1 mark

Mcq

Choose the correct answer.

(a) What colour does methyl orange exhibit in a basic solution? [1 mark]

A. Red

B. Colourless

C. Yellow

D. Green

Answer

C. Yellow

Step by step

1. **Select and justify the option:** Methyl orange turns yellow in basic solutions. Why: methyl orange is yellow in basic medium

Topic and concept

Properties of acids and bases using indicators (litmus, methyl orange, phenolphthalein). Acidic and basic solutions can be distinguished by specific indicators whose colour changes in predictable ways.

How marks are earned

1. Methyl orange turns yellow in basic solutions. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 2, §2.1.1: methyl orange is yellow in basic medium

Question 19

1 mark

Mcq

Choose the correct answer.

(a) Why do ionic compounds conduct electricity only in molten or aqueous state? [1 mark]

A. Their ions are free to move and carry charge

B. Electrons are free to move through a metallic lattice

C. Molecules form covalent bonds

D. Neutral atoms carry charges

Answer

A. Their ions are free to move and carry charge

Step by step

1. **Link conduction to ion mobility:** In molten or aqueous ionic compounds the ions are free to move, so they carry electric charge through the liquid; choose A. Why: In the solid crystal lattice ions are fixed in position, so they cannot move to carry current until melting or dissolution.

Topic and concept

Formation and properties of ionic compounds. Ionic compounds conduct in molten or aqueous state because their charged ions become mobile; solid ionic crystals have fixed ions and do not conduct.

How marks are earned

1. Mobile ions in molten or aqueous ionic compounds carry charge, whereas fixed ions in the solid crystal do not. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 3, §3.4.1: Ionic compounds conduct electricity when molten or dissolved because their ions are mobile.

Question 20

1 mark

Mcq

Choose the correct answer.

(a) Why do most carbon compounds exhibit low melting and boiling points? [1 mark]

A. They form ions that repel each other

B. They have weak forces between molecules

C. They conduct electricity in solid state

D. They consist of heavy atoms only

Answer

B. They have weak forces between molecules

Step by step

1. **Select and justify the option:** Most carbon compounds are held together by weak intermolecular attractions arising from covalent bonding, resulting in low melting and boiling points. Why: Covalent carbon compounds have low melting and boiling points because their intermolecular forces are weak.

Topic and concept

Covalent bonding in carbon compounds; versatile nature of carbon. Carbon atoms form covalent bonds by sharing electrons to achieve stable octets, resulting in molecules that are generally poor conductors with low melting and boiling points.

How marks are earned

1. Most carbon compounds are held together by weak intermolecular attractions arising from covalent bonding, resulting in low melting and boiling points. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.1: Covalent carbon compounds have low melting and boiling points because their intermolecular forces are weak.

Question 21

1 mark

Mcq

Choose the correct answer.

(a) Which of the following is an example of a combination reaction? [1 mark]

A. $CaO + H_2O \rightarrow Ca(OH)_2$

B. $CaCO_3 \rightarrow CaO + CO_2$

C. $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

D. $CaCl_2 + Na_2SO_4 \rightarrow CaSO_4 + 2NaCl$

Answer

A. $CaO + H_2O \rightarrow Ca(OH)_2$

Step by step

1. **Select and justify the option:** CaO and H2O combine to form a single product Ca(OH)2, which defines a combination reaction. Why: Combination reactions involve two or more reactants forming a single product.

Topic and concept

Types of chemical reactions — combination. In a combination reaction, two or more reactants combine to form a single product.

How marks are earned

1. CaO and H2O combine to form a single product Ca(OH)2, which defines a combination reaction. (1 mark)

Source check: Check the reasoning against NCERT Chemistry Class X, Ch.1, §1.2.1: Combination reactions involve two or more reactants forming a single product.

Question 22

1 mark

Mcq

Choose the correct answer.

(a) Bleaching powder is produced by passing chlorine over which substance? [1 mark]

A. Dry slaked lime, $Ca(OH)_2$

B. Quicklime, CaO

C. Gypsum, $CaSO_4 \cdot 2H_2O$

D. Washing soda, $Na_2CO_3 \cdot 10H_2O$

Answer

A. Chlorine acts on dry slaked lime, $Ca(OH)_2$, to produce bleaching powder.

Step by step

1. **Recall the preparation method:** Option A identifies dry slaked lime, calcium hydroxide [$Ca(OH)_2$]. Chlorine acts on this dry substance to produce bleaching powder. Why: The NCERT preparation statement identifies the reactant directly, without claiming that calcium hydroxide is oxidised.

Topic and concept

Preparation and uses of sodium hydroxide, bleaching powder, baking soda, washing soda, plaster of paris. Bleaching powder is prepared by passing chlorine over dry slaked lime, $Ca(OH)_2$, as stated in the downloaded NCERT Science X chapter on acids, bases and salts.

How marks are earned

1. Select A: bleaching powder is prepared by action of chlorine on dry slaked lime, calcium hydroxide. (1 mark)

Source check: Downloaded NCERT Science X, Ch. 2, bleaching powder: chlorine acts on dry slaked lime $Ca(OH)_2$ to produce it.

Question 23

1 mark

Mcq

Choose the correct answer.

(a) Which metal can displace copper from copper(II) sulfate solution? [1 mark]

A. Gold

B. Silver

C. Zinc

D. Mercury

Answer

C. Zinc is above copper in the reactivity series and displaces it from copper(II) sulfate solution.

Step by step

1. **Compare metals in the reactivity series:** Zinc is above copper in the reactivity series and displaces copper from copper(II) sulfate solution. Gold, silver and mercury are below copper, so revised option C is unique. Why: A more reactive metal can displace a less reactive metal from its salt solution.

Topic and concept

Reactivity series. In the NCERT reactivity series zinc lies above copper and can displace it. Mercury, silver and gold lie below copper and cannot displace it from copper sulfate.

How marks are earned

1. Select C because zinc lies above copper in the reactivity series; the other three listed metals lie below copper. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 3, §3.2.3: A metal higher in reactivity series can displace a lower one from its salt solution.

Question 24

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): Carbon compounds generally do not conduct electricity. Reason (R): Covalent bonding in carbon compounds does not generate ions. [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. **Select and justify the option:** Both assertion and reason are true, and the lack of ion formation due to covalent bonding explains why carbon compounds do not conduct electricity. Why: Covalent bonding in carbon compounds does not produce ions, so they are poor conductors of electricity.

Topic and concept

Covalent bonding in carbon compounds; versatile nature of carbon. Carbon atoms form covalent bonds by sharing electrons to achieve stable octets, resulting in molecules that are generally poor conductors with low melting and boiling points.

How marks are earned

1. Both assertion and reason are true, and the lack of ion formation due to covalent bonding explains why carbon compounds do not conduct electricity. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.1: Covalent bonding in carbon compounds does not produce ions, so they are poor conductors of electricity.

Question 25

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Write the chemical equation for the reaction of iron with copper sulphate solution and state the observable change in the solution's colour. [2 marks]

Answer

Equation: Fe(s) + CuSO4(aq) → FeSO4(aq) + Cu(s). The blue colour of the CuSO4 solution fades and becomes pale green due to formation of FeSO4, while a brownish copper metal precipitate appears.

Step by step

1. **Write the displacement reaction with states:** Iron reacts with copper sulphate solution: Fe(s) + CuSO4(aq) → FeSO4(aq) + Cu(s), with one Fe, one Cu, one S and four O atoms on each side, so it is balanced. Why: Iron is more reactive than copper, so iron displaces copper from its compound (CH1-C07); this makes the reaction a single displacement reaction.
2. **State the colour change and the deposit:** The blue colour of the copper sulphate solution fades and turns pale green as FeSO4 forms, and a brownish (reddish-brown) layer of copper metal is deposited on the iron. Why: Blue Cu^{2+} ions are removed from the solution as copper metal, and pale green Fe^{2+} ions enter it, which is the observable evidence that displacement has occurred.

Topic and concept

Types of chemical reactions — displacement and double displacement. In a displacement reaction, a more reactive element displaces a less reactive one from its compound. Iron is more reactive than copper, so it displaces copper from copper sulphate solution. The solution changes from blue to pale green and copper deposits on the iron.

How marks are earned

1. Equation: Fe(s) + CuSO4(aq) → FeSO4(aq) + Cu(s). (1 mark)
2. The blue colour of the CuSO4 solution fades and becomes pale green due to formation of FeSO4, while a brownish copper metal precipitate appears. (1 mark)

Source check: Check the reasoning against NCERT Chemistry, Ch. 1, §1.2.3: A more reactive element displaces a less reactive one from its compound, causing colour changes.

Question 26

3 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

(a) State the colour of phenolphthalein in acidic and basic solutions, and explain how this helps identify a basic solution. [3 marks]

Answer

Phenolphthalein is colourless in an acidic solution and pink in a basic solution. A pink colour after adding it therefore indicates that the tested solution is basic.

Step by step

1. **State the acidic observation:** Phenolphthalein appears colourless in acidic solution. Why: This is its observed indicator response in acid.
2. **State the basic observation:** The indicator turns pink in basic solution. Why: The different response is the observed sign of alkalinity.
3. **Use the colour to identify a base:** A colourless sample that turns pink when phenolphthalein is added is basic; compare this with the acidic colourless result. Why: The colour contrast lets learners distinguish a base from an acid in the Class X test.

Topic and concept

Properties of acids and bases using indicators (litmus, methyl orange, phenolphthalein). Phenolphthalein is an acid-base indicator: it stays colourless in an acid and turns pink in a base. The contrast is used to identify a basic solution.

How marks are earned

1. State that phenolphthalein is colourless in an acidic solution. (1 mark)
2. State that phenolphthalein turns pink in a basic solution. (1 mark)
3. Explain that the pink result after adding the indicator identifies a basic solution. (1 mark)

Source check: Downloaded NCERT Science X, Ch. 2, indicators: phenolphthalein is colourless in an acid and pink in a base.

OR

Option B

Answer the question with working and reasons where needed.

(a) Describe the neutralisation reaction between sodium hydroxide and hydrochloric acid in terms of ions, and state the products formed. [3 marks]

Answer

In aqueous solution NaOH dissociates into Na^+ and OH^- ions, and HCl dissociates into H^+ and Cl^- ions. The H^+ ions combine with OH^- ions to form water: $H^+ + OH^- \rightarrow H_2O$. The remaining Na^+ and Cl^- ions remain in solution as sodium chloride.

Step by step

1. **Work through marking point 1:** In aqueous solution NaOH dissociates into Na^+ and OH^- ions, and HCl dissociates into H^+ and Cl^- ions. Why: Neutralisation involves H^+ and OH^- combining to form water, leaving a salt
2. **Work through marking point 2:** The H^+ ions combine with OH^- ions to form water: $H^+ + OH^- \rightarrow H_2O$. Why: Neutralisation involves H^+ and OH^- combining to form water, leaving a salt
3. **Work through marking point 3:** The remaining Na^+ and Cl^- ions remain in solution as sodium chloride. Why: Neutralisation involves H^+ and OH^- combining to form water, leaving a salt

Topic and concept

Reaction of acids and bases with each other; neutralisation reaction. An acid and a base neutralise each other to yield a salt and water in a neutralisation reaction.

How marks are earned

1. In aqueous solution NaOH dissociates into Na^+ and OH^- ions, and HCl dissociates into H^+ and Cl^- ions. (1 mark)
2. The H^+ ions combine with OH^- ions to form water: $H^+ + OH^- \rightarrow H_2O$. (1 mark)
3. The remaining Na^+ and Cl^- ions remain in solution as sodium chloride. (1 mark)

Source check: Check the reasoning against NCERT Science Class 10, Ch. 2, §2.1.4: Neutralisation involves H^+ and OH^- combining to form water, leaving a salt

Question 27

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Explain how an ionic compound is formed between sodium and chlorine atoms, and state two characteristic properties of ionic compounds. [3 marks]

Answer

A sodium atom transfers one electron to a chlorine atom, forming Na^+ and Cl^- ions which attract each other to form NaCl. Ionic compounds have high melting and boiling points due to strong electrostatic forces between ions. They conduct electricity when molten or dissolved in water because the ions are free to move.

Step by step

1. **Describe electron transfer and ion formation between Na and Cl:** Sodium (2,8,1) loses its one outer electron to become Na^+ (2,8), and chlorine (2,8,7) gains that electron to become Cl^- (2,8,8); the oppositely charged ions attract each other and form NaCl. Why: Each atom reaches a stable noble-gas (octet) configuration by transfer of electrons from a metal to a non-metal, and the resulting electrostatic attraction between opposite charges is the ionic bond.
2. **State the first property: high melting and boiling points:** In solid NaCl each ion is held in a lattice by strong electrostatic forces in all directions, so a large amount of energy is needed to separate the ions; hence NaCl has high melting and boiling points. Why: Melting requires overcoming the attraction between ions; because ionic attraction is strong, the energy needed (and so the melting point) is high.
3. **State the second property: conduction when molten or dissolved:** In molten NaCl or aqueous solution the Na^+ and Cl^- ions are free to move and carry charge, so the compound conducts electricity; solid NaCl does not conduct because its ions are fixed in the lattice. Why: Electric current in ionic compounds is carried by moving ions, so conduction needs ions to be mobile, which happens only on melting or dissolving.

Topic and concept

Formation and properties of ionic compounds. In forming NaCl, a metal (Na) transfers an electron to a non-metal (Cl). The ions formed have noble-gas configurations and are held in a lattice by strong electrostatic forces, which explains the high melting points and the conduction in the molten state or in solution.

How marks are earned

1. A sodium atom transfers one electron to a chlorine atom, forming Na^+ and Cl^- ions which attract each other to form NaCl. (1 mark)
2. Ionic compounds have high melting and boiling points due to strong electrostatic forces between ions. (1 mark)

3. They conduct electricity when molten or dissolved in water because the ions are free to move. (1 mark)

Source check: Check the reasoning against NCERT Science, Ch. 3 §3.4 Formation of ionic compounds: Ionic compounds form by transfer of electrons from metals to non-metals, resulting in high melting points and conductivity when molten.

Question 28

4 marks

Case Based

A group of students investigated four organic compounds: Compound A is C2H6 with only single bonds; Compound B is C2H4 containing one C=C bond; Compound C is CH3CH2OH featuring an –OH group; and Compound D is CH3COOH 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 (C2H4) contains a C=C double bond and hence is unsaturated.

Step by step

1. **Work through marking point 1:** Compound B (C2H4) 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 (C2H4) 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:** Compound C is CH3CH2OH, whose structure contains an –OH group attached to the carbon chain, so the functional group is –OH and the compound belongs to the alcohols. Why: A functional group is the heteroatom-containing group that replaces hydrogen on the chain and decides the class and properties of the compound; –OH defines alcohols.
2. **Identify the reaction type of Compound B:** Compound B (C2H4) has a C=C double bond and reacts with hydrogen to give ethane, C2H6; hydrogen adds across the double bond, which becomes a C–C single bond, so the reaction is addition. Why: Unsaturated compounds contain double or triple bonds that can open up to take in atoms, which is why they undergo addition reactions, while saturated compounds like ethane do not.

Topic and concept

Nomenclature of carbon compounds; functional groups. Functional groups such as –OH decide the class of a carbon compound, and unsaturated compounds with C=C bonds undergo addition reactions. In this passage, C is an alcohol, and B adds hydrogen to become saturated 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) Write the balanced chemical equation for the formation of water from hydrogen and oxygen and identify the reaction type. [2 marks]

Answer

Balanced equation: $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$. This reaction is a combination reaction because two reactant species combine to form a single product.

Step by step

1. **Balance the equation by counting atoms:** Unbalanced: $H_2 + O_2 \rightarrow H_2O$ has 2 O on the left and 1 O on the right. Put 2 before H_2O to get 2 O on the right, which gives 4 H, then put 2 before H_2 to match: $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$, with 4 H and 2 O on each side. Why: Mass is conserved in a chemical reaction, so the number of atoms of each element must be equal on both sides, and only coefficients (never subscripts) may be changed to achieve this.
2. **Classify the reaction:** Two reactants, hydrogen and oxygen, join to form a single product, water, so the reaction is a combination reaction (it is also exothermic, since heat is released). Why: A combination reaction is defined as two or more reactants combining to form a single product, which is exactly what happens here.

Topic and concept

Types of chemical reactions — combination. A balanced equation has equal numbers of each kind of atom on both sides, and a reaction in which two or more reactants form one product is a combination reaction. Hydrogen and oxygen forming water fits both ideas.

How marks are earned

1. Balanced equation: $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$. (1 mark)
2. This reaction is a combination reaction because two reactant species combine to form a single product. (1 mark)

Source check: Check the reasoning against NCERT Chemistry, Ch. 1, §1.2.1: In a combination reaction, two or more reactants form a single product.

(b) Explain the chemical process involved in whitewashing walls using slaked lime. Write the balanced equation and state how a shiny finish is obtained. [3 marks]

Answer

Slaked lime, $Ca(OH)_2$, is applied to the wall and reacts with atmospheric CO_2: $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$. The $CaCO_3$ formed after two or three days gives the surface a shiny finish.

Step by step

1. **Describe what is applied:** For whitewashing, slaked lime calcium hydroxide is applied to the wall as a slurry and reacts slowly with carbon dioxide in air. Why: The air supplies the carbon dioxide needed to form the new surface substance.
2. **Write the balanced equation:** The reaction is $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$, with one calcium and one carbon on both sides. Why: The equation identifies calcium carbonate as the solid product.
3. **Explain the finish:** After two or three days, calcium carbonate forms on the wall and gives the whitewash its shiny finish. Why: The downloaded NCERT description attributes the finish to calcium carbonate formation over time.

Topic and concept

Types of chemical reactions — combination. Whitewashing uses slaked lime, $Ca(OH)_2$. Its reaction with atmospheric CO_2 forms $CaCO_3$ on the wall, and NCERT states this formation gives a shiny finish after two or three days.

How marks are earned

1. State that slaked lime calcium hydroxide is applied to the wall and reacts with atmospheric carbon dioxide. (1 mark)
2. Write the balanced equation $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$. (1 mark)
3. State that formation of calcium carbonate after two or three days gives the whitewashed wall a shiny finish. (1 mark)

Source check: Downloaded NCERT Science X, Ch. 2, whitewashing: $Ca(OH)_2$ reacts with CO_2 to form $CaCO_3$, which gives a shiny finish after two or three days.

OR

Option B

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

(a) Balance the chemical equation Fe + H2O → Fe3O4 + H2 and justify why it is balanced. [2 marks]

Answer

The balanced equation is 3Fe + 4H2O → Fe3O4 + 4H2. After balancing there are 3 Fe atoms, 8 H atoms and 4 O atoms on both sides, so the mass and atom counts are equal.

Step by step

1. **Work through marking point 1:** The balanced equation is 3Fe + 4H2O → Fe3O4 + 4H2. Why: Balanced equations ensure the number of each type of atom remains the same before and after the reaction.
2. **Work through marking point 2:** After balancing there are 3 Fe atoms, 8 H atoms and 4 O atoms on both sides, so the mass and atom counts are equal. Why: Balanced equations ensure the number of each type of atom remains the same before and after the reaction.

Topic and concept

Chemical equations and balancing chemical equations. Balancing a chemical equation ensures the number of each type of atom is equal on both sides, reflecting conservation of mass.

How marks are earned

1. The balanced equation is 3Fe + 4H2O → Fe3O4 + 4H2. (1 mark)
2. After balancing there are 3 Fe atoms, 8 H atoms and 4 O atoms on both sides, so the mass and atom counts are equal. (1 mark)

Source check: Check the reasoning against NCERT Chemistry, Ch. 1, §1.1.2: Balanced equations ensure the number of each type of atom remains the same before and after the reaction.

(b) Balance the equation Al + HCl → AlCl3 + H2, name the reaction type, and give a brief reason for its classification. [3 marks]

Answer

Balanced equation: 2Al + 6HCl → 2AlCl3 + 3H2. This is a displacement reaction because aluminium displaces hydrogen from hydrochloric acid. Aluminium is more reactive than hydrogen and thus removes hydrogen ions from the acid, producing hydrogen gas.

Step by step

1. **Work through marking point 1:** Balanced equation: 2Al + 6HCl → 2AlCl3 + 3H2. Why: A reactive metal displaces a less reactive element, classifying as displacement reaction.

2. **Work through marking point 2:** This is a displacement reaction because aluminium displaces hydrogen from hydrochloric acid. Why: A reactive metal displaces a less reactive element, classifying as displacement reaction.
3. **Work through marking point 3:** Aluminium is more reactive than hydrogen and thus removes hydrogen ions from the acid, producing hydrogen gas. Why: A reactive metal displaces a less reactive element, classifying as displacement reaction.

Topic and concept

Types of chemical reactions — displacement and double displacement. In a displacement reaction, a more reactive element displaces a less reactive element from its compound.

How marks are earned

1. Balanced equation: $2Al + 6HCl \rightarrow 2AlCl3 + 3H2$. (1 mark)
2. This is a displacement reaction because aluminium displaces hydrogen from hydrochloric acid. (1 mark)
3. Aluminium is more reactive than hydrogen and thus removes hydrogen ions from the acid, producing hydrogen gas. (1 mark)

Source check: Check the reasoning against NCERT Chemistry, Ch. 1, §1.2.3: A reactive metal displaces a less reactive element, classifying as displacement reaction.

Section C

Question 30

1 mark

Mcq

Choose the correct answer.

(a) In a glass prism, which colour of the visible spectrum deviates the most from the path of the incident white light beam? [1 mark]

A. Red

B. Orange

C. Green

D. Violet

Answer

D. Violet

Step by step

1. **Select and justify the option:** Violet light has the shortest wavelength and hence the highest refractive index in glass, causing it to deviate the most. Why: Different wavelengths refract by different amounts; shorter wavelengths (violet) refract more.

Topic and concept

Refraction of light through a prism; dispersion. Dispersion in a prism occurs because different wavelengths refract by different amounts, causing white light to split into its constituent colours.

How marks are earned

1. Violet light has the shortest wavelength and hence the highest refractive index in glass, causing it to deviate the most. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.3: Different wavelengths refract by different amounts; shorter wavelengths (violet) refract more.

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): The SI unit of potential difference is joule per coulomb. Reason (R): One volt is the potential difference that does one joule of work for one coulomb of 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 A and R true and R explains A

Step by step

1. **Check A and R and decide whether R explains A:** Potential difference is the work done per unit charge, V = W/Q, so 1 V = 1 J / 1 C = 1 J/C; thus A is true, and R (one volt does one joule of work per coulomb) is also true. R gives the definition of the volt, which is exactly why the unit is J/C, so R explains A and the answer is A. Why: Since V = W/Q, the unit follows directly from the definition of the volt, so R is the reason for A; option B is the nearest error, but it fails because R is not an unrelated fact.

Topic and concept

Heating effect of electric current; joule's law; electrical power; commercial unit (kWh). Electric potential difference is the work done in moving a unit charge between two points, V = W/Q. Hence 1 volt = 1 joule per coulomb, and the unit and its definition are the same statement.

How marks are earned

1. Both the assertion and reason are true; a volt is defined as one joule per coulomb, so the reason explains the assertion. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, §11.2 Electric potential and potential difference: 1 volt is the potential difference when 1 joule moves 1 coulomb.

Question 33

2 marks

Short Answer

Answer the question with working and reasons where needed.

(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:** The distance between the eye lens and the retina is fixed, so to form a sharp image the eye changes the focal length of its lens by altering the curvature, using the ciliary muscles; this ability is called accommodation. Why: Since the image distance cannot change, a sharp image of objects at different distances is possible only if the lens focal length is changed, and the ciliary muscles do this.
2. **Describe near and distant adjustment:** For a near object (down to the near point, about 25 cm) the ciliary muscles contract, the lens becomes thicker and its focal length decreases. For a distant object (up to the far point, infinity) the muscles relax, the lens becomes thinner and its focal length increases. Why: A near object needs a stronger converging lens (shorter focal length) to focus on the retina, whereas a distant object needs a weaker one (longer focal length).

Topic and concept

Human eye; far point, near point; accommodation. Accommodation is the change in curvature of the eye lens, thicker for near and thinner for distant objects, which changes its focal length so the image always falls on the retina.

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

Question 34

2 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

(a) Write the expression for the equivalent resistance of resistors connected in series. [2 marks]

Answer

When resistors are connected in series, their equivalent resistance is the sum of the individual resistances. Mathematically, this is expressed as Rs = R1 + R2 + R3 + … .

Step by step

1. **State the rule for series combination:** In a series combination the same current I flows through each resistor and the potential differences add: V = V1 + V2 + V3 = IR1 + IR2 + IR3 = I(R1 + R2 + R3). So the equivalent resistance is the sum of the individual resistances. Why: Resistors in series form a single path, so the current is the same through all, and the total potential difference is shared among them; this makes the equivalent resistance their sum.
2. **Write the expression:** Rs = V/I = R1 + R2 + R3 + … (in ohms, Ω); for example, 2 Ω, 3 Ω and 5 Ω in series give Rs = 2 + 3 + 5 = 10 Ω, which is larger than any single resistor. Why: Dividing the total V by the common current I using Ohm's law gives the equivalent resistance; the result is larger than any one resistor because each added resistor makes the path more opposing.

Topic and concept

Series and parallel combinations of resistors. For resistors in series, resistances add directly, Rs = R1 + R2 + R3 + …, because the same current passes through all and the voltages add. For parallel, by contrast, reciprocals add.

How marks are earned

1. When resistors are connected in series, their equivalent resistance is the sum of the individual resistances. (1 mark)
2. Mathematically, this is expressed as Rs = R1 + R2 + R3 + … . (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, Fig. 11.6 Resistors in series: In series connection equivalent resistance equals the sum of individual resistances.

OR

Option B

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.

Question 35

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Explain three linked reasons why convex mirrors are used as rear-view mirrors in vehicles. [3 marks]

Answer

A convex mirror forms a virtual, erect image, so the driver sees traffic behind in its normal orientation. The image is diminished, allowing more of the scene to fit within the limited mirror area. The outward-curved surface provides a wider field of view than a plane mirror, allowing the driver to see a larger area of traffic behind the vehicle.

Step by step

1. **Work through marking point 1:** A convex mirror forms a virtual, erect image, so the driver sees traffic behind in its normal orientation. Why: Convex mirrors produce virtual, erect, diminished images and are used in vehicle mirrors
2. **Work through marking point 2:** The image is diminished, allowing more of the scene to fit within the limited mirror area. Why: Convex mirrors produce virtual, erect, diminished images and are used in vehicle mirrors
3. **Work through marking point 3:** The outward-curved surface provides a wider field of view than a plane mirror, allowing the driver to see a larger area of traffic behind the vehicle. Why: Convex mirrors produce virtual, erect, diminished images and are used in vehicle mirrors

Topic and concept

Applications — real-world uses of mirrors and lenses. A convex mirror forms an erect, diminished image and has a wider field of view than a plane mirror, so it is used as a vehicle rear-view mirror.

How marks are earned

1. A convex mirror forms a virtual, erect image, so the driver sees traffic behind in its normal orientation. (1 mark)
2. The image is diminished, allowing more of the scene to fit within the limited mirror area. (1 mark)
3. The outward-curved surface provides a wider field of view than a plane mirror, allowing the driver to see a larger area of traffic behind the vehicle. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 9, §9.2.2: Convex mirrors produce virtual, erect, diminished images and are used in vehicle mirrors

Question 36

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) If a current of 5 A flows through a resistor of 2 Ω for 10 minutes, calculate the heat produced in the resistor. [3 marks]

Answer

Using the relation W = I² R t for heat produced by a current through a resistor. Convert time: t = 10 min = 600 s, then substitute I = 5 A, R = 2 Ω and t = 600 s to get W = 5² × 2 × 600 J. Evaluating gives W = 25 × 2 × 600 = 30 000 J of heat produced.

Step by step

1. **Work through marking point 1:** Using the relation W = I² R t for heat produced by a current through a resistor. Why: Heat produced in a resistor is given by W = I² R t demonstrating the heating effect of current.
2. **Work through marking point 2:** Convert time: t = 10 min = 600 s, then substitute I = 5 A, R = 2 Ω and t = 600 s to get W = 5² × 2 × 600 J. Why: Heat produced in a resistor is given by W = I² R t demonstrating the heating effect of current.
3. **Work through marking point 3:** Evaluating gives W = 25 × 2 × 600 = 30 000 J of heat produced. Why: Heat produced in a resistor is given by W = I² R t demonstrating the heating effect of current.

Topic and concept

Heating effect of electric current; joule's law; electrical power; commercial unit (kWh). When current flows through a resistor, heat produced is given by W = I²Rt, demonstrating the heating effect of electric current.

How marks are earned

1. Using the relation W = I² R t for heat produced by a current through a resistor. (1 mark)
2. Convert time: t = 10 min = 600 s, then substitute I = 5 A, R = 2 Ω and t = 600 s to get W = 5² × 2 × 600 J. (1 mark)
3. Evaluating gives W = 25 × 2 × 600 = 30 000 J of heat produced. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, §11.7 Joule's law of heating: Heat produced in a resistor is given by W = I² R t demonstrating the heating effect of current.

Question 37

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Explain the pattern of magnetic field lines produced by a current-carrying circular loop. [3 marks]

Answer

Magnetic field lines around a current-carrying circular loop form closed curves that pass through the centre of the loop, indicating continuous field lines. Inside the loop, the field lines are densely packed and nearly parallel, indicating a strong and approximately uniform magnetic field. Outside the loop, the field lines spread out and their pattern resembles that of a bar magnet along the axis of the loop.

Step by step

1. **Describe the field lines near the wire and the closed-loop continuity:** Near each small segment of the wire the field lines are concentric circles around the wire. They grow larger as distance from the wire increases. The lines from all segments combine into continuous lines that pass through the loop's centre and return around the outside. Magnetic field lines have no beginning or end. Why: A straight current element produces circular field lines, with direction given by the right-hand thumb rule. Adding the contributions of all segments gives continuous lines through the loop. Field lines do not start or stop, so they close on themselves. The keyed phrase 'closed curves' applies to the whole pattern, not to the circles near the wire.
2. **Explain the field at and near the centre of the loop:** At the centre, all segments of the loop add their fields in the same direction. The lines there are nearly straight and perpendicular to the plane of the loop. The field is strongest and nearly uniform at the centre. For a coil of N turns the field is N times as strong. Why: Each segment of the loop contributes a field in the same direction at the centre, so the contributions add up. The lines there are close together and almost parallel. This matches the concept that the field is strongest and most uniform at the centre (CH12-C03, NCERT §12.2.2). The 'inside the loop' wording in the key refers to this central region.
3. **Compare the outer pattern with a bar magnet:** Away from the wire, the lines spread out and curve around outside the loop. The overall pattern looks like that of a bar magnet whose axis is the axis of the loop. One face of the loop acts like a north pole, where the lines emerge, and the other like a south pole. Why: The field lines leave one face of the loop, spread outward and return to the other face. This is the same pattern as a bar magnet, so the current loop behaves as a magnetic dipole. This is the dipole-like pattern outside the loop.

Topic and concept

Magnetic field due to current-carrying conductor — circular loop. A current-carrying circular loop produces circular field lines near the wire. These combine into continuous lines through the

loop. The field is strongest and most uniform at the centre, and the outer pattern resembles a bar magnet along the loop's axis (CH12-C03).

How marks are earned

1. Magnetic field lines around a current-carrying circular loop form closed curves that pass through the centre of the loop, indicating continuous field lines. (1 mark)
2. Inside the loop, the field lines are densely packed and nearly parallel, indicating a strong and approximately uniform magnetic field. (1 mark)
3. Outside the loop, the field lines spread out and their pattern resembles that of a bar magnet along the axis of the loop. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.12, §12.3: A circular loop carrying current produces a magnetic field that is strong and uniform near its centre and resembles a dipole pattern outside.

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. **Identify the voltmeter's role in the circuit:** The voltmeter is connected in parallel across the variable resistor. It measures the potential difference across the resistor, which reads 6.0 V in both settings. The ammeter is connected in series to measure the current. Why: Potential difference is measured between two points of a component, so the voltmeter is connected in parallel across that component. An ammeter is connected in series because it must carry the whole circuit current. The parallel connection is why the voltmeter gives the voltage across the resistor, as in NCERT §11.3.

Topic and concept

Electric potential difference and electric current; Ohm's law. A voltmeter measures the potential difference between two points of a component and is connected in parallel with it. The ammeter measures current and is connected in series. Together they give V and I for Ohm's law (CH11-C03).

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. **Apply Ohm's law with V = 6.0 V and I = 0.04 A, then check the result:** The voltage across the resistor stays at 6.0 V. From Ohm's law, R = V/I = 6.0 V ÷ 0.04 A = 150 Ω. Check: 150 Ω lies between 100 Ω (0.06 A) and 200 Ω (0.03 A), and 0.04 A lies between 0.06 A and 0.03 A. Also 150 Ω × 0.04 A = 6.0 V. Why: At constant temperature, Ohm's law states that V is proportional to I, so R = V/I is constant for a given setting (CH11-C03). With the voltage fixed at 6.0 V, a smaller current means a larger resistance. The check confirms that 0.04 A lies between the two measured currents, so the resistance must lie between the two settings.

Topic and concept

Electric potential difference and electric current; Ohm’s law. Ohm's law gives V = IR, so R = V/I. In this circuit V stays at 6.0 V, so the current is inversely proportional to the resistance (CH11-C03).

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) 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 dispersion as refraction that depends on wavelength:** When white light enters a glass prism, each colour refracts at the first face and again at the second face. The refractive index of glass differs slightly for each wavelength, so each colour is bent through a different angle. White light therefore spreads into a band of colours (a spectrum) on the screen. Why: White light is a mixture of wavelengths. Glass has a different refractive index for each wavelength, so each colour is bent by a different amount at the prism faces. This variation of refractive index with wavelength is the reason for dispersion (CH10-C10, NCERT §10.3.2).
2. **Compare violet and red light:** Violet has a shorter wavelength than red, and glass has a higher refractive index for violet. Violet therefore travels slower in glass and is deviated more. Red, with a longer wavelength and lower refractive index, deviates the least. So the spectrum has violet at the base-side end and red at the apex-side end, in the order VIBGYOR. Why: A higher refractive index means a greater change in direction on refraction, so a larger deviation. Violet has the highest refractive index in glass, so it bends the most, and red the least. This is why the spectrum runs from red (least deviated) to violet (most deviated).

Topic and concept

Refraction of light through a prism; dispersion. Dispersion occurs because the refractive index of glass changes with wavelength. Violet, with the shortest visible wavelength, has the highest refractive index and deviates most. Red deviates least (CH10-C10).

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

(b) Explain how a triangular glass prism disperses white light into its constituent colours. Give three points. [3 marks]

Answer

White light contains different colours. Refraction at entry and exit of the prism separates their paths because different colours bend by different amounts. The result is a spectrum: red is least deviated and violet is most deviated.

Step by step

1. **Explain unequal refraction:** White light contains many colours, and glass refracts different colours by different amounts: violet deviates most and red least. Why: Their different refractive indices in glass separate their directions.
2. **Trace the prism path:** The light refracts when entering the triangular prism and again when leaving it, spreading the component colours into different outgoing directions. Why: The two sloping faces produce angular separation of the colours.
3. **Describe the spectrum:** The separated colours form a visible spectrum; red has the least deviation and violet the most, regardless of how the prism is turned. Why: Top-versus-bottom position depends on the prism orientation, so it is not required for marks.

Topic and concept

Refraction of light through a prism; dispersion. Dispersion occurs because colours in white light refract by different amounts in glass. A prism separates them into a spectrum; red bends least and violet bends most.

How marks are earned

1. Explain that different colours of white light refract by different amounts in glass, with red least and violet most deviated. (1 mark)
2. Explain that refraction at both prism faces causes the component colours to leave in different directions. (1 mark)
3. State that the separated colours form a spectrum and compare red least with violet most deviation; no top/bottom orientation is required. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.3.2: different wavelengths refract by different amounts at prism surfaces, causing spectrum

OR

Option B

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

(a) A person cannot see objects closer than 1 m clearly. Name the defect and state the type of lens used for its correction. [2 marks]

Answer

The defect in which the near point of the eye is farther than 25 cm is hypermetropia (farsightedness). Hypermetropia is corrected by using a convex (converging) lens that converges rays before they enter the eye.

Step by step

1. **Work through marking point 1:** The defect in which the near point of the eye is farther than 25 cm is hypermetropia (farsightedness). Why: hypermetropia correction with convex lens to focus near objects
2. **Work through marking point 2:** Hypermetropia is corrected by using a convex (converging) lens that converges rays before they enter the eye. Why: hypermetropia correction with convex lens to focus near objects

Topic and concept

Defects of vision — myopia, hypermetropia, presbyopia; correction with lenses.
Hypermetropia is the defect in which close objects form images behind the retina, causing near vision to be blurred.

How marks are earned

1. The defect in which the near point of the eye is farther than 25 cm is hypermetropia (farsightedness). (1 mark)
2. Hypermetropia is corrected by using a convex (converging) lens that converges rays before they enter the eye. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.2(b): hypermetropia correction with convex lens to focus near objects

(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