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CLASS X · 2026-27 · MODEL PAPER

Class X Science (Code 086) Model Paper 5

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) The growth movement of plant shoots towards light is known as: [1 mark]

A. Phototropism

B. Geotropism

C. Thigmotropism

D. Hydrotropism

Answer

A. Phototropism

Step by step

1. **Select and justify the option:** Growth of shoots towards light is called phototropism. Why: Plants grow directionally towards stimuli such as light (phototropism).

Topic and concept

Tropic movements in plants. Tropic movements are directional growth responses of plants toward or away from stimuli such as light (phototropism) and gravity (geotropism).

How marks are earned

1. Growth of shoots towards light is called phototropism. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.2 Coordination in Plants: Plants grow directionally towards stimuli such as light (phototropism).

Question 2

1 mark

Mcq

Choose the correct answer.

(a) Which feature best describes budding in Hydra? [1 mark]

A. Parent splits symmetrically into two halves

B. Gametes fuse to produce a new organism

C. An outgrowth forms on the body, detaches and grows independently

D. The organism produces resistant spores

Answer

C. An outgrowth forms on the body, detaches and grows independently

Step by step

1. **Select and justify the option:** Budding in Hydra involves repeated cell division at one site to form an outgrowth that detaches as a new individual. Why: Hydra forms buds that detach to become new individuals

Topic and concept

Asexual reproduction — fission, fragmentation, regeneration, budding. Budding in organisms such as yeast and Hydra produces new individuals as outgrowths from the parent body that eventually detach and mature independently.

How marks are earned

1. Budding in Hydra involves repeated cell division at one site to form an outgrowth that detaches as a new individual. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.2.4: Hydra forms buds that detach to become new individuals

Question 3

1 mark

Mcq

Choose the correct answer.

(a) In human sex determination, the probability that a child will be male is: [1 mark]

A. 25%

B. 50%

C. 75%

D. 100%

Answer

B. 50%

Step by step

1. **Select and justify the option:** Since half of the sperm produced carry a Y chromosome, there is a 50% chance of a male child. Why: Half of the sperm carry Y, determining a 50% probability of a male child.

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. Since half of the sperm produced carry a Y chromosome, there is a 50% chance of a male child. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.4: Half of the sperm carry Y, determining a 50% probability of a male child.

Question 4

1 mark

Mcq

Choose the correct answer.

(a) Which of the following is not a basic life process? [1 mark]

A. Nutrition

B. Respiration

C. Locomotion

D. Excretion

Answer

C. Locomotion

Step by step

1. **Select and justify the option:** Locomotion is a movement function and not one of the maintenance life processes (nutrition, respiration, transport, excretion). Why: Defines life processes as maintenance functions (nutrition, respiration, transport, excretion) that sustain organisms.

Topic and concept

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

How marks are earned

1. Locomotion is a movement function and not one of the maintenance life processes (nutrition, respiration, transport, excretion). (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.5, §5.1: Defines life processes as maintenance functions (nutrition, respiration, transport, excretion) that sustain organisms.

Question 5

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 6

1 mark

Mcq

Choose the correct answer.

(a) Which of these is an example of vegetative propagation? [1 mark]

A. Bean plant producing seeds

B. Potato tubers producing new plants

C. Puffball releasing spores

D. Plasmodium undergoing fission

Answer

B. Potato tubers producing new plants

Step by step

1. **Select and justify the option:** Vegetative propagation uses plant parts like tubers, as in potato, to generate genetically identical plants without seeds. Why: Plant structures like stems or tubers can grow into new individuals

Topic and concept

Asexual reproduction — vegetative propagation, spore formation. Vegetative propagation in plants uses structural parts like stems, roots, or leaves to produce genetically identical new plants without seeds.

How marks are earned

1. Vegetative propagation uses plant parts like tubers, as in potato, to generate genetically identical plants without seeds. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.3.1: Plant structures like stems or tubers can grow into new individuals

Question 7

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. **Cross a carrier mother (X^cX) with a normal father (XY) and select option C:** Gametes: mother gives X^c or X with equal chance; father gives X or Y. Offspring: X^cX (carrier daughter), XX (normal daughter), X^cY (affected son), XY (normal son). Sons are X^cY and XY, so 1 of 2 sons, i.e. 50%, express the trait. Key C (50%) follows; option A (0%) wrongly assumes a carrier cannot affect sons, and D (100%) wrongly assumes every son gets the mother's recessive allele. Why: A son receives his Y from the father, so his only X comes from the mother. Because the allele is on X with no matching allele on Y, whichever X he gets is expressed. The carrier mother passes X^c to half her sons by chance.

Topic and concept

Sex determination in human beings; sex-linked traits (qualitative). Genes on the X chromosome but not on Y show sex-linked inheritance (NCERT Class 10 Science, Ch. 8, §8.2.4). Males have one X and one Y, so a recessive X-linked allele is expressed in a male without a second copy. The mother's X chromosome decides whether a son shows the trait.

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 8

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): In aerobic respiration, glucose is fully broken down to carbon dioxide and water. Reason (R): In the presence of oxygen, pyruvate is broken down in mitochondria to carbon dioxide and water. [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. **Evaluate the assertion and revised reason:** A is true: aerobic respiration breaks glucose down completely to carbon dioxide and water. R is true: with oxygen, pyruvate is broken down in mitochondria to carbon dioxide and water, so R explains A; choose option A. Why: The cited Class X pathway connects oxygen-dependent pyruvate breakdown with the final products, without invoking the advanced electron transport chain.

Topic and concept

Respiration — aerobic and anaerobic; human respiratory system. In aerobic respiration glucose first forms pyruvate, and in the presence of oxygen pyruvate is broken down in mitochondria to carbon dioxide and water, releasing energy.

How marks are earned

1. Both statements are true, and oxygen-dependent pyruvate breakdown in mitochondria explains the aerobic products CO_2 and H_2O. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.5, §5.1: Respiration uses oxygen to oxidize food molecules fully to CO_2 and water.

Question 9

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): Reflex actions are faster than voluntary actions. Reason (R): Reflex actions do not involve the forebrain. [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. **Evaluate A and R separately, then test whether R explains A:** A is true: a reflex such as pulling the hand from a hot object happens very quickly. R is true: the reflex pathway (receptor → sensory neuron → spinal cord → motor neuron → effector) acts without conscious thinking and does not need processing in the forebrain. Skipping the long route through the thinking part of the brain shortens the pathway and saves time, so R explains A and the key is A. Option B is the nearest error, since R is not a separate fact but the cause of the speed. Why: Reflex actions are immediate, involuntary responses without conscious thought, while voluntary actions are deliberate and initiated by the brain. Voluntary actions need the extra step of brain processing, which takes more time, so skipping it makes reflexes faster.

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 (NCERT Class 10 Science, Ch. 6, §6.1.1). The reflex pathway is short and bypasses conscious thinking, which makes it fast and protective.

How marks are earned

1. Both A and R are true, and reflex actions are faster because they bypass forebrain processing. (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 10

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Suggest two household practices that promote recycling and reuse of materials. [2 marks]

Answer

Segregating paper waste at home and sending it to a recycling centre reduces landfill. Reusing glass jars as storage containers prevents the need to buy new containers.

Step by step

1. **Give a recycling practice: segregate paper waste:** Separating paper waste at home and handing it to a recycling centre lets the paper be reprocessed into new paper instead of going to landfill, so this reduces landfill. This earns mark 1. Why: Recycling means converting waste material into new usable material. Sorting waste at the source keeps recyclable material clean and separate, which is why segregation is a sustainable waste-management step (NCERT Ch. 13, §13.2.2).
2. **Give a reuse practice: reuse glass jars:** Using empty glass jars as storage containers means the same object is used again without reprocessing, so there is no need to buy new containers. This earns mark 2. Any other valid practice such as reusing bags, composting kitchen waste or repairing items would also earn credit, so any two valid practices get full marks. Why: Reuse differs from recycling because the object is used again in its original form, which cuts both waste and demand for new materials. Both practices reduce the amount of garbage sent to landfill.

Topic and concept

Waste and its management; recycling and reuse. Effective waste management uses recycling and reuse to reduce landfill, along with segregation and composting for biodegradable waste (NCERT Class 10 Science, Ch. 13, §13.2.2). Recycling reprocesses material into something new, while reuse uses the same item again.

How marks are earned

1. Segregating paper waste at home and sending it to a recycling centre reduces landfill. (1 mark)
2. Reusing glass jars as storage containers prevents the need to buy new containers. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 13, §13.2.2: Effective waste management includes methods like recycling and reuse.

Question 11

2 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

(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. **State the law in terms of alleles of different genes:** Mendel's law of independent assortment says that alleles of different genes, located on different chromosomes, assort independently into gametes, so the inheritance of one trait does not affect another. This earns mark 1. Why: Each parent carries two alleles of a gene, and these segregate during gamete formation so each gamete gets one allele (NCERT Ch. 8, §8.2.2). Independent assortment extends this to two genes together: which allele of one gene a gamete gets does not decide which allele of the other it gets.
2. **State the result: new combinations of alleles, with the dihybrid example:** Because assortment is independent, gametes have various allele combinations. In Mendel's dihybrid cross of round yellow with wrinkled green seeds, the F1 are all round yellow, and F2 shows round yellow : round green : wrinkled yellow : wrinkled green in the ratio 9:3:3:1. The new combinations round green and wrinkled yellow appear. This earns mark 2. Why: The 9:3:3:1 F2 ratio is what independence predicts: each trait alone gives 3:1, and combining two independent 3:1 ratios gives 9:3:3:1. The appearance of new trait combinations shows the traits are inherited separately (NCERT Ch. 8, §8.2.3).

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 (NCERT Class 10 Science, Ch. 8, §8.2.2). Independent assortment applies this to two genes at once, as in Mendel's dihybrid cross (§8.2.3), producing new combinations of traits.

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.

OR

Option B

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. **Work through marking point 1:** Human females have two X chromosomes (XX) and males have one X and one Y chromosome (XY). Why: Human sex is determined genetically by inheriting XX for females or XY for males, with the father's contribution deciding the outcome.
2. **Work through marking point 2:** All children inherit an X chromosome from their mother, and the father's X or Y chromosome determines the child's sex. Why: Human sex is determined genetically by inheriting XX for females or XY for males, with the father's contribution deciding the outcome.

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. 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 12

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) State any two roles of saliva in the human digestive system. [2 marks]

Answer

Saliva contains the enzyme salivary amylase, which initiates the chemical breakdown of starch into maltose. It moistens and lubricates food, forming a bolus that can be easily swallowed and moved along the alimentary canal.

Step by step

1. **State the chemical role: salivary amylase:** Saliva contains salivary amylase, an enzyme that starts the chemical digestion of starch in the mouth, breaking it down into maltose (a sugar). This earns mark 1. Why: Digestion in the alimentary canal begins in the mouth with salivary amylase, which starts breaking complex food into absorbable units (NCERT Ch. 5, §5.2.4). The enzyme acts on starch specifically, so it gives the chemical role.
2. **State the physical role: moistening and lubricating food:** Saliva moistens and lubricates the chewed food and helps form a bolus that is easy to swallow and move along the alimentary canal. This earns mark 2. Any two valid roles earn full marks, and helping taste by dissolving food is another acceptable role. Why: Dry crushed food would be hard to swallow. Mixing with saliva wets it and makes it slippery, so it can be propelled down the food pipe. This is a physical role, different from the enzyme's chemical role.

Topic and concept

Human digestive system. The alimentary canal is a tube from mouth to anus in which chewing and enzyme actions, beginning with salivary amylase in the mouth, break down food into absorbable units (NCERT Class 10 Science, Ch. 5, §5.2.4). Saliva therefore has both chemical and physical roles.

How marks are earned

1. Saliva contains the enzyme salivary amylase, which initiates the chemical breakdown of starch into maltose. (1 mark)
2. It moistens and lubricates food, forming a bolus that can be easily swallowed and moved along the alimentary canal. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 5, §5.2.4: Saliva wets food for easier swallowing and contains amylase to digest starch.

Question 13

3 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Write the formula and substitute the values:** Energy stored = (percentage captured / 100) × incident energy = (1/100) × 2×10^5 J. Here 1% means 1 part in 100, so the incident 2×10^5 J is multiplied by 0.01. This earns mark 1. Why: Green plants capture only about 1% of the sunlight falling on them to make food (NCERT Ch. 13, §13.1.1). A percentage is a fraction of the whole, so the stored energy is found by multiplying the incident energy by 1/100.
2. **Evaluate and state the answer with the unit:** 2×10^5 J × 1/100 = 2×10^5 / 10^2 = 2×10^3 J = 2000 J. Check: 1% of 200000 J is 2000 J, since 200000/100 = 2000. Producers store 2000 J as chemical energy. This earns mark 2. Why: Dividing by 100 lowers the power of ten by 2, from 10^5 to 10^3. The answer is in joules, the same unit as the incident energy. Most of the sunlight is not captured, so the stored amount is small.
3. **State why the stored energy is important:** The 2000 J of chemical energy is stored in the food made by producers. It passes to herbivores and then to higher trophic levels, supporting the nutritional needs of heterotrophs in the ecosystem. This earns mark 3. Why: Producers are at the first trophic level of a food chain, and consumers get energy only by eating them (NCERT Ch. 13, §13.1.1). Energy flows one way along the chain, so the energy producers store supports all other organisms.

Topic and concept

Ecosystem and its components. A food chain is a linear sequence of organisms, each forming a trophic level, and a food web is a network of linked chains showing energy flow (NCERT Class 10 Science, Ch. 13, §13.1.1). Producers are at the first level, and the small fraction of sunlight they capture is the energy source for the whole ecosystem.

How marks are earned

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

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

Question 14

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Describe vegetative propagation in plants and name two methods with examples. [3 marks]

Answer

Vegetative propagation is an asexual method where new plants grow from vegetative parts such as stems, roots or leaves without seed formation, contributing 1 mark. One method is the use of stem cuttings, for example rose cuttings develop into new plants when planted in soil, contributing 1 mark. Another method is leaf propagation, for example Bryophyllum produces plantlets along leaf margins that fall and grow into independent plants, contributing 1 mark.

Step by step

1. **Define vegetative propagation and state how it differs from seed-based reproduction:** Vegetative propagation is an asexual method in which a new plant grows from a vegetative part of the parent, such as a stem, root or leaf, without any seed or gamete fusion. Why: Only mitosis in body cells of the parent is involved, so the offspring are genetically identical clones of the parent. This is the concept that separates vegetative propagation from sexual reproduction through seeds.
2. **Give the first method, stem cutting, with an example:** In stem cutting, a piece of stem with nodes from a rose plant is planted in moist soil. Roots and shoots develop at the nodes and the cutting grows into a new rose plant. Why: Stem tissue near the nodes can divide and form roots and shoots, so a detached stem piece can grow into a complete plant. The new rose plant has the same traits as the parent.
3. **Give the second method, leaf propagation, with an example:** In Bryophyllum, small plantlets form in the notches along the leaf margin. They fall to the ground and grow into independent plants. Why: The leaf-margin notches hold tissue that can divide and develop into whole plants, so the leaf serves as the propagating part. The NCERT section on natural vegetative propagation cites Bryophyllum for this reason. Other valid methods, such as layering or grafting, would also earn credit.

Topic and concept

Asexual reproduction — vegetative propagation, spore formation. Vegetative propagation lets plants such as rose, potato and Bryophyllum produce new plants from stems, roots or leaves without seeds. Because the offspring arise from the parent's body cells by mitosis, they are genetically identical to the parent and show the same traits.

How marks are earned

1. Vegetative propagation is an asexual method where new plants grow from vegetative parts such as stems, roots or leaves without seed formation, contributing 1 mark. (1 mark)

2. One method is the use of stem cuttings, for example rose cuttings develop into new plants when planted in soil, contributing 1 mark. (1 mark)
3. Another method is leaf propagation, for example Bryophyllum produces plantlets along leaf margins that fall and grow into independent plants, contributing 1 mark. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.3.1: Vegetative propagation uses plant parts like stems and leaves to form new plants.

Question 15

4 marks

Case Based

Renu conducted an experiment to demonstrate photosynthesis. She placed a potted plant in darkness for 48 hours to de-starch it. After that, she covered half of a leaf (Leaf X) with black paper and placed the plant in sunlight for 6 hours. After exposure, she plucked Leaf X, boiled it in water and then in alcohol to remove chlorophyll. Finally, she soaked the leaf in iodine solution. She observed that only the uncovered part of Leaf X turned blue-black, while the covered part remained brown. Meanwhile, a control Leaf Y, not covered but kept in light, showed blue-black all over when tested with iodine.

(a) Identify the biological process Renu demonstrated in her experiment with the de-starched and sun-exposed leaf. [1 mark]

Answer

Renu demonstrated photosynthesis.

Step by step

1. **Work through marking point 1:** Renu demonstrated photosynthesis. Why: Photosynthesis is the process by which plants convert CO_2 and H_2O into carbohydrates using light and chlorophyll.

Topic and concept

Autotrophic nutrition; photosynthesis — raw materials, process, outcomes. In photosynthesis, autotrophs use chlorophyll to capture sunlight and convert carbon dioxide and water into carbohydrates, storing excess as starch for future energy needs.

How marks are earned

1. Renu demonstrated photosynthesis. (1 mark)

Source check: Check the reasoning against NCERT Class 10 Science, Ch. 5, §5.2.1 Autotrophic Nutrition: Photosynthesis is the process by which plants convert CO_2 and H_2O into carbohydrates using light and chlorophyll.

(b) Why did Renu keep the plant in complete darkness for 48 hours before exposing the leaf to sunlight? [1 mark]

Answer

She kept the plant in darkness to de-starch the leaves, ensuring that any starch detected later was newly produced by photosynthesis.

Step by step

1. **Work through marking point 1:** She kept the plant in darkness to de-starch the leaves, ensuring that any starch detected later was newly produced by photosynthesis. Why: Leaves are de-starched in darkness so that only starch produced during the experiment is detected.

Topic and concept

Autotrophic nutrition; photosynthesis — raw materials, process, outcomes. In photosynthesis, autotrophs use chlorophyll to capture sunlight and convert carbon dioxide and water into carbohydrates, storing excess as starch for future energy needs.

How marks are earned

1. She kept the plant in darkness to de-starch the leaves, ensuring that any starch detected later was newly produced by photosynthesis. (1 mark)

Source check: Check the reasoning against NCERT Class 10 Science, Ch. 5, §5.2.1 Autotrophic Nutrition: Leaves are de-starched in darkness so that only starch produced during the experiment is detected.

Attempt one of the final two-mark options.

Option A

(c) (i) Explain why only the uncovered part of Leaf X turned blue-black when treated with iodine. (ii) Name the cellular organelle responsible for the light-capturing stage of the process demonstrated by Renu. [2 marks]

Answer

Only the uncovered part received light, so chlorophyll there synthesised starch during photosynthesis, which turned blue-black with iodine. The chloroplast is the organelle where the light-capturing stage of photosynthesis occurs.

Step by step

1. **Explain the blue-black patch by comparing the covered and uncovered parts of Leaf X:** The plant was de-starched in darkness, so any starch found later was made during the experiment. The uncovered part of Leaf X received light and had chlorophyll, so it carried out photosynthesis and made starch, which turned blue-black with iodine. The black paper blocked light from the covered part, so no starch formed there and it stayed brown. Control Leaf Y, fully lit, turned blue-black all over, which confirms that light is the factor that made the difference. Why: Photosynthesis needs light, chlorophyll, CO_2 and water to make carbohydrate that is stored as starch, and iodine turns starch blue-black. De-starching removes starch made earlier, and the control shows that the covered part stayed brown because of missing light, not because of the treatment.
2. **Name the organelle for light capture:** The chloroplast is the organelle where the light-capturing stage of photosynthesis occurs, because its chlorophyll absorbs sunlight. Why: Chlorophyll is contained in the chloroplasts of leaf cells, so light absorption happens there. The nearest wrong answer is the mitochondrion, which is the site of respiration, not photosynthesis.

Topic and concept

Autotrophic nutrition; photosynthesis — raw materials, process, outcomes. In photosynthesis, chlorophyll absorbs sunlight and the plant converts carbon dioxide and water into carbohydrates, which are stored as starch. In Renu's setup, the presence or absence of light decides whether starch forms, and iodine detects it.

How marks are earned

1. Only the uncovered part received light, so chlorophyll there synthesised starch during photosynthesis, which turned blue-black with iodine. (1 mark)
2. The chloroplast is the organelle where the light-capturing stage of photosynthesis occurs. (1 mark)

Source check: Check the reasoning against NCERT Class 10 Science, Ch. 5, §5.2.1 Autotrophic Nutrition: Chlorophyll in illuminated regions converts CO_2 and H_2O into carbohydrates that give a blue-black colour with iodine. Check the reasoning against NCERT Class 10 Science, Ch. 5, §5.2.2 Heterotrophic Nutrition: Chloroplasts in leaf cells contain chlorophyll that captures light energy for photosynthesis.

OR

Option B

(c) Why did the covered part of Leaf X remain brown after the iodine test, and what does that show about photosynthesis? [2 marks]

Answer

The black paper blocked light, so the covered part could not make new starch and iodine remained brown there. The uncovered part turned blue-black while the covered part did not, showing that light is required for photosynthesis.

Step by step

1. **Read the given facts:** The black paper blocked light, so the covered part could not make new starch and iodine remained brown there. Why: Iodine turns blue-black only where starch formed; comparing the covered and lit leaf regions isolates light as a requirement for photosynthesis.
2. **Apply the concept and check the result:** The uncovered part turned blue-black while the covered part did not, showing that light is required for photosynthesis. Why: Iodine turns blue-black only where starch formed; comparing the covered and lit leaf regions isolates light as a requirement for photosynthesis.

Topic and concept

Autotrophic nutrition; photosynthesis — raw materials, process, outcomes. Iodine turns blue-black only where starch formed; comparing the covered and lit leaf regions isolates light as a requirement for photosynthesis.

How marks are earned

1. The black paper blocked light, so the covered part could not make new starch and iodine remained brown there. (1 mark)
2. The uncovered part turned blue-black while the covered part did not, showing that light is required for photosynthesis. (1 mark)

Source check: Check the passage facts and NCERT Class 10 Science, Ch. 5, §5.2.1 Autotrophic Nutrition 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) Name the enzyme responsible for protein digestion in the stomach, specify its site of secretion, and state the main products formed. [2 marks]

Answer

The stomach chief cells secrete pepsinogen, which is activated to pepsin in the gastric lumen to begin protein digestion. Pepsin hydrolyses proteins into smaller polypeptides and peptides as the primary products.

Step by step

1. **Identify the enzyme and its site of secretion:** The enzyme is pepsin. It is released as inactive pepsinogen by the chief cells of the gastric glands in the stomach wall. Hydrochloric acid in the gastric juice then activates it to pepsin in the stomach lumen. Why: Secreting the enzyme in an inactive form protects the stomach's own protein-containing cells from being digested. The acidic pH from HCl converts pepsinogen to pepsin and gives the acidic medium that pepsin needs to work.
2. **State the products of pepsin action:** Pepsin breaks proteins into smaller polypeptides and peptides (peptones), so protein digestion is only partly complete in the stomach. Why: Pepsin cuts large protein chains into shorter fragments but does not reach amino acids. The final breakdown into amino acids is done later in the small intestine by enzymes such as trypsin, so the product here is peptides and not amino acids.

Topic and concept

Human digestive system. In the human alimentary canal, enzymes act in sequence. Salivary amylase starts starch digestion in the mouth, and in the stomach pepsin starts protein digestion in an acidic medium. This question tests where pepsin is made and what it produces.

How marks are earned

1. The stomach chief cells secrete pepsinogen, which is activated to pepsin in the gastric lumen to begin protein digestion. (1 mark)
2. Pepsin hydrolyses proteins into smaller polypeptides and peptides as the primary products. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 5, §5.2.4: Chief cells of gastric glands release pepsinogen which converts to pepsin and acts on proteins

(b) Explain the double circulatory system in humans, naming the two circuits and their pathways.
[3 marks]

Answer

Pulmonary circulation takes deoxygenated blood from the right heart to the lungs and returns oxygenated blood to the left heart. Systemic circulation sends oxygenated blood from the left heart to the body and returns deoxygenated blood to the right heart. The separation prevents mixing and supplies oxygen efficiently.

Step by step

1. **Trace the pulmonary circuit:** Deoxygenated blood enters the right atrium, moves to the right ventricle and is pumped through the pulmonary artery to the lungs, where it gains oxygen. Why: This is the heart-to-lungs-to-heart part of double circulation.
2. **Trace the systemic circuit:** Oxygenated blood returns by pulmonary veins to the left atrium, passes to the left ventricle and is sent through the aorta to the body; it returns deoxygenated to the right atrium. Why: This is the heart-to-body-to-heart part of double circulation.
3. **Explain the separation:** The right and left sides keep oxygen-rich and oxygen-poor blood from mixing, supporting an efficient oxygen supply for the high energy needs of humans. Why: The Class X source gives separation and efficient oxygen supply as the purpose; a specific pulmonary/systemic pressure comparison is not required.

Topic and concept

Blood and lymph; human circulatory system; heart. Double circulation has pulmonary flow from the right heart to lungs and back to the left heart, and systemic flow from the left heart to the body and back to the right heart. Separation limits mixing and supports efficient oxygen supply.

How marks are earned

1. Trace deoxygenated blood through right atrium and right ventricle via pulmonary artery to lungs for oxygenation. (1 mark)
2. Trace oxygenated blood via pulmonary veins to left atrium and left ventricle, then through aorta to the body and back to the right heart. (1 mark)
3. Explain that the circuits prevent oxygenated and deoxygenated blood from mixing, enabling efficient oxygen supply to the body. (1 mark)

Source check: Downloaded NCERT Science X, Ch. 5, circulation: pulmonary and systemic pathways keep oxygenated and deoxygenated blood separate for efficient supply.

OR

Option B

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

(a) Define transpiration pull and explain how it assists in the ascent of sap. [2 marks]

Answer

Transpiration pull is the force generated by the evaporation of water from leaf stomata, creating a negative pressure (tension) in the xylem. This tension pulls water upward from the roots through the continuous column of xylem vessels, contributing to the ascent of sap.

Step by step

1. **Work through marking point 1:** Transpiration pull is the force generated by the evaporation of water from leaf stomata, creating a negative pressure (tension) in the xylem. Why: Water and minerals ascend from roots via xylem under negative pressure created by transpiration, and phloem moves sugars and other solutes through positive pressure differences between source and sink.
2. **Work through marking point 2:** This tension pulls water upward from the roots through the continuous column of xylem vessels, contributing to the ascent of sap. Why: Water and minerals ascend from roots via xylem under negative pressure created by transpiration, and phloem moves sugars and other solutes through positive pressure differences between source and sink.

Topic and concept

Transportation in plants — xylem and phloem; transpiration. In plants, xylem transports water and dissolved minerals from roots to leaves driven by transpiration pull, while phloem distributes organic solutes bidirectionally through pressure flow.

How marks are earned

1. Transpiration pull is the force generated by the evaporation of water from leaf stomata, creating a negative pressure (tension) in the xylem. (1 mark)
2. This tension pulls water upward from the roots through the continuous column of xylem vessels, contributing to the ascent of sap. (1 mark)

Source check: Check the reasoning against NCERT Science X, Chapter 5, §5.4 TRANSPORTATION IN PLANTS: Water and minerals ascend from roots via xylem under negative pressure created by transpiration, and phloem moves sugars and other solutes through positive pressure differences between source and sink.

(b) Outline the structure and functions of the stomach, small intestine and large intestine in humans. [3 marks]

Answer

The stomach acts as a reservoir where food is mixed with gastric juice containing hydrochloric acid and pepsinogen, initiating protein digestion and killing pathogens. The small intestine is the primary site for chemical digestion and absorption; pancreatic enzymes and bile juices break down nutrients and villi absorb amino acids, glucose and fatty acids into the blood. The large intestine absorbs water and electrolytes from undigested food, forming semi-solid faeces, which are stored in the rectum before elimination.

Step by step

1. **Work through marking point 1:** The stomach acts as a reservoir where food is mixed with gastric juice containing hydrochloric acid and pepsinogen, initiating protein digestion and killing pathogens. Why: Food is first crushed by teeth and mixed with saliva containing salivary amylase, which initiates starch breakdown, and then propelled through specialized regions of the alimentary canal for further digestion and absorption.
2. **Work through marking point 2:** The small intestine is the primary site for chemical digestion and absorption; pancreatic enzymes and bile juices break down nutrients and villi absorb amino acids, glucose and fatty acids into the blood. Why: Food is first crushed by teeth and mixed with saliva containing salivary amylase, which initiates starch breakdown, and then propelled through specialized regions of the alimentary canal for further digestion and absorption.
3. **Work through marking point 3:** The large intestine absorbs water and electrolytes from undigested food, forming semi-solid faeces, which are stored in the rectum before elimination. Why: Food is first crushed by teeth and mixed with saliva containing salivary amylase, which initiates starch breakdown, and then propelled through specialized regions of the alimentary canal for further digestion and absorption.

Topic and concept

Human digestive system. The human alimentary canal is a specialized tube from mouth to anus where mechanical mastication and sequential enzymatic actions—beginning with salivary amylase in the mouth—break down food into absorbable units.

How marks are earned

1. The stomach acts as a reservoir where food is mixed with gastric juice containing hydrochloric acid and pepsinogen, initiating protein digestion and killing pathogens. (1 mark)
2. The small intestine is the primary site for chemical digestion and absorption; pancreatic enzymes and bile juices break down nutrients and villi absorb amino acids, glucose and fatty acids into the blood. (1 mark)
3. The large intestine absorbs water and electrolytes from undigested food, forming semi-solid faeces, which are stored in the rectum before elimination. (1 mark)

Source check: Check the reasoning against NCERT Science X, Chapter 5, §5.2.4 Nutrition in Human Beings: Food is first crushed by teeth and mixed with saliva containing salivary amylase, which initiates starch breakdown, and then propelled through specialized regions of the alimentary canal for further digestion and absorption.

Section B

Question 17

1 mark

Mcq

Choose the correct answer.

(a) Copper(II) oxide dissolves in dilute HCl to give a blue-green solution because: [1 mark]

A. CuO is reduced

B. CuCl is formed

C. $CuCl_2$ is formed

D. $Cu(OH)_2$ is formed

Answer

C. $CuCl_2$ is formed

Step by step

1. **Select and justify the option:** CuO reacts with HCl producing $CuCl_2$, which imparts a blue-green colour. Why: Metallic oxides react with acids to form salt and water; CuO gives $CuCl_2$.

Topic and concept

Reaction of metal oxides with acids. Metallic oxides behave as bases as they dissolve in acids to form salt and water.

How marks are earned

1. CuO reacts with HCl producing $CuCl_2$, which imparts a blue-green colour. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 2, §2.1.5: Metallic oxides react with acids to form salt and water; CuO gives $CuCl_2$.

Question 18

1 mark

Mcq

Choose the correct answer.

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

A. Ions are fixed in the crystal lattice

B. Electrons are free to move

C. Molecules form covalent bonds

D. Neutral atoms carry charges

Answer

A. Ions are fixed in the crystal lattice

Step by step

1. **Select and justify the option:** In the solid state, ions are fixed and cannot move; in molten or aqueous state, ions are free to move and carry charge, allowing conduction. Why: Ionic compounds conduct electricity when molten or dissolved because their ions are mobile.

Topic and concept

Formation and properties of ionic compounds. Ionic compounds form by transfer of electrons from a metal to a non-metal, resulting in high melting points and electrical conductivity when molten.

How marks are earned

1. In the solid state, ions are fixed and cannot move; in molten or aqueous state, ions are free to move and carry charge, allowing conduction. (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 19

1 mark

Mcq

Choose the correct answer.

(a) In a haloalkane, which atom replaces a hydrogen on the carbon chain? [1 mark]

A. Oxygen

B. Nitrogen

C. Halogen

D. Sulfur

Answer

C. Halogen

Step by step

1. **Select and justify the option:** A halogen atom (such as Cl or Br) replaces a hydrogen in a haloalkane. Why: Halogens like Cl or Br can replace hydrogen to form haloalkanes.

Topic and concept

Nomenclature of carbon compounds; functional groups. Functional groups like –OH, –CHO, –CO–, –COOH, and –Cl define classes of carbon compounds and determine their nomenclature and chemical behavior.

How marks are earned

1. A halogen atom (such as Cl or Br) replaces a hydrogen in a haloalkane. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.2.3: Halogens like Cl or Br can replace hydrogen to form haloalkanes.

Question 20

1 mark

Mcq

Choose the correct answer.

(a) Which of the following represents the skeletal chemical equation for the reaction of zinc with sulphuric acid to form zinc sulphate and hydrogen? [1 mark]

A. Zn + H_2SO_4 → $ZnSO_4$ + H_2

B. Zn + SO_4 → $ZnSO_4$ + H_2

C. Zn + H_2SO_4 → ZnH_2 + SO_4

D. Zn + H_2SO_4 → $ZnSO_4$ + H

Answer

A. Zn + H_2SO_4 → $ZnSO_4$ + H_2

Step by step

1. **Choose the equation with the correct formulae for all reactants and products.:** Option A is correct: Zn + H_2SO_4 → $ZnSO_4$ + H_2, because zinc reacts with sulphuric acid to form zinc sulphate and hydrogen gas. Why: A skeletal chemical equation is written using correct chemical symbols and formulae for the substances in the reaction; it may or may not already be balanced, and in this case the correct skeletal equation is also balanced as written.

Topic and concept

Chemical equations and balancing chemical equations. A chemical equation represents a reaction by writing the chemical formulae of the reactants on the left and the products on the right. For this reaction, the formulae are Zn for zinc, H_2SO_4 for sulphuric acid, $ZnSO_4$ for zinc sulphate, and H_2 for hydrogen gas.

How marks are earned

1. The skeletal chemical equation is Zn + H_2SO_4 → $ZnSO_4$ + H_2, representing formulas of reactants and products without balancing. (1 mark)

Source check: Check the reasoning against NCERT Chemistry Class X, Ch.1, §1.1.1: Skeletal equations use chemical formulas to represent a reaction succinctly, without yet balancing atom counts.

Question 21

1 mark

Mcq

Choose the correct answer.

(a) Which of the following indicators turns pink in basic solution but remains colourless in acidic solution? [1 mark]

A. Methyl orange

B. Phenolphthalein

C. Litmus

D. Bromothymol blue

Answer

B. Phenolphthalein

Step by step

1. **Select and justify the option:** Phenolphthalein is colourless in acidic medium and turns pink in base. Why: Indicators show characteristic colour changes in acid or base solutions.

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. Phenolphthalein is colourless in acidic medium and turns pink in base. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 2, §2.1.1: Indicators show characteristic colour changes in acid or base solutions.

Question 22

1 mark

Mcq

Choose the correct answer.

(a) What property of metallic bonding primarily enables metals to be hammered into thin sheets (malleability)? [1 mark]

A. Directional covalent bonds

B. Nondirectional electrostatic attraction between cations and delocalised electrons

C. Hydrogen bonding between layers

D. Ionic bonds between fixed ions

Answer

B. Nondirectional electrostatic attraction between cations and delocalised electrons

Step by step

1. **Select and justify the option:** In metals, positive ions are held in a sea of delocalised electrons by nondirectional electrostatic forces, allowing ions to slide past each other without breaking the bond, which gives malleability. Why: Some metals can be beaten into thin sheets due to the nondirectional nature of metallic bonds.

Topic and concept

Physical properties of metals and non-metals. Non-metals generally lack malleability, ductility and electrical conductivity, unlike metals.

How marks are earned

1. In metals, positive ions are held in a sea of delocalised electrons by nondirectional electrostatic forces, allowing ions to slide past each other without breaking the bond, which gives malleability. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 3, §3.1.3: Some metals can be beaten into thin sheets due to the nondirectional nature of metallic bonds.

Question 23

1 mark

Mcq

Choose the correct answer.

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

A. Addition of bromine across the C=C bond

B. Substitution of a hydrogen atom by chlorine

C. Formation of a ring structure without breaking bonds

D. Decomposition into methane

Answer

A. Addition of bromine across the C=C bond

Step by step

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

Topic and concept

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

How marks are earned

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

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

Question 24

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): In a balanced chemical equation, the total mass of reactants equals the total mass of products. Reason (R): Balancing a chemical equation ensures equal numbers of each type of atom on both sides. [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 Reason correctly explains the Assertion. Why: Law of conservation of mass requires equal atom counts, so balanced equations keep mass constant.

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. Both Assertion and Reason are true and the Reason correctly explains the Assertion. (1 mark)

Source check: Check the reasoning against NCERT Chemistry Class X, Ch.1, §1.1.2: Law of conservation of mass requires equal atom counts, so balanced equations keep mass constant.

Question 25

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Write the chemical equation for the reaction between copper(II) oxide and dilute hydrochloric acid and state the nature of copper(II) oxide based on this reaction. [2 marks]

Answer

$CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$. Copper(II) oxide neutralises acid to give salt and water and therefore behaves as a basic oxide.

Step by step

1. **Write the equation and check that it is balanced:** $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$. Atom count on each side: Cu 1, O 1, H 2, Cl 2. Both sides match, so the equation is balanced. The black CuO dissolves and the solution turns blue-green because of copper(II) chloride. Why: A balanced equation obeys conservation of mass. Each CuO needs two HCl because the copper(II) chloride formed needs two chloride ions and the oxygen leaves as water with the two H. The colour change is an observable sign that a new salt has formed.
2. **Deduce the nature of copper(II) oxide:** CuO reacts with acid to give a salt and water only, so copper(II) oxide is a basic oxide. Why: Metal oxide + acid → salt + water is the neutralisation pattern, and a substance that neutralises an acid is a base. The nearest wrong answer is amphoteric, which would need CuO to react with a base as well, and this reaction does not show that.

Topic and concept

Reaction of metal oxides with acids. Metallic oxides are generally basic because they dissolve in acids to give a salt and water. Copper(II) oxide with dilute hydrochloric acid gives copper(II) chloride and water, which shows its basic nature.

How marks are earned

1. $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$. (1 mark)
2. Copper(II) oxide neutralises acid to give salt and water and therefore behaves as a basic oxide. (1 mark)

Source check: Check the reasoning against NCERT Science Class 10, Ch. 2, §2.1.5: Metallic oxides dissolve in acids to form salt and water, showing basic character

Question 26

3 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Write the balanced equation and check it:** $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$. Atom count on each side: Fe 1, Cu 1, S 1, O 4. Both sides match, so no coefficients are needed. Why: Conservation of mass requires equal numbers of each atom on both sides. This is a displacement reaction, in which iron takes the place of copper in the sulfate.
2. **State the observation and link it to the products:** A reddish-brown deposit of copper forms on the iron nail. The blue colour of the solution fades towards pale green. Why: The brown deposit is the copper metal that has been displaced. The blue colour comes from Cu^{2+} ions, which are used up, and the pale green colour comes from the $FeSO_4$ that forms. So the colour change shows that the reaction took place.
3. **Explain the reaction with the reactivity series:** Iron is above copper in the reactivity series, so it displaces copper from copper(II) sulfate solution. Iron atoms lose electrons to form Fe^{2+}, and Cu^{2+} ions gain electrons to form Cu. Why: A more reactive metal displaces a less reactive metal from the solution of its salt. Iron is oxidised and copper ions are reduced, which shows why the reaction goes in this direction. Copper would not displace iron from iron sulfate.

Topic and concept

Reactivity series. The reactivity series arranges metals by their tendency to lose electrons and be oxidised. It predicts that iron, which is more reactive, will displace copper from copper(II) sulfate solution.

How marks are earned

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

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

OR

Option B

Answer the question with working and reasons where needed.

(a) What is corrosion? Describe two methods to prevent it. [3 marks]

Answer

Corrosion is the gradual destruction of metals by chemical reaction with substances in the environment, especially oxygen and moisture. Coating the metal surface with paint or a layer of another material prevents direct contact with oxygen and moisture, thereby preventing corrosion. Attaching a more reactive metal as a sacrificial anode causes that metal to corrode in place of the protected metal.

Step by step

1. **Work through marking point 1:** Corrosion is the gradual destruction of metals by chemical reaction with substances in the environment, especially oxygen and moisture. Why: Corrosion is prevented by coatings and by using sacrificial anodes.
2. **Work through marking point 2:** Coating the metal surface with paint or a layer of another material prevents direct contact with oxygen and moisture, thereby preventing corrosion. Why: Corrosion is prevented by coatings and by using sacrificial anodes.
3. **Work through marking point 3:** Attaching a more reactive metal as a sacrificial anode causes that metal to corrode in place of the protected metal. Why: Corrosion is prevented by coatings and by using sacrificial anodes.

Topic and concept

Corrosion and its prevention. Corrosion is the gradual oxidation of metals by environmental agents and is prevented by coatings, sacrificial anodes and alloying.

How marks are earned

1. Corrosion is the gradual destruction of metals by chemical reaction with substances in the environment, especially oxygen and moisture. (1 mark)
2. Coating the metal surface with paint or a layer of another material prevents direct contact with oxygen and moisture, thereby preventing corrosion. (1 mark)
3. Attaching a more reactive metal as a sacrificial anode causes that metal to corrode in place of the protected metal. (1 mark)

Source check: Check the reasoning against NCERT Science, Ch. 3 §3.6 Corrosion and its Prevention: Corrosion is prevented by coatings and by using sacrificial anodes.

Question 27

3 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Name the compound step by step:** The longest carbon chain has 3 carbons, so the parent is propane. The –OH group is on the middle carbon. Numbering from either end puts it at C2, so the locant is 2. Dropping the final 'e' of propane and adding 'ol' gives propan-2-ol. Why: IUPAC naming starts from the longest chain, and the functional group gets the lowest locant. For an alcohol the suffix 'ol' replaces the final 'e' of the alkane name. Here the locant 2 shows that –OH is on the second carbon and not at the end.
2. **Write the structural formula:** The structure is CH_3–CH(OH)–CH_3. Fully expanded, the middle carbon is bonded to one H, one –OH and two CH_3 groups, and each CH_3 carbon has three H atoms. The –OH is on the middle carbon. Why: The structural formula must show how the atoms are joined. It shows that –OH is on carbon 2, which separates propan-2-ol from its isomer propan-1-ol, where –OH is on an end carbon.
3. **Identify the functional group:** The functional group is the hydroxyl group (–OH), which makes the compound an alcohol. Why: A functional group is the atom or group that replaces hydrogen in the hydrocarbon chain and gives the compound its characteristic properties and name suffix. The –OH group places this compound in the alcohol class, so it ends in 'ol'.

Topic and concept

Nomenclature of carbon compounds; functional groups. Functional groups such as –OH, –CHO, –CO–, –COOH and –Cl define classes of carbon compounds and set their names. In CH_3–CH(OH)–CH_3 the –OH group on the middle carbon of a three-carbon chain gives propan-2-ol, an alcohol.

How marks are earned

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

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

Question 28

4 marks

Case Based

In a cement factory, limestone (calcium carbonate) is heated strongly in a kiln, decomposing into calcium oxide (quicklime) and carbon dioxide gas. This thermal decomposition reaction is represented by the equation:
$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

(a) According to the passage, which compound is being decomposed on heating? [1 mark]

Answer

Calcium carbonate ($CaCO_3$) is the compound decomposed on heating.

Step by step

1. **Work through marking point 1:** Calcium carbonate ($CaCO_3$) is the compound decomposed on heating. Why: Calcium carbonate on heating yields calcium oxide and carbon dioxide.

Topic and concept

Types of chemical reactions — decomposition. Thermal decomposition of $CaCO_3$ on heating produces CaO and CO_2.

How marks are earned

1. Calcium carbonate ($CaCO_3$) is the compound decomposed on heating. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 1, §1.2.2 Decomposition Reaction: Calcium carbonate on heating yields calcium oxide and carbon dioxide.

(b) Write the skeletal chemical equation for the process described in the passage. [1 mark]

Answer

The skeletal chemical equation is: $CaCO_3 \rightarrow CaO + CO_2$.

Step by step

1. **Work through marking point 1:** The skeletal chemical equation is: $CaCO_3 \rightarrow CaO + CO_2$. Why: Decomposition of calcium carbonate yields calcium oxide and carbon dioxide.

Topic and concept

Types of chemical reactions — decomposition. Thermal decomposition of $CaCO_3$ on heating produces CaO and CO_2.

How marks are earned

1. The skeletal chemical equation is: $CaCO_3 \rightarrow CaO + CO_2$. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 1, §1.2.2 Decomposition Reaction: Decomposition of calcium carbonate yields calcium oxide and carbon dioxide.

Attempt one of the final two-mark options.

Option A

(c) (i) Balance the chemical equation for the reaction given in the passage. (ii) Identify the type of chemical reaction illustrated in the passage. [2 marks]

Answer

The balanced equation is: $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$. (No additional coefficients are needed.) This reaction is a thermal decomposition reaction.

Step by step

1. **Check whether $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ is already balanced by counting atoms on both sides:** Left side: Ca = 1, C = 1, O = 3. Right side: CaO gives Ca = 1, O = 1; CO_2 gives C = 1, O = 2; total Ca = 1, C = 1, O = 3. Every element matches, so all coefficients are 1 and no extra coefficients are needed. Why: A chemical equation is balanced when each element has the same number of atoms on both sides, as mass is conserved in a reaction. Because the counts already match, adding any coefficient would unbalance it.
2. **Classify the reaction by comparing the number of reactants and products and the energy source:** One reactant, $CaCO_3$, breaks into two simpler products, CaO and CO_2, and the passage says it is heated strongly in a kiln. One compound splitting into simpler substances on heating is a thermal decomposition reaction. Why: A decomposition reaction is one in which a single compound breaks into two or more simpler products, and the word 'thermal' shows that heat supplies the energy. This separates it from a combination reaction, where several reactants join into one product.

Topic and concept

Types of chemical reactions — decomposition. In a decomposition reaction a single compound breaks into two or more simpler products. When heat causes the breakdown it is a thermal decomposition. Heating $CaCO_3$ gives CaO and CO_2, and the equation is balanced when atoms of Ca, C and O are equal on both sides.

How marks are earned

1. The balanced equation is: $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$. (No additional coefficients are needed.) (1 mark)
2. This reaction is a thermal decomposition reaction. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 1, §1.2.2 Decomposition Reaction: Calcium carbonate decomposes to CaO and CO_2 with one-to-one stoichiometry. Check the reasoning against NCERT Class 10 science, Ch. 1, §1.2.2 Decomposition Reaction: A decomposition reaction involves one compound breaking into simpler products when heated.

OR

Option B

(c) Count the calcium, carbon and oxygen atoms on both sides of the given equation and explain whether mass is conserved. [2 marks]

Answer

$CaCO_3$ has one calcium atom, one carbon atom and three oxygen atoms on the reactant side. CaO and CO_2 together have one calcium atom, one carbon atom and three oxygen atoms, so the equation is balanced and conserves mass.

Step by step

1. **Read the given facts:** $CaCO_3$ has one calcium atom, one carbon atom and three oxygen atoms on the reactant side. Why: A balanced chemical equation preserves the number of atoms of each element, so the calcium, carbon and oxygen counts must agree across the arrow.
2. **Apply the concept and check the result:** CaO and CO_2 together have one calcium atom, one carbon atom and three oxygen atoms, so the equation is balanced and conserves mass. Why: A balanced chemical equation preserves the number of atoms of each element, so the calcium, carbon and oxygen counts must agree across the arrow.

Topic and concept

Types of chemical reactions — decomposition. A balanced chemical equation preserves the number of atoms of each element, so the calcium, carbon and oxygen counts must agree across the arrow.

How marks are earned

1. $CaCO_3$ has one calcium atom, one carbon atom and three oxygen atoms on the reactant side. (1 mark)
2. CaO and CO_2 together have one calcium atom, one carbon atom and three oxygen atoms, so the equation is balanced and conserves mass. (1 mark)

Source check: Check the passage facts and NCERT Class 10 science, Ch. 1, §1.2.2 Decomposition Reaction 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 balanced chemical equations for the neutralisation reactions: (i) sodium hydroxide with hydrochloric acid, (ii) barium hydroxide with sulfuric acid. [2 marks]

Answer

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$. $Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$.

Step by step

1. **Write the neutralisation of NaOH with HCl as acid + base → salt + water, and check the atom counts:** $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$. Left: Na 1, O 1, H 2, Cl 1. Right: Na 1, Cl 1, H 2, O 1. All counts match, so every coefficient is 1. Why: In neutralisation the acid and base react to give a salt and water. The salt is formed from the metal of the base (Na) and the acid radical (Cl).
2. **Write $Ba(OH)_2$ with H_2SO_4 as salt + water and balance the hydrogen and oxygen atoms:** $Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$. Left: Ba 1, S 1, O 2+4 = 6, H 2+2 = 4. Right: Ba 1, S 1, O 4+2 = 6, H 4. The coefficient 2 on H_2O is needed because 2 OH^- and 2 H^+ give 2 water molecules. $BaSO_4$ is an insoluble white precipitate, so it is marked (s). Why: $Ba(OH)_2$ supplies two OH^- ions and H_2SO_4 supplies two H^+ ions, so two water molecules form. This is why the water needs the coefficient 2 to balance both H and O.

Topic and concept

Reaction of acids and bases with each other; neutralisation reaction. An acid and a base neutralise each other to form a salt and water. The equation must be balanced so that the atoms of each element are equal on both sides, and state symbols show which product is dissolved and which is a solid.

How marks are earned

1. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$. (1 mark)
2. $Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$. (1 mark)

Source check: Check the reasoning against NCERT Science Class 10, Ch. 2, §2.1.4: Neutralisation of acid and base yields salt and water

(b) 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. **Write the dissociation of the strong acid and strong base into ions in water:** $NaOH(aq) \rightarrow Na^+(aq) + OH^-(aq)$ and $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$. So the mixture contains Na^+, OH^-, H^+ and Cl^- ions. Why: In aqueous solution an acid releases H^+ ions and a base releases OH^- ions. These ions are the actual reacting species in neutralisation.
2. **Show the H^+ and OH^- ions combining to form water:** $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$. One H^+ and one OH^- combine to give one water molecule, and heat is released, so the reaction is exothermic. Why: Neutralisation is the combination of H^+ from the acid with OH^- from the base to form water. This ionic change is the same for any strong acid and strong base.
3. **Identify the spectator ions and write the full and net ionic equations:** Full ionic equation: $Na^+ + OH^- + H^+ + Cl^- \rightarrow Na^+ + Cl^- + H_2O$. Cancelling Na^+ and Cl^-, which appear unchanged on both sides, gives the net equation $H^+ + OH^- \rightarrow H_2O$. The Na^+ and Cl^- stay dissolved as sodium chloride, so the products are NaCl and water. The solution is close to neutral, pH about 7, when the acid and base are in equal amounts. Why: Ions that appear unchanged on both sides take no part in the reaction and are called spectator ions. The salt NaCl is the combination of these remaining ions, and since H^+ and OH^- are used up in equal numbers the solution becomes neutral.

Topic and concept

Reaction of acids and bases with each other; neutralisation reaction. Neutralisation of an acid with a base gives a salt and water. In terms of ions, H^+ from the acid and OH^- from the base combine to form water, while the other ions remain in solution as the salt.

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

OR

Option B

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

(a) Write the balanced chemical equation for the reaction of aqueous hydrochloric acid with sodium hydroxide and state one use of the reaction. [2 marks]

Answer

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$. This neutralisation is used to prepare sodium chloride in the laboratory.

Step by step

1. **Work through marking point 1:** $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$. Why: neutralisation of HCl by NaOH yields NaCl and water
2. **Work through marking point 2:** This neutralisation is used to prepare sodium chloride in the laboratory. Why: neutralisation of HCl by NaOH yields NaCl and water

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. $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$. (1 mark)
2. This neutralisation is used to prepare sodium chloride in the laboratory. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 2, §2.1.4: neutralisation of HCl by NaOH yields NaCl and water

(b) Explain why phenolphthalein is colourless in acidic solution but turns pink when added to a basic solution. [3 marks]

Answer

In acidic solution phenolphthalein exists in its lactone form, which does not absorb visible light and is therefore colourless. In basic solution phenolphthalein loses protons to form a quinoid anion. The quinoid form absorbs in the visible region and appears pink, indicating alkalinity.

Step by step

1. **Work through marking point 1:** In acidic solution phenolphthalein exists in its lactone form, which does not absorb visible light and is therefore colourless. Why: Phenolphthalein changes colour only in basic media

2. **Work through marking point 2:** In basic solution phenolphthalein loses protons to form a quinoid anion. Why: Phenolphthalein changes colour only in basic media
3. **Work through marking point 3:** The quinoid form absorbs in the visible region and appears pink, indicating alkalinity. Why: Phenolphthalein changes colour only in basic media

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. In acidic solution phenolphthalein exists in its lactone form, which does not absorb visible light and is therefore colourless. (1 mark)
2. In basic solution phenolphthalein loses protons to form a quinoid anion. (1 mark)
3. The quinoid form absorbs in the visible region and appears pink, indicating alkalinity. (1 mark)

Source check: Check the reasoning against NCERT Science Class 10, Ch. 2, §2.1.1: Phenolphthalein changes colour only in basic media

Section C

Question 30

1 mark

Mcq

Choose the correct answer.

(a) During accommodation for viewing near objects, what change occurs in the eye lens and its focal length? [1 mark]

A. curvature increases and focal length decreases

B. curvature decreases and focal length decreases

C. curvature increases and focal length increases

D. curvature decreases and focal length increases

Answer

A. curvature increases and focal length decreases

Step by step

1. **Select and justify the option:** When viewing near objects, ciliary muscles contract making the lens thicker, so its curvature increases and focal length decreases. Why: Contraction of ciliary muscles increases lens curvature and reduces focal length for near vision

Topic and concept

Human eye; far point, near point; accommodation. Accommodation is the process by which the eye lens changes curvature—becoming thicker for near objects and thinner for distant ones—to adjust its focal length.

How marks are earned

1. When viewing near objects, ciliary muscles contract making the lens thicker, so its curvature increases and focal length decreases. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.1.1 Power of Accommodation: Contraction of ciliary muscles increases lens curvature and reduces focal length for near vision

Question 31

1 mark

Mcq

Choose the correct answer.

(a) A myopic person has a far point of 50 cm. What is the power of the lens required to correct this defect? [1 mark]

A. –1.5 D

B. –2.0 D

C. +2.0 D

D. +1.5 D

Answer

B. –2.0 D

Step by step

1. **Take the focal length equal to minus the far point, then apply P = 1/f in metres:** The far point is 50 cm = 0.50 m, so the concave lens must have f = –0.50 m. P = 1/f = 1/(–0.50 m) = –2.0 D. Check: a negative power means a diverging concave lens, as expected for myopia, so option B (–2.0 D) is correct. Why: A myopic eye cannot see beyond its far point. The corrective lens must form a virtual image of distant objects at the far point, so its focal length equals the far point distance and is negative for a concave lens. Options C and D have the wrong sign, which would converge rays and worsen myopia. Option A comes from using 66.7 cm instead of 50 cm.

Topic and concept

Defects of vision — myopia, hypermetropia, presbyopia; correction with lenses. Myopia is corrected by a concave lens, which diverges the incoming rays so that they focus on the retina. The lens needed has a focal length equal in magnitude to the far point. It has negative power, found from P = 1/f with f in metres.

How marks are earned

1. Power P = –1/f = –1/0.50 m = –2.0 dioptre, so a concave lens of –2.0 D is required. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.2 Defects of Vision and Their Correction: Power of corrective lens for myopia is P = 1/f where f is negative of far point

Question 32

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): In an electric circuit, conventional current flows from the positive to the negative terminal of a cell. Reason (R): Electrons move from the negative to the positive terminal inside the conductor. [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 A and R true but R does not explain A

Step by step

1. **Evaluate the assertion and reason separately:** A is true: by convention current is directed from the positive to negative terminal outside the cell. R is also true: electrons in the metal move from negative to positive. The correct choice is B. Why: NCERT states that the convention was set before electrons were known, so electron motion is opposite to the convention but does not cause or explain its historical choice.

Topic and concept

Electric potential difference and electric current; Ohm's law. Conventional current is defined as the direction positive charge would flow; in a metallic conductor electrons move in the opposite direction. Both statements are true, but electron flow does not explain why the convention was chosen.

How marks are earned

1. Both A and R are true, but electron flow is opposite to the historically chosen conventional-current direction and does not explain why that convention was adopted. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, §11.1 Electric current and circuit: Conventional current direction is opposite to electron flow.

Question 33

2 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Explain how a prism splits white light because refractive index varies with wavelength:** White light is a mixture of colours. When it enters a glass prism each colour refracts at a different angle because the refractive index n of glass is different for each wavelength. The light refracts again at the second face, which increases the separation, and spreads out into a spectrum VIBGYOR. Why: Refractive index n = c/v, so a different n means the colours travel at different speeds in glass. Since each colour bends by a different amount, white light splits into its colours, and this is dispersion.
2. **Compare violet and red light to show which bends more:** Violet has a shorter wavelength and a higher refractive index in glass than red, so it slows more and deviates more. Red has a longer wavelength and a lower refractive index, so it deviates least. Thus violet appears towards the base of the prism and red towards the apex side in the emergent spectrum. Why: A higher refractive index means a greater bending towards the normal at each face, so the total deviation is larger. This is why violet lies at one end of the spectrum and red at the other.

Topic and concept

Refraction of light through a prism; dispersion. Dispersion happens because different wavelengths of light refract by different amounts in glass. The refractive index is larger for shorter wavelengths, so violet deviates more than red, and white light splits into a spectrum.

How marks are earned

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

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

Question 34

2 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

(a) State the expression for the magnetic field due to a long straight current-carrying conductor at a point located at a distance r from it. Also state its SI unit. [2 marks]

Answer

According to Ampère's circuital law, the magnitude of the magnetic field at a distance r from a long straight conductor carrying current I is given by $B = \mu_0 I/(2\pi r)$. The SI unit of magnetic field is tesla (T), which is equivalent to $N \cdot A^{-1} \cdot m^{-1}$.

Step by step

1. **State the expression for the field of a long straight wire and identify the quantities:** $B = \mu_0 I/(2\pi r)$, where I is the current in amperes, r is the distance from the wire in metres and $\mu_0 = 4\pi \times 10^{-7}$ T·m/A. So B is directly proportional to I and inversely proportional to r. Why: The field lines around a straight current-carrying wire are concentric circles, and the field gets weaker farther away. The formula gives this dependence numerically: B increases with current and decreases as 1/r. Note that the formula itself goes beyond the Class X syllabus, which only teaches the qualitative result.
2. **Check the SI unit of B from the formula:** The SI unit of B is the tesla (T). From $B = \mu_0 I/(2\pi r)$, the units are (T·m/A)(A)/(m) = T. Also 1 T = 1 $N \cdot A^{-1} \cdot m^{-1}$, since B = F/(Il) gives N/(A·m). Why: Checking that the units on both sides agree confirms the formula. Defining the tesla from force on a current element shows it is the unit of magnetic field strength.

Topic and concept

Magnetic field due to current-carrying conductor — straight wire. A straight wire carrying current produces a magnetic field in concentric circles around it, with direction given by the right-hand thumb rule. The field is stronger for larger current and weaker at larger distance. The quantitative formula $B = \mu_0 I/(2\pi r)$ is a physics extension beyond the Class X level.

How marks are earned

1. According to Ampère's circuital law, the magnitude of the magnetic field at a distance r from a long straight conductor carrying current I is given by $B = \mu_0 I/(2\pi r)$. (1 mark)
2. The SI unit of magnetic field is tesla (T), which is equivalent to $N \cdot A^{-1} \cdot m^{-1}$. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.12, §12.2.1: The magnetic field lines around a straight current-carrying conductor form concentric circles whose strength decreases with distance from the conductor.

OR

Option B

Answer the question with working and reasons where needed.

(a) State two characteristics of the magnetic field inside a long current-carrying solenoid. [2 marks]

Answer

The magnetic field inside a long solenoid is uniform, as indicated by equally spaced, parallel field lines. The field strength inside is strong and nearly constant at all points away from the ends of the solenoid.

Step by step

1. **Work through marking point 1:** The magnetic field inside a long solenoid is uniform, as indicated by equally spaced, parallel field lines. Why: A long solenoid produces a strong, uniform magnetic field inside, shown by parallel field lines.
2. **Work through marking point 2:** The field strength inside is strong and nearly constant at all points away from the ends of the solenoid. Why: A long solenoid produces a strong, uniform magnetic field inside, shown by parallel field lines.

Topic and concept

Magnetic field due to current-carrying conductor — solenoid. A long solenoid carrying current produces a uniform magnetic field inside, with field lines parallel and closely spaced, indicating strong, nearly constant field strength.

How marks are earned

1. The magnetic field inside a long solenoid is uniform, as indicated by equally spaced, parallel field lines. (1 mark)
2. The field strength inside is strong and nearly constant at all points away from the ends of the solenoid. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.12, §12.4: A long solenoid produces a strong, uniform magnetic field inside, shown by parallel field lines.

Question 35

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Describe the characteristics of the image formed by a concave mirror when the object is placed between its pole and principal focus. [3 marks]

Answer

Because the reflected rays diverge, their backward extensions meet behind the mirror, forming a virtual image. The image is erect with respect to the object. The image is larger than the object, that is, magnified.

Step by step

1. **Work through marking point 1:** Because the reflected rays diverge, their backward extensions meet behind the mirror, forming a virtual image. Why: Object between pole and focus yields virtual, erect, enlarged image
2. **Work through marking point 2:** The image is erect with respect to the object. Why: Object between pole and focus yields virtual, erect, enlarged image
3. **Work through marking point 3:** The image is larger than the object, that is, magnified. Why: Object between pole and focus yields virtual, erect, enlarged image

Topic and concept

Reflection of light at curved surfaces; spherical mirrors; mirror formula. For a spherical mirror, the object distance (u), image distance (v) and focal length (f) satisfy the mirror equation 1/v + 1/u = 1/f, with f negative for concave and positive for convex mirrors.

How marks are earned

1. Because the reflected rays diverge, their backward extensions meet behind the mirror, forming a virtual image. (1 mark)
2. The image is erect with respect to the object. (1 mark)
3. The image is larger than the object, that is, magnified. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 9, §9.2.1: Object between pole and focus yields virtual, erect, enlarged image

Question 36

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

Near each segment of the current-carrying loop, field lines are concentric circles around the wire. Moving toward the centre, their arcs grow larger and look almost straight. The fields from all loop segments reinforce one another in the same direction at the centre.

Step by step

1. **Describe field near the wire:** Around each small part of the current-carrying loop, magnetic field lines appear as concentric circles centred on that wire segment. Why: A current-carrying wire has circular magnetic field lines around it.
2. **Describe the field toward the centre:** The circles become larger farther from the wire; near the loop's centre their arcs appear almost straight and the contributions from the loop point in the same direction. Why: This describes the central pattern stated by the Class X source rather than claiming a perfectly uniform field everywhere inside.
3. **Connect the local patterns:** Together the fields of all parts of the loop produce a strong central magnetic field, with its direction given by the right-hand rule. Why: Each wire segment contributes in the same direction within the loop, reinforcing the central field.

Topic and concept

Magnetic field due to current-carrying conductor — circular loop. A current-carrying loop has concentric-circle field patterns around its wire. Toward the centre these circles grow, their arcs appear almost straight, and contributions add in the same direction.

How marks are earned

1. Describe concentric-circle magnetic field lines around each segment of the current-carrying circular wire. (1 mark)
2. Explain that the circles grow larger away from the wire and their arcs appear nearly straight at the loop centre. (1 mark)
3. Explain that contributions from all loop segments point in the same direction near the centre, strengthening the field. (1 mark)

Source check: Downloaded NCERT Science X, Ch. 12, magnetic field of a circular loop: circular lines around the wire grow larger and appear nearly straight at the centre.

Question 37

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Explain the concept of electric potential difference between two points in a circuit and define its SI unit. [3 marks]

Answer

Potential difference between two points is the work done to move a unit positive charge from one point to the other. This potential difference is maintained by a battery through chemical action that expends energy to move charges. Its SI unit is volt, defined as one joule per coulomb of charge.

Step by step

1. **Define potential difference:** Potential difference between two points is the work done to move a unit positive charge from one point to the other, so V = W/Q. For example, if W = 6 J is done moving Q = 2 C, then V = 6 J / 2 C = 3 V. Why: Potential difference is the work (energy transfer) per unit charge between two points (NCERT Class 10 Science, Ch. 11, §11.2). Dividing by the charge makes the quantity independent of how much charge moves. It then describes only the two points in the circuit.
2. **State how it is maintained:** A battery or cell keeps a potential difference between its terminals through chemical action. This action spends chemical energy to move charges, and so it drives a current through the circuit. Why: Charges flow only while a potential difference is kept up. A source that converts chemical energy into electrical energy does this. Without it the current would stop, which is why the battery is the source of the potential difference.
3. **Define the SI unit:** The SI unit is the volt. 1 volt = 1 joule / 1 coulomb, that is, 1 V = 1 J C^{-1}. In the example above, 6 J / 2 C = 3 J C^{-1} = 3 V, which is consistent. Why: The unit follows directly from V = W/Q, with W in joules and Q in coulombs. One volt is the potential difference when 1 J of work moves 1 C of charge between the two points. The unit check confirms that J/C is the volt.

Topic and concept

Electric potential difference and electric current; Ohm's law. Potential difference between two points is the work done per unit charge to move the charge from one point to the other, V = W/Q. It acts like the electrical push that makes charge flow, and a cell maintains it by chemical action. Its SI unit is the volt, equal to one joule per coulomb.

How marks are earned

1. Potential difference between two points is the work done to move a unit positive charge from one point to the other. (1 mark)
2. This potential difference is maintained by a battery through chemical action that expends energy to move charges. (1 mark)

3. Its SI unit is volt, defined as one joule per coulomb of charge. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, §11.2 Electric potential and potential difference: Potential difference is defined as work done per unit charge to move charge between two points, with unit volt.

Question 38

4 marks

Case Based

A teacher conducts demonstrations on a flat cardboard: first, a bar magnet is placed and iron filings are sprinkled, showing the arrangement of field lines. Next, a straight conductor connected to a battery is passed normally through the cardboard, and filings show the magnetic field pattern around the current. The conductor is then bent into a circular loop carrying the same current, and filings reveal the field pattern. Finally, multiple turns are arranged to form a long solenoid carrying current and filings show the field inside the solenoid.

(a) In the first demonstration with the bar magnet, the iron filings align to form which pattern of magnetic field lines? [1 mark]

Answer

Field lines of a bar magnet form closed loops that emerge from its north pole and enter its south pole.

Step by step

1. **Identify the bar-magnet field pattern:** The iron filings align along curved lines that form closed loops. Outside the magnet they run from the north pole to the south pole, and inside the magnet they run from south to north. The lines are closest together near the poles. Why: Filings sprinkled around a magnet line up along the field and so reveal the region where the magnet's force acts (NCERT Science X, Ch. 12, §12.1). By convention the lines emerge from the north pole and enter the south pole. They close up inside the magnet, which is why they form loops with no starting or ending point.

Topic and concept

Magnetic field and field lines; bar magnet. Magnetic field lines of a bar magnet form closed loops that emerge from the north pole and enter the south pole. They show the region where the magnet's force is detected. Lines crowded together, as near the poles, mean a stronger field.

How marks are earned

1. Field lines of a bar magnet form closed loops that emerge from its north pole and enter its south pole. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 12, §12.1 Magnetic Field and Field Lines: Magnetic field lines of a bar magnet form closed loops from north to south

(b) During the second demonstration with the straight conductor carrying current, the iron filings show which pattern? [1 mark]

Answer

The iron filings form concentric circles around the straight current-carrying conductor, indicating circular magnetic field lines.

Step by step

1. **Identify the pattern around a straight current-carrying conductor:** The iron filings form concentric circles around the conductor. These circles lie in the plane of the cardboard, perpendicular to the conductor, and their direction is given by the right-hand thumb rule. The field is weaker at larger distances, so the circles spread out farther from the wire. Why: A current produces a magnetic field around the conductor. Because the wire is straight, the field has the same strength at every point at a given distance, and this gives circles centred on the wire (NCERT Science X, Ch. 12, §12.2.1). The right-hand thumb rule says that if the thumb points along the current, the curled fingers show the field direction.

Topic and concept

Magnetic field due to current-carrying conductor — straight wire. A straight conductor carrying current produces magnetic field lines in concentric circles around it. The direction follows the right-hand thumb rule. The field becomes weaker as the distance from the wire increases.

How marks are earned

1. The iron filings form concentric circles around the straight current-carrying conductor, indicating circular magnetic field lines. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 12, §12.2.1 Magnetic Field due to a Current through a Straight Conductor: Magnetic field lines around a straight current-carrying conductor are concentric circles

Attempt one of the final two-mark options.

Option A

(c) (i) In the third demonstration with the circular loop, what is the shape of the field lines observed at the center of the loop? (ii) In the final demonstration with the solenoid, how are the field lines arranged inside it? [2 marks]

Answer

At the centre of a current-carrying circular loop, the magnetic field lines appear as straight lines parallel to the axis of the loop. Inside a long current-carrying solenoid, the magnetic field lines are parallel, closely spaced, and nearly uniform.

Step by step

1. **Describe the field at the centre of the circular loop:** (i) Near the centre of the loop the field lines appear as straight lines perpendicular to the plane of the loop, that is, parallel to its axis. Each segment of the loop adds to the field in the same direction here, so the field is strongest and nearly uniform at the centre. Why: Far from the wire, the concentric circles are large and a small arc of a large circle looks straight. At the centre every part of the loop contributes in the same direction (NCERT Science X, Ch. 12, §12.2.2). Together these give a strong, straight, uniform field there.
2. **Describe the field inside the solenoid:** (ii) Inside a long current-carrying solenoid the field lines are straight, parallel to the axis, closely spaced and evenly spaced. This means the field is nearly uniform. The solenoid therefore behaves like a bar magnet, with one end acting as north and the other as south. Why: The turns of the coil are placed side by side. Each turn's field adds in the same direction inside, so the fields reinforce each other (NCERT Science X, Ch. 12, §12.2.3). This gives a strong, uniform field of nearly constant strength.

Topic and concept

Magnetic field due to current-carrying conductor — circular loop. A current-carrying circular loop gives field lines that are dense and nearly uniform near its centre, and they look straight there, perpendicular to the plane of the loop. A long solenoid carrying current produces a uniform field inside, with parallel and closely spaced lines. Its outside pattern resembles that of a bar magnet.

How marks are earned

1. At the centre of a current-carrying circular loop, the magnetic field lines appear as straight lines parallel to the axis of the loop. (1 mark)
2. Inside a long current-carrying solenoid, the magnetic field lines are parallel, closely spaced, and nearly uniform. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 12, §12.2.3 Magnetic Field due to a Current through a Circular Loop: At the centre of a current-carrying circular loop, magnetic field lines appear straight and uniform Check the reasoning against NCERT Science X, Ch. 12, §12.2.4 Magnetic Field due to a Current through a Solenoid: A long solenoid produces a uniform magnetic field inside represented by closely spaced parallel lines

OR

Option B

(c) If the current through the straight conductor is reversed, what happens to its magnetic field, and which rule predicts the new direction? [2 marks]

Answer

Reversing the current reverses the direction of the circular magnetic field around the straight conductor. The right-hand thumb rule predicts it: point the thumb along the new current and the curled fingers show the new field direction.

Step by step

1. **Read the given facts:** Reversing the current reverses the direction of the circular magnetic field around the straight conductor. Why: The magnetic field circles a straight current-carrying wire; reversing current reverses the field direction under the right-hand thumb rule.
2. **Apply the concept and check the result:** The right-hand thumb rule predicts it: point the thumb along the new current and the curled fingers show the new field direction. Why: The magnetic field circles a straight current-carrying wire; reversing current reverses the field direction under the right-hand thumb rule.

Topic and concept

Magnetic field due to current-carrying conductor — circular loop. The magnetic field circles a straight current-carrying wire; reversing current reverses the field direction under the right-hand thumb rule.

How marks are earned

1. Reversing the current reverses the direction of the circular magnetic field around the straight conductor. (1 mark)
2. The right-hand thumb rule predicts it: point the thumb along the new current and the curled fingers show the new field direction. (1 mark)

Source check: Check the passage facts and NCERT Science X, Ch. 12, §12.1 Magnetic Field and Field Lines 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) 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. **Identify the defect:** A normal eye sees clearly from a near point of 25 cm. This person cannot see objects closer than 1 m, so the near point is 1 m, which is farther than 25 cm. The defect is hypermetropia (farsightedness). Why: In hypermetropia, close objects form images behind the retina. The cause is a shortened eyeball or an eye lens that is too weak, with too long a focal length (NCERT Science X, Ch. 10, §10.2). The eye cannot bring near objects to focus, so the near point moves away to 1 m.
2. **State the lens used for correction:** The correction is a convex (converging) lens. It converges the rays slightly before they enter the eye. It forms a virtual image of a nearby object at the person's near point of 1 m, from which the eye can focus it on the retina. Why: The eye lens alone is not converging enough, so extra converging power is needed. A convex lens adds this power. A concave lens would make the rays diverge further, which is the correction for myopia and not for this defect.

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, so near vision is blurred. Its near point is farther than the normal 25 cm. Here the near point is 1 m, so the person has hypermetropia, and a convex lens corrects it.

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. **State the causes of myopia (cause):** Myopia arises when the eyeball is too long, or the eye lens is too strongly curved (so its focal length is too short). Because of this, parallel rays from a distant object converge before reaching the retina, at a point inside the eye in front of it. Why: The retina is at a fixed distance from the lens. If the eye's converging power is too high for that distance, whether from a long eyeball or an over-curved lens, the focus falls short of the retina. This is why both causes give the same defect.
2. **State the effect on vision (consequence):** The rays that focus in front of the retina spread out again and reach the retina as a patch, not a point. The image of a distant object on the retina is therefore blurred, while nearby objects can still be seen clearly. Why: A sharp image needs the rays from each object point to meet exactly on the retina. A distant object sends nearly parallel rays, which this eye over-converges, so it is blurred. Near objects send diverging rays, which the strong eye lens can bring to a focus on the retina. This is why the defect is called short-sightedness.
3. **Describe the correction with a concave lens:** A concave (diverging) lens of suitable power is placed in front of the eye. It spreads the incoming parallel rays slightly, so they seem to come from the person's far point. The eye lens then focuses them exactly on the retina. Its focal length is f = –(distance of the far point), and its power is P = 1/f. This power is negative, in dioptres (D). For example, a far point of 50 cm = 0.5 m gives f = –0.5 m and P = 1/(–0.5) = –2 D. Why: The eye lens is too strong for distant objects, so the extra correction must reduce the total converging power. A diverging lens does this. It makes parallel rays look as if they start at the far point, which the myopic eye can already focus on the retina. The negative sign of P shows that the lens is concave. Taking f as the far-point distance with a negative sign is a standard sign convention. The worked example is an illustration, not part of the source.

Topic and concept

Defects of vision — myopia, hypermetropia, presbyopia; correction with lenses. In myopia the eye's converging power is too high for the distance from lens to retina. This can be caused by an elongated eyeball or an over-curved lens, so distant parallel rays focus in front of the retina and the image is blurred. A concave lens of suitable power diverges the rays before they enter the eye. The eye lens then focuses them on the retina and distant vision is restored. The correcting lens has negative power, P = 1/f, with f equal to minus the far-point distance.

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

OR

Option B

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

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

Answer

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

Step by step

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

Topic and concept

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

How marks are earned

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

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

(b) A beam of white light passes through a colloidal suspension and its path becomes visible. Name and explain this phenomenon in three points. [3 marks]

Answer

This phenomenon is called the Tyndall effect, which is the scattering of light by colloidal-sized particles in a medium. The colloidal particles are large enough to scatter the shorter and longer wavelengths appreciably but small enough to remain suspended. As light is

scattered in all directions by these particles, the path of the beam becomes visible to an observer.

Step by step

1. **Work through marking point 1:** This phenomenon is called the Tyndall effect, which is the scattering of light by colloidal-sized particles in a medium. Why: scattering of light by colloidal particles makes beam visible
2. **Work through marking point 2:** The colloidal particles are large enough to scatter the shorter and longer wavelengths appreciably but small enough to remain suspended. Why: scattering of light by colloidal particles makes beam visible
3. **Work through marking point 3:** As light is scattered in all directions by these particles, the path of the beam becomes visible to an observer. Why: scattering of light by colloidal particles makes beam visible

Topic and concept

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

How marks are earned

1. This phenomenon is called the Tyndall effect, which is the scattering of light by colloidal-sized particles in a medium. (1 mark)
2. The colloidal particles are large enough to scatter the shorter and longer wavelengths appreciably but small enough to remain suspended. (1 mark)
3. As light is scattered in all directions by these particles, the path of the beam becomes visible to an observer. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.4(a): scattering of light by colloidal particles makes beam visible