SHUNYASAARTHI

CLASS X · 2026-27 · MODEL PAPER

Class X Science (Code 086) Model Paper 3

Worked answers & explanations

Maximum marks: 80

Time: 3 hours

Subject code: 086

Instructions

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

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

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

Section A

Question 1

1 mark

Mcq

Choose the correct answer.

(a) Which of the following traits is acquired and not passed on to offspring? [1 mark]

A. Riding a bicycle

B. Blood group

C. Eye colour

D. Freckles pattern

Answer

A. Riding a bicycle

Step by step

1. **Select and justify the option:** Ability to ride a bicycle is learned through practice and environmental factors, and cannot be inherited by offspring. Why: Traits acquired through environment or practice, such as learned skills, are not inherited.

Topic and concept

Variations; inherited and acquired characteristics. Inherited traits arise from parental DNA, whereas acquired traits develop from environment or practice and are not passed on.

How marks are earned

1. Ability to ride a bicycle is learned through practice and environmental factors, and cannot be inherited by offspring. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.1: Traits acquired through environment or practice, such as learned skills, are not inherited.

Question 2

1 mark

Mcq

Choose the correct answer.

(a) What is the functional unit of the human kidney called? [1 mark]

A. Nephron

B. Glomerulus

C. Collecting duct

D. Loop of Henle

Answer

A. Nephron

Step by step

1. **Select and justify the option:** The nephron is the basic structural and functional unit of the kidney responsible for filtration and urine formation. Why: Identifies the nephron as the functional unit of the kidney.

Topic and concept

Excretion in humans — kidneys, dialysis; plants — stomata, bark. Excretion in humans is carried out by kidneys that filter metabolic wastes into urine, whereas plants eliminate excess water and gases through stomata and shed waste-laden bark.

How marks are earned

1. The nephron is the basic structural and functional unit of the kidney responsible for filtration and urine formation. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.5, §5.8: Identifies the nephron as the functional unit of the kidney.

Question 3

1 mark

Mcq

Choose the correct answer.

(a) Which region of the brain is responsible for interpreting sensory information and higher thinking?
[1 mark]

A. Hind-brain

B. Mid-brain

C. Fore-brain

D. Spinal cord

Answer

C. Fore-brain

Step by step

1. **Select and justify the option:** The fore-brain interprets sensory input and is the main thinking part of the brain. Why: The fore-brain is the main thinking part and receives sensory inputs.

Topic and concept

Human nervous system — brain, spinal cord, reflex arc. The human nervous system consists of the central nervous system (brain and spinal cord) and the peripheral nervous system (cranial and spinal nerves).

How marks are earned

1. The fore-brain interprets sensory input and is the main thinking part of the brain. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.1.2 Human Brain: The fore-brain is the main thinking part and receives sensory inputs.

Question 4

1 mark

Mcq

Choose the correct answer.

(a) Fungal spores are advantageous because they are [1 mark]

A. diploid

B. desiccation-resistant and can germinate later

C. formed by fragmentation

D. produced only underground

Answer

B. desiccation-resistant and can germinate later

Step by step

1. **Select and justify the option:** Fungal spores are resistant to adverse conditions like dryness and can germinate into new individuals when favourable. Why: Spores can resist unfavourable conditions and later germinate

Topic and concept

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

How marks are earned

1. Fungal spores are resistant to adverse conditions like dryness and can germinate into new individuals when favourable. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.3.2: Spores can resist unfavourable conditions and later germinate

Question 5

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 6

1 mark

Mcq

Choose the correct answer.

(a) Which of the following is not directly required for photosynthesis? [1 mark]

A. Carbon dioxide

B. Water

C. Oxygen

D. Chlorophyll

Answer

C. Oxygen

Step by step

1. **Select and justify the option:** Oxygen is a product released during the light-reaction; CO_2, H_2O and chlorophyll are required inputs. Why: Photosynthesis uses CO_2 and water in presence of sunlight and chlorophyll to form carbohydrates; O_2 evolves as by-product.

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. Oxygen is a product released during the light-reaction; CO_2, H_2O and chlorophyll are required inputs. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.5, §5.2.1: Photosynthesis uses CO_2 and water in presence of sunlight and chlorophyll to form carbohydrates; O_2 evolves as by-product.

Question 7

1 mark

Mcq

Choose the correct answer.

(a) Which characteristic is true of reflex actions but not of voluntary actions? [1 mark]

A. Slower response time

B. Requires conscious decision

C. Does not involve forebrain processing

D. Based on growth in tissues

Answer

C. Does not involve forebrain processing

Step by step

1. **Trace the reflex pathway and select option C:** A reflex follows receptor → sensory neuron → spinal cord → motor neuron → effector, and the response is produced without the signal being processed by the forebrain. Only option C, 'Does not involve forebrain processing', describes this, so the key is C. Option B (requires conscious decision) describes voluntary actions, which are planned in the forebrain. Why: A reflex arc is a short, fixed path through the spinal cord, so the response is fast and automatic. Voluntary actions need forebrain thinking and a deliberate decision. This difference decides which option belongs only to reflexes.

Topic and concept

Voluntary, involuntary and reflex actions. Reflex actions are immediate, involuntary responses to a stimulus. They run along a short reflex arc without conscious thought. Voluntary actions are deliberate movements initiated by the brain. The question asks which listed feature belongs only to reflexes.

How marks are earned

1. Reflex actions do not involve forebrain processing, making them immediate and involuntary. (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 8

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): Regeneration is the normal mode of reproduction in Hydra. Reason (R): Hydra reproduces mainly by budding as an outgrowth. [1 mark]

A. Both A and R true and R explains A

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

C. A true, R false

D. A false, R true

Answer

D. A false, R true

Step by step

1. **Select and justify the option:** Assertion is false because regeneration (rebuilding from fragments) is not Hydra's primary reproductive method; Reason is true as Hydra reproduces mainly by budding. Why: Hydra reproduces by budding rather than by regeneration

Topic and concept

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

How marks are earned

1. Assertion is false because regeneration (rebuilding from fragments) is not Hydra's primary reproductive method; Reason is true as Hydra reproduces mainly by budding. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.2.4: Hydra reproduces by budding rather than by regeneration

Question 9

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): All daughters of a normal male (XY) and a colour-blind mother (X^cX^c) will be colour-blind. Reason (R): Colour blindness is a recessive X-linked trait. [1 mark]

A. Both A and R true and R explains A

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

C. A true, R false

D. A false, R true

Answer

D. A false, R true

Step by step

1. **Test the assertion and reason separately, then choose the matching option.:** A daughter of a normal male receives his normal X chromosome and receives X^c from the colour-blind mother, so her genotype is XX^c; therefore she is a carrier and not colour-blind, while the reason that colour blindness is a recessive X-linked trait is true, making the correct choice D: A false, R true. Why: For a recessive X-linked trait in a female, the recessive allele on one X chromosome is not expressed when the other X chromosome carries the normal allele, so the plausible choice A is wrong because it treats carrier daughters as affected daughters.

Topic and concept

Sex determination in human beings; sex-linked traits (qualitative). In this cross, the father contributes a normal X chromosome to every daughter, and the colour-blind mother contributes X^c; because colour blindness is recessive and X-linked, daughters with XX^c are carriers rather than colour-blind.

How marks are earned

1. Daughters inherit one normal X from the father and one recessive X^c from the mother, making them carriers but not colour-blind. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.4: Females have two X chromosomes, so a recessive allele on one X does not cause expression if the other X carries the normal allele.

Question 10

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Write the two-step process by which ozone is formed in the stratosphere, including the role of UV radiation. [2 marks]

Answer

High-energy UV radiation splits an O_2 molecule into two free oxygen atoms (UV: $O_2 \rightarrow 2O$). Each free oxygen atom then combines with an O_2 molecule to form an ozone molecule ($O + O_2 \rightarrow O_3$).

Step by step

1. **State step 1: UV splits O_2 into free oxygen atoms:** High-energy UV radiation splits an O_2 molecule into two free oxygen atoms (UV: $O_2 \rightarrow 2O$). Why: UV radiation supplies the energy needed to break the bond between the two oxygen atoms in O_2. Without this energy input no free oxygen atoms form, so no ozone can be made.
2. **State step 2: O combines with O_2 to form O_3:** Each free oxygen atom then combines with an O_2 molecule to form an ozone molecule ($O + O_2 \rightarrow O_3$). Why: A free oxygen atom is very reactive, so it joins an ordinary O_2 molecule. This gives O_3, a molecule of three oxygen atoms. The ozone layer formed this way absorbs harmful UV radiation.

Topic and concept

Ozone layer and its depletion; effect on humans; chlorofluorocarbons. Ozone in the stratosphere forms in two steps. UV splits O_2 into atoms, and each atom joins an O_2 molecule to give O_3. This ozone layer protects living things by absorbing harmful UV, and its concentration has fallen because of CFC emissions.

How marks are earned

1. High-energy UV radiation splits an O_2 molecule into two free oxygen atoms (UV: $O_2 \rightarrow 2O$). (1 mark)
2. Each free oxygen atom then combines with an O_2 molecule to form an ozone molecule ($O + O_2 \rightarrow O_3$). (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 13, §13.2.1: UV radiation splits O_2 to O atoms which then form O_3.

Question 11

2 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

(a) In an experiment, a potted shoot kept in darkness for two days is then exposed to light from one side. After 48 hours the shoot bends toward the light. State the observation and give the reason. [2 marks]

Answer

Observation: The shoot tip bends toward the side receiving light after 48 hours. Reason: Unequal auxin distribution causes higher auxin concentration on the shaded side, promoting cell elongation there and resulting in bending toward the light.

Step by step

1. **Record the observation: shoot bends toward light:** With light coming from one side, the shoot tip bends toward the lit side after 48 hours. Why: This directional growth response toward a light stimulus is positive phototropism. It is a growth movement, so it shows up slowly over hours rather than at once.
2. **Explain the reason using auxin distribution:** Reason: Unequal auxin distribution causes higher auxin concentration on the shaded side, promoting cell elongation there and resulting in bending toward the light. The sequence is: light from one side, auxin moves to the shaded side, shaded cells elongate more, shoot bends toward the light. Why: Auxin is a plant hormone made at the shoot tip that helps cells grow longer. More elongation on the shaded side than the lit side makes the stem curve toward the light.

Topic and concept

Tropic movements in plants. Tropic movements are directional growth responses of plants to a stimulus. In phototropism, light from one side shifts auxin to the shaded side of the shoot, and the longer shaded cells bend the shoot toward the light.

How marks are earned

1. Observation: The shoot tip bends toward the side receiving light after 48 hours. (1 mark)
2. Reason: Unequal auxin distribution causes higher auxin concentration on the shaded side, promoting cell elongation there and resulting in bending toward the light. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.2.1: Plants show growth-dependent directional movement toward light due to uneven cell elongation.

OR

Option B

Answer the question with working and reasons where needed.

(a) Distinguish between voluntary and involuntary actions with one example of each. [2 marks]

Answer

Voluntary actions are conscious, deliberate movements initiated by the brain, for example walking. Involuntary actions occur without conscious control, such as the heartbeat or reflex responses like sneezing.

Step by step

1. **Work through marking point 1:** Voluntary actions are conscious, deliberate movements initiated by the brain, for example walking. Why: Voluntary actions are based on conscious decisions by the brain, while involuntary actions happen without conscious control.
2. **Work through marking point 2:** Involuntary actions occur without conscious control, such as the heartbeat or reflex responses like sneezing. Why: Voluntary actions are based on conscious decisions by the brain, while involuntary actions happen without 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. Voluntary actions are conscious, deliberate movements initiated by the brain, for example walking. (1 mark)
2. Involuntary actions occur without conscious control, such as the heartbeat or reflex responses like sneezing. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.1.2: Voluntary actions are based on conscious decisions by the brain, while involuntary actions happen without conscious control.

Question 12

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Differentiate between fragmentation and budding in asexual reproduction and give one example of each. [2 marks]

Answer

In fragmentation, the parent organism breaks into several fragments, each of which develops into a new individual, as seen in Spirogyra. In budding, a new organism develops as an outgrowth (bud) on the parent body and detaches when mature, as observed in Hydra.

Step by step

1. **Define fragmentation and give Spirogyra:** In fragmentation, the parent organism breaks into several fragments, each of which develops into a new individual, as seen in Spirogyra. Why: Mature Spirogyra filaments break into smaller pieces, and each piece grows into a new filament. Here the whole body splits into parts that each regrow.
2. **Define budding and give Hydra:** In budding, a new organism develops as an outgrowth (bud) on the parent body and detaches when mature, as observed in Hydra. Why: In budding only a localised region of the parent divides repeatedly to form a bud, and the parent stays intact. Fragmentation differs because the whole body breaks up.

Topic and concept

Asexual reproduction — fission, fragmentation, regeneration, budding. Fragmentation and budding are both asexual reproduction. In fragmentation, such as Spirogyra, the body breaks into pieces that regenerate into new individuals. In budding, such as Hydra, a bud grows from one spot on the parent and detaches when mature.

How marks are earned

1. In fragmentation, the parent organism breaks into several fragments, each of which develops into a new individual, as seen in Spirogyra. (1 mark)
2. In budding, a new organism develops as an outgrowth (bud) on the parent body and detaches when mature, as observed in Hydra. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.7, §7.2.2: In Spirogyra, the filament breaks into fragments that grow into new individuals.

Question 13

3 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Calculate the biodegradable waste:** Biodegradable waste = (60/100) × 500 kg = 0.60 × 500 kg = 300 kg. Why: A percentage means a part out of 100 of the total waste. Multiplying the total by 60/100 gives the mass that microbes can break down.
2. **Calculate the non-biodegradable waste:** Non-biodegradable waste = total − biodegradable = 500 kg − 300 kg = 200 kg. Check: 300 kg + 200 kg = 500 kg, and 200 kg is 40% of 500 kg. Why: The two types together make up all the waste. The remainder after removing the biodegradable part is therefore non-biodegradable.
3. **Suggest disposal for each type after segregation:** The 300 kg biodegradable portion can be composted, and the 200 kg non-biodegradable part should be sent for recycling or safe landfill disposal. Why: Biodegradable waste is broken down by microbes, so composting returns it to the soil. Non-biodegradable materials persist in the environment, so they should be segregated and recycled or landfilled safely.

Topic and concept

Waste and its management; recycling and reuse. Waste is either biodegradable, which decomposes naturally, or non-biodegradable, which persists. Segregating the waste lets each type be handled suitably, with composting for biodegradable waste and recycling or landfill for the rest. Here the percentage gives the mass of each type.

How marks are earned

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

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

Question 14

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Describe the stages of urine formation in the human kidney. [3 marks]

Answer

In the glomerulus, blood under high pressure is filtered through the basement membrane into Bowman's capsule, allowing water and small solutes to form the filtrate. In the proximal convoluted tubule, essential nutrients such as glucose, amino acids and ions are actively reabsorbed into the peritubular capillaries. In the distal tubule and collecting duct, selective secretion removes additional wastes like H^+ and K^+ into the filtrate, and water reabsorption concentrates the urine before excretion.

Step by step

1. **Describe filtration at the glomerulus:** In the glomerulus, blood under high pressure is filtered through the basement membrane into Bowman's capsule, allowing water and small solutes to form the filtrate. Why: Filtration is the first step because the nephron begins at this cluster of capillaries. Small dissolved substances pass into the capsule while large cells and proteins stay in the blood.
2. **Describe reabsorption in the tubule:** In the proximal convoluted tubule, essential nutrients such as glucose, amino acids and ions are actively reabsorbed into the peritubular capillaries. Why: The filtrate holds useful substances along with wastes. Reabsorbing them returns what the body needs to the blood instead of losing it in urine.
3. **Describe secretion and concentration of urine:** In the distal tubule and collecting duct, selective secretion removes additional wastes like H^+ and K^+ into the filtrate, and water reabsorption concentrates the urine before excretion. Why: Extra wastes are added to the filtrate and water is taken back according to the body's needs. This produces concentrated urine, which passes on to be excreted. The stages may be accepted in alternate wording.

Topic and concept

Excretion in humans — kidneys, dialysis; plants — stomata, bark. Urine formation in the nephron has three stages: filtration at the glomerulus into Bowman's capsule, reabsorption of useful substances in the tubule, and removal of extra wastes with water adjustment in the distal tubule and collecting duct. Together these remove nitrogenous wastes while keeping what the body needs.

How marks are earned

1. In the glomerulus, blood under high pressure is filtered through the basement membrane into Bowman's capsule, allowing water and small solutes to form the filtrate. (1 mark)
2. In the proximal convoluted tubule, essential nutrients such as glucose, amino acids and ions are actively reabsorbed into the peritubular capillaries. (1 mark)

3. In the distal tubule and collecting duct, selective secretion removes additional wastes like H^+ and K^+ into the filtrate, and water reabsorption concentrates the urine before excretion. (1 mark)

Source check: Check the reasoning against NCERT Science X, Chapter 5, §5.6 EXCRETION: The human kidney filters blood to remove nitrogenous wastes as urine, while plants manage excretory products and excess water through leaf stomata and outer bark layers.

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. **Link the blue-black colour to light reaching the uncovered half of Leaf X, and explain why the covered half stays brown.:** The leaf was de-starched for 48 hours, so any starch found later was made during the experiment. The uncovered half received sunlight for 6 hours, so its chlorophyll made carbohydrate that was stored as starch. This starch turned blue-black with iodine. The half under black paper got no light, made no starch, and stayed brown. Control Leaf Y, fully lit, turned blue-black all over, so light is the variable. Why: Photosynthesis needs chlorophyll, light, CO_2 and water, and the excess carbohydrate is stored as starch. Iodine gives a blue-black colour specifically with starch. Removing light from one half therefore removes starch formation there, which makes the colour difference a test of the need for light.
2. **Name the organelle where the light-capturing stage occurs.:** The light-capturing stage of photosynthesis takes place in the chloroplast, the organelle in leaf cells that contains chlorophyll. Why: Chlorophyll is the pigment that absorbs sunlight, and it is held inside chloroplasts. The light energy captured there drives the conversion of CO_2 and water into carbohydrates. So the chloroplast is the organelle that carries out the light-capturing step.

Topic and concept

Autotrophic nutrition; photosynthesis — raw materials, process, outcomes. In photosynthesis, chlorophyll in chloroplasts absorbs sunlight and the plant converts CO_2 and water into carbohydrates, storing the excess as starch. De-starching the leaf first means any starch later found with iodine was made during the experiment. The covered-half and control-leaf comparison therefore shows that light is needed to make starch.

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) State any two features of regeneration as seen in Planaria. [2 marks]

Answer

Specialised regenerative cells proliferate to form a mass of undifferentiated cells (1 mark). These cells subsequently differentiate in an organised sequence to rebuild missing tissues and organs (1 mark).

Step by step

1. **State the first feature of regeneration in Planaria: formation of a cell mass.:** When Planaria is cut or injured, specialised regenerative cells near the wound divide repeatedly. They form a mass of undifferentiated cells at the cut surface. Why: Regeneration begins with proliferation. Dividing cells build a stock of unspecialised material that can later become any missing tissue. Without this first stage there would be no cells available to rebuild the lost part.
2. **State the second feature: organised differentiation into tissues and organs.:** The undifferentiated cells then change into the different cell types in an organised sequence. This rebuilds the missing tissues and organs, so a whole Planaria can form from a body piece. Regrowth of a complete individual from a cut piece is also an accepted feature. Why: Differentiation is the second stage that follows proliferation. Cells become specialised for particular tasks, which gives the missing structures their correct form and function. Proliferation alone would only give a lump of cells, not organs.

Topic and concept

Asexual reproduction — fission, fragmentation, regeneration, budding. Regeneration in Planaria and Hydra works through two stages. Specialised cells proliferate into a mass, and these cells then differentiate into the tissues and organs that are missing. This is how a complete organism can form from a body piece. Any two correct features of this process answer the question.

How marks are earned

1. Specialised regenerative cells proliferate to form a mass of undifferentiated cells (1 mark). (1 mark)
2. These cells subsequently differentiate in an organised sequence to rebuild missing tissues and organs (1 mark). (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.2.3: Regeneration involves cell proliferation and differentiation

(b) Distinguish between fragmentation and regeneration as modes of asexual reproduction with one example each. [3 marks]

Answer

Fragmentation is a process where the parent body breaks into two or more fragments and each fragment develops into a new individual, as seen in Spirogyra, contributing 1 mark. Regeneration is the ability of certain organisms to regrow lost body parts and form a complete individual from the fragment, exemplified by Planaria regenerating from body pieces, contributing 1 mark. The key difference is that in fragmentation the breakage initiates reproduction, whereas in regeneration specialized cells proliferate and differentiate to recreate missing structures after injury, contributing 1 mark.

Step by step

1. **Define fragmentation and give Spirogyra as its example.:** In fragmentation the parent body breaks into two or more pieces. Each piece grows into a new individual. Mature Spirogyra filaments break into smaller fragments, and each fragment develops into a new filament. Why: Here the breaking of the body is itself the start of reproduction. Each fragment already has the cells needed to grow into a complete organism. This is why filamentous forms like Spirogyra reproduce this way.
2. **Define regeneration and give Planaria as its example, matching the key.:** Regeneration is the regrowth of lost body parts to form a complete individual. A Planaria cut into pieces regenerates a whole animal from each piece. Hydra is another organism that shows this, but Planaria is the example used here. Why: Regeneration relies on specialised cells that rebuild missing structures. It is usually triggered by cutting or injury, and the piece rebuilds what it has lost. This differs from fragmentation, where the body simply breaks apart.
3. **State the key difference using a short comparison.:** Cause: fragmentation is breaking of the body, while regeneration follows injury or cutting. Cells involved: in fragmentation the existing cells of each piece grow, while in regeneration specialised cells proliferate and then differentiate. Example: Spirogyra for fragmentation and Planaria for regeneration. Why: Comparing the cause, the cells involved and the example shows that the two modes are distinct. In fragmentation the breakage starts reproduction. In regeneration cell proliferation and differentiation rebuild the missing part. A table or three clear contrasts earns the difference mark.

Topic and concept

Asexual reproduction — fission, fragmentation, regeneration, budding. Fragmentation and regeneration are both asexual modes, but they work differently. In fragmentation, as in Spirogyra, the body breaks and each piece grows into a new individual. In regeneration, as in Planaria, specialised cells proliferate and differentiate to rebuild missing parts and form a whole organism.

How marks are earned

1. Fragmentation is a process where the parent body breaks into two or more fragments and each fragment develops into a new individual, as seen in Spirogyra, contributing 1 mark. (1 mark)
2. Regeneration is the ability of certain organisms to regrow lost body parts and form a complete individual from the fragment, exemplified by Planaria regenerating from body pieces, contributing 1 mark. (1 mark)
3. The key difference is that in fragmentation the breakage initiates reproduction, whereas in regeneration specialized cells proliferate and differentiate to recreate missing structures after injury, contributing 1 mark. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.2.2–7.2.3: Fragmentation breaks filaments; regeneration regrows missing parts via specialized cells.

OR

Option B

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

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

Answer

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

Step by step

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

Topic and concept

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

How marks are earned

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

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

(b) Outline the main phases of the human menstrual cycle and name the hormones regulating these phases. [3 marks]

Answer

The menstrual cycle begins with the menstrual phase, during which the endometrial lining is shed (days 1–5), contributing 1 mark. This is followed by the proliferative phase (days 6–14) under the influence of rising oestrogen and FSH, leading to endometrial repair, contributing 1 mark. Finally, the secretory phase (days 15–28) is controlled by progesterone and LH, preparing the endometrium for possible implantation, contributing 1 mark.

Step by step

1. **Work through marking point 1:** The menstrual cycle begins with the menstrual phase, during which the endometrial lining is shed (days 1–5), contributing 1 mark. Why: Hormonal fluctuations of FSH, LH, oestrogen and progesterone regulate the menstrual cycle phases.
2. **Work through marking point 2:** This is followed by the proliferative phase (days 6–14) under the influence of rising oestrogen and FSH, leading to endometrial repair, contributing 1 mark. Why: Hormonal fluctuations of FSH, LH, oestrogen and progesterone regulate the menstrual cycle phases.
3. **Work through marking point 3:** Finally, the secretory phase (days 15–28) is controlled by progesterone and LH, preparing the endometrium for possible implantation, contributing 1 mark. Why: Hormonal fluctuations of FSH, LH, oestrogen and progesterone regulate the menstrual cycle phases.

Topic and concept

Human reproductive system; reproduction in human beings. The menstrual cycle in females spans approximately 28 days and is regulated by cyclical fluctuation of hormones—FSH, LH, estrogen, and progesterone—to prepare the uterus for possible pregnancy.

How marks are earned

1. The menstrual cycle begins with the menstrual phase, during which the endometrial lining is shed (days 1–5), contributing 1 mark. (1 mark)
2. This is followed by the proliferative phase (days 6–14) under the influence of rising oestrogen and FSH, leading to endometrial repair, contributing 1 mark. (1 mark)
3. Finally, the secretory phase (days 15–28) is controlled by progesterone and LH, preparing the endometrium for possible implantation, contributing 1 mark. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.6.2: Hormonal fluctuations of FSH, LH, oestrogen and progesterone regulate the menstrual cycle phases.

Section B

Question 17

1 mark

Mcq

Choose the correct answer.

(a) Why does carbon form a wide variety of stable compounds compared to silicon? [1 mark]

A. Carbon has stronger C–C bonds

B. Carbon has fewer valence electrons

C. Silicon does not bond covalently

D. Silicon atoms are smaller

Answer

A. Carbon has stronger C–C bonds

Step by step

1. **Select and justify the option:** Carbon forms more stable and diverse compounds because the C–C bond is stronger and less reactive than Si–Si bonds. Why: The carbon–carbon bond is very strong and stable, unlike silicon chains which are more reactive.

Topic and concept

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

How marks are earned

1. Carbon forms more stable and diverse compounds because the C–C bond is stronger and less reactive than Si–Si bonds. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.2: The carbon–carbon bond is very strong and stable, unlike silicon chains which are more reactive.

Question 18

1 mark

Mcq

Choose the correct answer.

(a) Which of the following represents the thermal decomposition of calcium carbonate? [1 mark]

A. $CaCO_3 \rightarrow CaO + CO_2$

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

C. $CaCO_3 + HCl \rightarrow CaCl_2 + CO_2 + H_2O$

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

Answer

A. $CaCO_3 \rightarrow CaO + CO_2$

Step by step

1. **Select and justify the option:** $CaCO_3(s)$ on heating breaks down into $CaO(s)$ and $CO_2(g)$, illustrating thermal decomposition. Why: Thermal decomposition involves breaking a single reactant into two or more products on heating.

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. $CaCO_3(s)$ on heating breaks down into $CaO(s)$ and $CO_2(g)$, illustrating thermal decomposition. (1 mark)

Source check: Check the reasoning against NCERT Chemistry Class X, Ch.1, §1.2.2: Thermal decomposition involves breaking a single reactant into two or more products on heating.

Question 19

1 mark

Mcq

Choose the correct answer.

(a) A solution has pH 2. Which of the following statements is correct? [1 mark]

A. $[H^+] = 2$ M

B. $[H^+] = 10^{-2}$ M

C. $[OH^-] = 10^2$ M

D. It is slightly acidic

Answer

B. $[H^+] = 10^{-2}$ M

Step by step

1. **Select and justify the option:** pH = −log$[H^+]$, so $[H^+] = 10^{-2}$ M for pH 2. Why: pH scale quantifies acidity by –log$[H^+]$.

Topic and concept

pH scale; importance of pH in everyday life. The pH scale quantifies how acidic or basic a solution is based on its hydrogen ion concentration.

How marks are earned

1. pH = −log$[H^+]$, so $[H^+] = 10^{-2}$ M for pH 2. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 2, §2.2: pH scale quantifies acidity by –log$[H^+]$.

Question 20

1 mark

Mcq

Choose the correct answer.

(a) Which of the following metal oxides exhibits amphoteric behavior? [1 mark]

A. Sodium oxide (Na2O)

B. Aluminium oxide (Al2O3)

C. Magnesium oxide (MgO)

D. Calcium oxide (CaO)

Answer

B. Aluminium oxide (Al2O3)

Step by step

1. **Select and justify the option:** Aluminium oxide is amphoteric, reacting with both acids and bases to form salts and water. Why: Some metal oxides such as aluminium oxide show both acidic and basic behaviour.

Topic and concept

Chemical properties — reaction with oxygen, water, acids and other metal salts. Most metals react with oxygen on heating to form basic oxides; some oxides like aluminium oxide are amphoteric.

How marks are earned

1. Aluminium oxide is amphoteric, reacting with both acids and bases to form salts and water. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 3, §3.2.1: Some metal oxides such as aluminium oxide show both acidic and basic behaviour.

Question 21

1 mark

Mcq

Choose the correct answer.

(a) Which feature distinguishes saturated hydrocarbons from unsaturated ones? [1 mark]

A. Presence of rings

B. Only single C–C bonds

C. Branching in the carbon chain

D. Higher molecular weight

Answer

B. Only single C–C bonds

Step by step

1. **Select and justify the option:** Saturated hydrocarbons contain only single bonds between carbon atoms, unlike unsaturated ones. Why: Saturated compounds have only single C–C bonds, while unsaturated compounds have double or triple bonds.

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. Saturated hydrocarbons contain only single bonds between carbon atoms, unlike unsaturated ones. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.2.1: Saturated compounds have only single C–C bonds, while unsaturated compounds have double or triple bonds.

Question 22

1 mark

Mcq

Choose the correct answer.

(a) In the reaction Fe + CuSO4 → FeSO4 + Cu, iron displaces copper because iron is more: [1 mark]

A. reactive than copper

B. noble than copper

C. ductile than copper

D. malleable than copper

Answer

A. reactive than copper

Step by step

1. **Select and justify the option:** Iron is more reactive than copper, so it displaces copper ions from CuSO4 to form FeSO4 and Cu. Why: A more reactive element displaces a less reactive element from its compound.

Topic and concept

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

How marks are earned

1. Iron is more reactive than copper, so it displaces copper ions from CuSO4 to form FeSO4 and Cu. (1 mark)

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

Question 23

1 mark

Mcq

Choose the correct answer.

(a) Which one of the following reactions represents neutralisation? [1 mark]

A. $HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$

B. $H_2SO_4 + Zn \rightarrow ZnSO_4 + H_2$

C. $HCl + NaOH \rightarrow NaCl + H_2O$

D. $CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$

Answer

C. $HCl + NaOH \rightarrow NaCl + H_2O$

Step by step

1. **Select and justify the option:** Neutralisation is the reaction of an acid with a base to form a salt and water only. Why: Neutralisation produces salt and water from an acid and a base.

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. Neutralisation is the reaction of an acid with a base to form a salt and water only. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 2, §2.1.4: Neutralisation produces salt and water from an acid and a base.

Question 24

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): Metals show lustre because they have mobile electrons at their surface. Reason (R): These electrons reflect incident light from the metal surface. [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. **Test both statements:** Metallic lustre results when mobile electrons at a metal surface reflect incident light, so the assertion and revised reason are both true and the reason explains the assertion. Why: This is the Class X description of metallic lustre; it does not require a claim about coherent photon re-emission.

Topic and concept

Physical properties of metals and non-metals. Metals appear lustrous because the mobile electrons at their surface reflect incident light.

How marks are earned

1. Select A because mobile electrons reflect incident light and thereby explain the metallic lustre of metals. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 3, §3.1.1: Metallic lustre is due to free electrons reflecting light.

Question 25

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Write the balanced chemical equation for the complete combustion of ethanol and state one observable change during the reaction. [2 marks]

Answer

The balanced equation for complete combustion of ethanol is C2H5OH + 3O2 → 2CO2 + 3H2O. During the reaction, a clean blue flame is observed and water vapor condenses as droplets on cooler surfaces.

Step by step

1. **Write and balance the combustion equation by counting atoms.:** Unbalanced: $C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$. Balance C first: 2 CO_2. Balance H next: ethanol has 6 H, so 3 H_2O. Count O on the right: 2×2 + 3 = 7. Ethanol supplies 1 O, so 6 O are needed from O_2, which is 3 O_2. Balanced: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$. Check: left C 2, H 6, O 1+6 = 7. Right C 2, H 6, O 4+3 = 7. Why: A chemical equation must obey conservation of mass, so each element has the same number of atoms on both sides. Complete combustion of a carbon compound gives CO_2 and H_2O. Balancing C, then H, then O fixes the coefficients and the atom count confirms it.
2. **State an observable change during the burning.:** Ethanol burns with a clean blue flame and releases heat. Water vapour formed condenses as droplets on a cool surface held above the flame. Why: Combustion is an exothermic oxidation, so heat and a flame are seen. The blue flame shows that the carbon burns completely with enough oxygen. The water produced as vapour condenses on cooler surfaces. Any one of these observations is accepted, including heat release.

Topic and concept

Chemical properties — combustion, oxidation, addition, substitution. Carbon compounds burn in oxygen to give carbon dioxide and water, and the reaction releases heat. For ethanol, complete combustion gives 2 CO_2 and 3 H_2O for each C_2H_5OH. The equation must be balanced so that atoms are conserved.

How marks are earned

1. The balanced equation for complete combustion of ethanol is C2H5OH + 3O2 → 2CO2 + 3H2O. (1 mark)
2. During the reaction, a clean blue flame is observed and water vapor condenses as droplets on cooler surfaces. (1 mark)

> **Source check:** Check the reasoning against NCERT Class 10 science, Ch. 4, §4.2.3: Ethanol combusts to form carbon dioxide and water.

Question 26

3 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Balance the equation Al + HCl → $AlCl_3$ + H_2 step by step.:** Start with Al + HCl → $AlCl_3$ + H_2. Balance Cl first: $AlCl_3$ has 3 Cl, so use 3 HCl. That gives 3 H on the left, but H_2 comes in pairs, so take 6 HCl and 3 H_2. Then Cl on the right needs 2 $AlCl_3$, which means 2 Al. Balanced: 2Al + 6HCl → 2$AlCl_3$ + 3H_2. Check: Al 2 = 2, H 6 = 6, Cl 6 = 6. Why: Mass is conserved in a chemical reaction, so each element must have the same atom count on both sides. Balancing the element that sits in one compound first, here Cl, avoids repeated changes. The final atom count confirms the coefficients.
2. **Name the reaction type.:** Aluminium (an element) replaces hydrogen in HCl and hydrogen is released as a gas. This is a displacement reaction. Why: In a displacement reaction one element takes the place of another in a compound. Here Al takes the place of H in HCl to form $AlCl_3$, while H_2 is set free. That pattern of an element replacing another from a compound defines displacement.
3. **Give the reason using reactivity.:** Aluminium lies above hydrogen in the reactivity series, so it is more reactive than hydrogen. It therefore removes hydrogen from the acid and H_2 gas is produced. Why: A more reactive element can displace a less reactive one from its compound. Because Al is more reactive than H, the displacement happens. A metal below hydrogen would not displace it from the acid.

Topic and concept

Types of chemical reactions — displacement and double displacement. In a displacement reaction a more reactive element displaces a less reactive element from its compound. Aluminium is more reactive than hydrogen, so it displaces hydrogen from hydrochloric acid and forms aluminium chloride and hydrogen gas. The equation must also be balanced for atoms.

How marks are earned

1. Balanced equation: 2Al + 6HCl → 2AlCl3 + 3H2. (1 mark)

2. This is a displacement reaction because aluminium displaces hydrogen from hydrochloric acid. (1 mark)
3. Aluminium is more reactive than hydrogen and thus removes hydrogen ions from the acid, producing hydrogen gas. (1 mark)

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

OR

Option B

Answer the question with working and reasons where needed.

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

Answer

Whitewashing applies calcium hydroxide slurry [Ca(OH)2], which reacts with atmospheric CO2 to form calcium carbonate on the wall surface. Balanced equation: Ca(OH)2(aq) + CO2(g) → CaCO3(s) + H2O(l). The insoluble calcium carbonate layer gives a shiny and durable finish after forming on the walls.

Step by step

1. **Work through marking point 1:** Whitewashing applies calcium hydroxide slurry [Ca(OH)2], which reacts with atmospheric CO2 to form calcium carbonate on the wall surface. Why: Slaked lime reacts with CO2 to form CaCO3, used in whitewashing.
2. **Work through marking point 2:** Balanced equation: Ca(OH)2(aq) + CO2(g) → CaCO3(s) + H2O(l). Why: Slaked lime reacts with CO2 to form CaCO3, used in whitewashing.
3. **Work through marking point 3:** The insoluble calcium carbonate layer gives a shiny and durable finish after forming on the walls. Why: Slaked lime reacts with CO2 to form CaCO3, used in whitewashing.

Topic and concept

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

How marks are earned

1. Whitewashing applies calcium hydroxide slurry [Ca(OH)2], which reacts with atmospheric CO2 to form calcium carbonate on the wall surface. (1 mark)
2. Balanced equation: Ca(OH)2(aq) + CO2(g) → CaCO3(s) + H2O(l). (1 mark)
3. The insoluble calcium carbonate layer gives a shiny and durable finish after forming on the walls. (1 mark)

Source check: Check the reasoning against NCERT Chemistry, Ch. 1, §1.2.1: Slaked lime reacts with CO2 to form CaCO3, used in whitewashing.

Question 27

3 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Write the ions present in the two solutions.:** In water, NaOH dissociates: $NaOH \rightarrow Na^+ + OH^-$. HCl dissociates: $HCl \rightarrow H^+ + Cl^-$. The mixture therefore has Na^+, OH^-, H^+ and Cl^- ions. Why: Neutralisation is best understood in terms of ions. A strong base supplies OH^- and a strong acid supplies H^+ once dissolved, so writing them first shows which ions can react with each other.
2. **Show the H^+ and OH^- ions combining to form water.:** $H^+ + OH^- \rightarrow H_2O$. This is the essential change in neutralisation, and the reaction gives out heat, so it is exothermic. Why: An acid gives H^+ and a base gives OH^-, and these join to form water. This combination is what removes the acidic and basic character. It is also why the pink colour of phenolphthalein in the base disappears at neutralisation.
3. **Identify the salt formed and write the full equation.:** Na^+ and Cl^- do not react further and stay in solution as sodium chloride. Full equation: $NaOH + HCl \rightarrow NaCl + H_2O$. Products: sodium chloride (salt) and water. Why: An acid and a base give a salt and water. Na^+ and Cl^- are spectator ions, which means they stay unchanged in solution. Together they are the salt NaCl, so the ionic description agrees with the full equation.

Topic and concept

Reaction of acids and bases with each other; neutralisation reaction. In neutralisation an acid and a base react to give a salt and water. For NaOH and HCl, the H^+ from the acid and OH^- from the base form water. The Na^+ and Cl^- ions stay in solution as sodium chloride, and heat is released.

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

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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:
$CaCO3(s) \rightarrow CaO(s) + CO2(g)$

(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. **Count atoms of each element on both sides of $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ to test whether it is balanced:** 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 = 1 + 2 = 3. Every element matches, so all coefficients stay 1 and the balanced equation is $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$. Why: The law of conservation of mass requires the same number of atoms of each element before and after a reaction. Because the counts already agree, adding any coefficient would unbalance the equation.
2. **Classify the reaction by comparing the number of reactants and products and noting the energy source:** One reactant ($CaCO_3$) breaks into two simpler products (CaO and CO_2) when strongly heated in the kiln, so it is a thermal decomposition reaction. Heat is absorbed, so it is also endothermic. Why: A decomposition reaction is one in which a single compound breaks into two or more simpler substances. When heat supplies the energy it is called thermal decomposition, as NCERT describes for calcium carbonate.

Topic and concept

Types of chemical reactions — decomposition. Balancing means the atoms of each element are equal on both sides, in keeping with conservation of mass. This equation has one reactant giving two products on heating, which is the pattern of a thermal decomposition reaction of $CaCO_3$ into CaO and CO_2.

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) Name the functional group present in aldehydes, write its general formula, and give one example of an aldehyde. [2 marks]

Answer

The functional group in aldehydes is –CHO, called the aldehyde group with general formula R–CHO. An example of an aldehyde is ethanal, with the formula CH3CHO.

Step by step

1. **Identify the aldehyde functional group and write its general formula:** The aldehyde functional group is –CHO. It is a carbonyl carbon (C=O) with one hydrogen attached, and it is bonded to an alkyl group R. Its general formula is R–CHO. Why: A functional group is the atom or group of atoms that decides a compound's class and properties. The carbon of –CHO has a C=O and an H on it, so it can bond to only one carbon chain. This places the group at the end of the chain, which distinguishes aldehydes from ketones.
2. **Give an example of an aldehyde and check that it contains –CHO:** Ethanal is an example, with formula CH3CHO. Here R = CH3, and the –CHO group sits at the end of the two-carbon chain, so it fits R–CHO. Why: An example must contain the group –CHO. Ethanal does, and it is the aldehyde listed in NCERT Table 4.3. The check R = CH3 confirms that the general formula matches the example.

Topic and concept

Nomenclature of carbon compounds; functional groups. Functional groups such as –OH, –CHO, –CO– and –COOH decide the class, name and behaviour of carbon compounds. In an aldehyde the –CHO group (C=O with an H on the carbon) sits at the end of the carbon chain, and its general formula is R–CHO.

How marks are earned

1. The functional group in aldehydes is –CHO, called the aldehyde group with general formula R–CHO. (1 mark)
2. An example of an aldehyde is ethanal, with the formula CH3CHO. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, Table 4.3: An aldehyde functional group is –CHO and is present in compounds like ethanal.

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

Answer

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

Step by step

1. **Derive the IUPAC name by finding the chain, the suffix and the position:** Longest chain: 3 carbons, so the parent is propane. The –OH group makes it an alcohol, so drop the final 'e' and add 'ol', giving propanol. Number the chain from either end. The –OH is on carbon 2 both ways, so the locant is 2. Name: propan-2-ol. Why: IUPAC naming uses the parent chain for the carbon count and a suffix for the functional group. An alcohol takes the suffix '-ol', and the number shows which carbon carries the group. Numbering is chosen to give the group the lowest locant.
2. **Write the displayed structural formula:** CH3–CH(OH)–CH3, drawn out: the middle carbon is bonded to one CH3 on each side, to one H, and to one O–H group. That is 3 carbons, 8 hydrogens and 1 oxygen, so the molecular formula is C3H8O. Why: A structural formula shows how the atoms are joined. The –OH sits on the middle carbon, which is why the locant is 2 and why this is propan-2-ol and not propan-1-ol. Each carbon has four bonds, which checks the structure.
3. **Identify the functional group from the –OH attached to carbon:** The group present is –OH, the hydroxyl group, so the compound belongs to the alcohols. Why: The functional group decides the class of the compound. A hydroxyl group on a carbon chain defines an alcohol, which is also why the suffix '-ol' is used.

Topic and concept

Nomenclature of carbon compounds; functional groups. Naming a carbon compound has three parts: the carbon count gives the parent chain, the functional group gives the suffix, and the position of the group is given by a number. For CH3–CH(OH)–CH3 this gives propane, then propanol, then propan-2-ol, with the –OH on carbon 2.

How marks are earned

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

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

OR

Option B

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

(a) Name the functional group in alcohols and give the structural formula of ethanol. [2 marks]

Answer

Alcohols contain the hydroxyl functional group –OH attached to a carbon atom. Ethanol has the structural formula CH3–CH2–OH, with the –OH group on the second carbon of the two-carbon chain.

Step by step

1. **Explain marking point 1:** Alcohols contain the hydroxyl functional group –OH attached to a carbon atom. Why: Functional groups such as –OH, –CHO, –CO– and –COOH decide the class, name and behaviour of carbon compounds. In an aldehyde the –CHO group (C=O with an H on the carbon) sits at the end of the carbon chain, and its general formula is R–CHO.
2. **Explain marking point 2:** Ethanol has the structural formula CH3–CH2–OH, with the –OH group on the second carbon of the two-carbon chain. Why: Functional groups such as –OH, –CHO, –CO– and –COOH decide the class, name and behaviour of carbon compounds. In an aldehyde the –CHO group (C=O with an H on the carbon) sits at the end of the carbon chain, and its general formula is R–CHO.

Topic and concept

Nomenclature of carbon compounds; functional groups. Functional groups such as –OH, –CHO, –CO– and –COOH decide the class, name and behaviour of carbon compounds. In an aldehyde the –CHO group (C=O with an H on the carbon) sits at the end of the carbon chain, and its general formula is R–CHO.

How marks are earned

1. Alcohols contain the hydroxyl functional group –OH attached to a carbon atom. (1 mark)
2. Ethanol has the structural formula CH3–CH2–OH, with the –OH group on the second carbon of the two-carbon chain. (1 mark)

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

(b) Identify the compound CH3COOH by IUPAC name, show its carboxyl structure, and explain how its functional group differs from ethanol's. [3 marks]

Answer

CH3COOH has the IUPAC name ethanoic acid, a two-carbon carboxylic acid. Its displayed carboxyl structure is CH3–C(=O)–OH, showing a carbonyl and hydroxyl on the same carbon. Its –COOH carboxyl group differs from ethanol's –OH hydroxyl group; the carbonyl part makes it a carboxylic acid rather than an alcohol.

Step by step

1. **Explain marking point 1:** CH3COOH has the IUPAC name ethanoic acid, a two-carbon carboxylic acid. Why: Naming a carbon compound has three parts: the carbon count gives the parent chain, the functional group gives the suffix, and the position of the group is given by a number. For CH3–CH(OH)–CH3 this gives propane, then propanol, then propan-2-ol, with the –OH on carbon 2.
2. **Explain marking point 2:** Its displayed carboxyl structure is CH3–C(=O)–OH, showing a carbonyl and hydroxyl on the same carbon. Why: Naming a carbon compound has three parts: the carbon count gives the parent chain, the functional group gives the suffix, and the position of the group is given by a number. For CH3–CH(OH)–CH3 this gives propane, then propanol, then propan-2-ol, with the –OH on carbon 2.
3. **Explain marking point 3:** Its –COOH carboxyl group differs from ethanol's –OH hydroxyl group; the carbonyl part makes it a carboxylic acid rather than an alcohol. Why: Naming a carbon compound has three parts: the carbon count gives the parent chain, the functional group gives the suffix, and the position of the group is given by a number. For CH3–CH(OH)–CH3 this gives propane, then propanol, then propan-2-ol, with the –OH on carbon 2.

Topic and concept

Nomenclature of carbon compounds; functional groups. Naming a carbon compound has three parts: the carbon count gives the parent chain, the functional group gives the suffix, and the position of the group is given by a number. For CH3–CH(OH)–CH3 this gives propane, then propanol, then propan-2-ol, with the –OH on carbon 2.

How marks are earned

1. CH3COOH has the IUPAC name ethanoic acid, a two-carbon carboxylic acid. (1 mark)
2. Its displayed carboxyl structure is CH3–C(=O)–OH, showing a carbonyl and hydroxyl on the same carbon. (1 mark)
3. Its –COOH carboxyl group differs from ethanol's –OH hydroxyl group; the carbonyl part makes it a carboxylic acid rather than an alcohol. (1 mark)

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

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) Why does the clear sky appear blue to an observer on Earth? [1 mark]

A. Tyndall effect

B. Rayleigh scattering

C. Mie scattering

D. Atmospheric refraction

Answer

B. Rayleigh scattering

Step by step

1. **Select and justify the option:** Rayleigh scattering of sunlight by air molecules is more effective at shorter wavelengths, making the sky appear blue. Why: Rayleigh scattering by air molecules is inversely proportional to the fourth power of wavelength, causing the sky to look blue.

Topic and concept

Scattering of light — Tyndall effect, Rayleigh scattering; colour of sky and sunset. Rayleigh scattering by air molecules is inversely proportional to the fourth power of wavelength, making the sky appear blue and sunsets red.

How marks are earned

1. Rayleigh scattering of sunlight by air molecules is more effective at shorter wavelengths, making the sky appear blue. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.4: Rayleigh scattering by air molecules is inversely proportional to the fourth power of wavelength, causing the sky to look blue.

Question 32

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): In a series circuit, the current through each resistor is the same. Reason (R): The potential difference across each resistor in series is the same. [1 mark]

A. Both A and R true and R explains A

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

C. A true, R false

D. A false, R true

Answer

C. A true, R false

Step by step

1. **Select and justify the option:** The assertion is true because a single current flows through series resistors; the reason is false since voltages across series resistors add, not remain equal. Why: Current is same in series; voltage divides among resistors.

Topic and concept

Series and parallel combinations of resistors. In series connections resistances add directly, while in parallel connections the reciprocals of resistances add to give the reciprocal of the equivalent resistance.

How marks are earned

1. The assertion is true because a single current flows through series resistors; the reason is false since voltages across series resistors add, not remain equal. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, Fig. 11.6 Resistors in series: Current is same in series; voltage divides among resistors.

Question 33

2 marks

Short Answer

Answer the question with working and reasons where needed.

(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. **Compare the person's near point with the normal near point to name the defect:** The person cannot see objects closer than 1 m clearly, so the near point is 1 m = 100 cm. The normal near point is 25 cm. Since 100 cm > 25 cm, the near point is too far, which is the defect hypermetropia (farsightedness). Why: In hypermetropia the eye cannot focus nearby objects, because the focal length of the eye lens is too long or the eyeball is too short. Near objects form their images behind the retina. This makes the near point recede beyond 25 cm.
2. **Choose the correcting lens from what the eye lacks:** The eye needs extra converging power, so a convex (converging) lens is placed in front of it. The lens converges the rays slightly before they enter the eye. Then objects at 25 cm form images on the retina. Why: A convex lens adds converging power to the eye lens, so the image moves forward from behind the retina onto it. A concave lens would diverge the rays and make the fault worse. That lens is used for myopia.

Topic and concept

Defects of vision — myopia, hypermetropia, presbyopia; correction with lenses.
Hypermetropia is a defect in which near objects form images behind the retina, so the near point lies beyond 25 cm. A convex lens supplies the missing converging power, so the image falls on the retina.

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

Question 34

2 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

(a) State two properties of magnetic field lines of a bar magnet. [2 marks]

Answer

Magnetic field lines emerge from the north pole and enter the south pole of a bar magnet, forming continuous closed loops through the interior of the magnet. No two magnetic field lines ever intersect each other at any point in space.

Step by step

1. **State the direction and closed-loop nature of field lines:** Outside the bar magnet the lines run from the north pole to the south pole. Inside the magnet they continue from south to north, so each line is a continuous closed loop. Why: Field lines show the direction of the magnetic field, which is taken as the direction a north pole would move. A magnet has no isolated pole, so the lines cannot end at the poles and must form closed loops.
2. **State that field lines never intersect and explain why:** No two field lines cross. If two lines crossed at a point, a compass needle there would have two directions to point in, which is impossible. Where the lines are crowded, as near the poles, the field is stronger. Why: At any point the magnetic field has only one direction, and the tangent to the field line gives it. Two crossing lines would give two tangents at one point, so lines cannot intersect.

Topic and concept

Magnetic field and field lines; bar magnet. Magnetic field lines of a bar magnet are closed curves that go from north to south outside the magnet. They show the direction of the field, and they never cross because the field has one direction at each point.

How marks are earned

1. Magnetic field lines emerge from the north pole and enter the south pole of a bar magnet, forming continuous closed loops through the interior of the magnet. (1 mark)
2. No two magnetic field lines ever intersect each other at any point in space. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.12, §12.1: Field lines around a bar magnet are closed loops and never intersect.

OR

Option B

Answer the question with working and reasons where needed.

(a) List the factors on which the magnitude of the force experienced by a current-carrying conductor in a magnetic field depends. [2 marks]

Answer

The force on a current-carrying conductor in a magnetic field is directly proportional to the magnetic field strength (B), the current in the conductor (I), the length of the conductor within the field (l), and sin θ, where θ is the angle between the field and the current direction. This relationship is expressed by the equation F = B I l sin θ.

Step by step

1. **Work through marking point 1:** The force on a current-carrying conductor in a magnetic field is directly proportional to the magnetic field strength (B), the current in the conductor (I), the length of the conductor within the field (l), and sin θ, where θ is the angle between the field and the current direction. Why: The magnitude of magnetic force on a current-carrying conductor depends on B, I, l and the angle between current and field.
2. **Work through marking point 2:** This relationship is expressed by the equation F = B I l sin θ. Why: The magnitude of magnetic force on a current-carrying conductor depends on B, I, l and the angle between current and field.

Topic and concept

Force on current-carrying conductor in magnetic field; Fleming's left hand rule. A current-carrying conductor in a magnetic field experiences a force F = B I l sinθ, whose direction is given by Fleming’s left-hand rule.

How marks are earned

1. The force on a current-carrying conductor in a magnetic field is directly proportional to the magnetic field strength (B), the current in the conductor (I), the length of the conductor within the field (l), and sin θ, where θ is the angle between the field and the current direction. (1 mark)
2. This relationship is expressed by the equation F = B I l sin θ. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.12, §12.5: The magnitude of magnetic force on a current-carrying conductor depends on B, I, l and the angle between current and field.

Question 35

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Explain how a parallel-sided glass slab produces lateral displacement of a ray and name two factors on which the magnitude of this displacement depends. [3 marks]

Answer

When a ray enters and exits a parallel-sided slab it emerges parallel to the incident ray but is shifted sideways, called lateral displacement. The lateral displacement depends on the thickness of the slab. It also depends on the refractive index of the slab material.

Step by step

1. **Work through marking point 1:** When a ray enters and exits a parallel-sided slab it emerges parallel to the incident ray but is shifted sideways, called lateral displacement. Why: Parallel slab displaces transmitted ray laterally though emergent ray is parallel to incident
2. **Work through marking point 2:** The lateral displacement depends on the thickness of the slab. Why: Parallel slab displaces transmitted ray laterally though emergent ray is parallel to incident
3. **Work through marking point 3:** It also depends on the refractive index of the slab material. Why: Parallel slab displaces transmitted ray laterally though emergent ray is parallel to incident

Topic and concept

Refraction through a glass slab; total internal reflection (qualitative). A parallel-sided glass slab displaces a transmitted ray laterally by a distance that depends on its thickness and refractive index, though the emergent ray remains parallel to the incident one.

How marks are earned

1. When a ray enters and exits a parallel-sided slab it emerges parallel to the incident ray but is shifted sideways, called lateral displacement. (1 mark)
2. The lateral displacement depends on the thickness of the slab. (1 mark)
3. It also depends on the refractive index of the slab material. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 9, §9.3.1: Parallel slab displaces transmitted ray laterally though emergent ray is parallel to incident

Question 36

3 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Define the fuse and state how it breaks the circuit:** A fuse is a safety device containing a thin wire of low melting point, connected in series with the live wire; when the current exceeds its specified value, the heat produced ($H = I^2Rt$) melts the wire and breaks the circuit. Why: Heat produced grows with the square of the current, so a thin wire heats far more during a fault than during normal use; being in series means all the current must pass through it, so melting it stops the flow.
2. **State the protective consequence of the melting:** Once the fuse wire melts, the circuit is open and the excessive current stops flowing, so appliances and wiring are not damaged and the risk of overheating and fire is removed. Why: Overcurrent from a short circuit or overload would otherwise overheat the wires and appliances; the fuse sacrifices itself first, which is the overcurrent protection described for domestic circuits.
3. **Explain why the rating must be chosen correctly:** The fuse rating must be just above the normal current of the circuit: e.g. a 1000 W heater on 220 V draws $I = 1000/220 \approx 4.5$ A, so a 5 A fuse suits it. A rating too low would blow during normal use, and one much too high would not blow in a fault. Why: The rating is the largest current the fuse can carry without melting. It must exceed the normal load current to avoid false trips, but stay low enough to melt under fault conditions, so it protects without interrupting normal operation.

Topic and concept

Domestic electric circuits; earthing; fuse; MCB. A fuse uses the heating effect of current ($H = I^2Rt$). Being connected in series with the live wire, its thin wire melts when current exceeds the rated value, breaking the circuit. This protects the wiring and appliances from overcurrent, and its rating must suit the normal load.

How marks are earned

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

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

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

Question 37

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) A bulb is rated 120 W at 220 V. Calculate the current drawn by the bulb and the resistance of its filament. [3 marks]

Answer

Using P = VI, the current drawn is I = P/V. Substituting P = 120 W and V = 220 V gives I = 120/220 = 0.545 A. Then using R = V/I with V = 220 V and I = 0.545 A gives R ≈ 403 Ω.

Step by step

1. **Choose the formula for current:** The bulb's rating gives its power and the supply voltage, so use P = VI, which rearranges to I = P/V. Why: Electrical power is the product of potential difference and current (P = VI), so current can be found directly when P and V are known.
2. **Substitute and calculate the current with units:** I = P/V = 120 W / 220 V = 0.545 A (approximately 0.55 A). Why: Since 1 W = 1 V × 1 A, dividing watts by volts gives amperes, so the unit of the answer is correct. A bulb of modest power at 220 V draws a fraction of an ampere, which is reasonable.
3. **Find the filament resistance using Ohm's law:** R = V/I = 220 V / 0.545 A ≈ 403 Ω. Check: R = V²/P = (220)²/120 = 48400/120 ≈ 403 Ω. Why: Ohm's law states that V/I is constant for a conductor at constant temperature, and this ratio is the resistance in ohms. The alternative formula V²/P gives the same value, which confirms the result.

Topic and concept

Heating effect of electric current; joule's law; electrical power; commercial unit (kWh). The power rating of an appliance means it uses that power when operated at the stated voltage. Using P = VI gives the current drawn, and Ohm's law (R = V/I) then gives the filament resistance. Since P = I²R = V²/R, the heating effect links these quantities.

How marks are earned

1. Using P = VI, the current drawn is I = P/V. (1 mark)
2. Substituting P = 120 W and V = 220 V gives I = 120/220 = 0.545 A. (1 mark)
3. Then using R = V/I with V = 220 V and I = 0.545 A gives R ≈ 403 Ω. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, §11.8 Electrical power: Electrical power relates voltage and current by P = VI, which can be used to calculate current drawn.

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 pattern formed by the filings around the bar magnet:** The iron filings arrange themselves along curved lines that run from the north pole of the magnet round to its south pole outside the magnet, and the field lines continue inside the magnet from south to north, so they form closed loops. Why: Filings in a magnetic field become tiny magnets and align along the direction of the field, so they trace the field lines. By convention the lines emerge from the north pole and enter the south pole, and a magnetic field line has no beginning or end.

Topic and concept

Magnetic field and field lines; bar magnet. The region around a magnet where its force can be detected is its magnetic field, and iron filings make it visible as field lines. For a bar magnet these lines are closed curves that go from the north pole to the south pole outside the magnet.

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 formed around the straight current-carrying wire:** The iron filings arrange themselves in concentric circles around the straight conductor, with the wire at the centre. The direction of the field is given by the right-hand thumb rule: with the thumb along the current, the curled fingers show the field direction. Why: A current produces a magnetic field around it, and the field at each point is directed along a circle around the wire. Filings align along the field, so the rings show the circular field lines. The field is weaker farther from the wire, as the circles get larger.

Topic and concept

Magnetic field due to current-carrying conductor — straight wire. A straight conductor carrying current produces a magnetic field that is circular around it. The field lines are concentric circles in the plane perpendicular to the wire, and the right-hand thumb rule gives their direction.

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 lines at the centre of the circular loop:** Near the loop each small segment of wire gives circular field lines, but at the centre the arcs of the concentric circles become so large that they look like straight lines perpendicular to the plane of the loop, that is, along its axis. Why: The circles around the wire grow larger with distance from the wire, so at the centre of the loop the field of every segment points the same way. These add up to give a strong, nearly uniform field there.
2. **Describe the field lines inside the solenoid:** Inside a long current-carrying solenoid the field lines are straight, parallel and closely spaced, so the magnetic field is uniform and strong. Outside, the pattern resembles that of a bar magnet. Why: The fields of the many turns add up inside the coil, which makes the field strong and uniform, in the same direction at every point inside. This is why the solenoid behaves like a bar magnet.

Topic and concept

Magnetic field due to current-carrying conductor — circular loop. Bending a current-carrying wire into a loop makes its circular field lines add up at the centre, where they look straight. A solenoid has many such turns, which produce a uniform magnetic field inside it, with parallel and closely spaced field lines.

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) 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. **Define the near point and the far point:** The near point is the minimum distance at which an object can be seen clearly without strain, also called the least distance of distinct vision. The far point is the farthest point up to which the eye can see objects clearly. Why: The eye can focus clearly only within a certain range of distances. Its limits are fixed by how much the ciliary muscles can change the curvature of the lens, so these two points mark the ends of that range.
2. **Give the values with units:** For a normal eye of a young adult the near point is about 25 cm, and the far point is at infinity. So a normal eye sees objects clearly from 25 cm to infinity. Why: The relaxed lens can focus parallel rays from very distant objects on the retina, so the far point is at infinity. For nearby objects the ciliary muscles make the lens thicker, but this accommodation has a limit, which gives 25 cm as the closest comfortable distance.

Topic and concept

Human eye; far point, near point; accommodation. The range of distinct vision is limited by the near point (about 25 cm) and the far point (infinity). Within this range the eye focuses by accommodation, the lens becoming thicker for near objects and thinner for distant ones.

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

Answer

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

Step by step

1. **Describe accommodation for a near object (ciliary muscles, lens shape, focal length):** For a near object the ciliary muscles contract and the zonular fibres relax, so the lens becomes thicker and more convex; its greater curvature gives a shorter focal length, which bends the diverging rays from the close object enough to meet on the retina. Why: The distance between lens and retina is fixed, so the image distance cannot change; by the lens formula $1/f = 1/v - 1/u$, a nearer object (smaller $|u|$) needs a smaller f to keep v the same, and a more curved lens surface refracts more strongly and so has a smaller f.
2. **Describe accommodation for a distant object (ciliary muscles, lens shape, focal length):** For a distant object the ciliary muscles relax and the zonular fibres pull the lens into a thinner, flatter shape; its curvature decreases, so the focal length increases and the nearly parallel rays are brought to a focus on the retina. Why: As $|u|$ becomes very large, $1/u$ tends to zero, so the same fixed image distance v is obtained only with a larger f; a flatter lens refracts less, which is exactly what gives this longer focal length.
3. **State the result and the range over which it works:** This continual adjustment of focal length, called accommodation, lets the eye form a sharp image on the retina for any object from the near point at about 25 cm out to the far point at infinity. Why: A normal eye has a near point of about 25 cm and a far point at infinity, and accommodation is the mechanism that makes the whole range between them distinctly visible without changing the lens-to-retina distance.

Topic and concept

Human eye; far point, near point; accommodation. Accommodation is the eye lens changing its curvature, thicker for near objects and thinner for distant ones, so that its focal length varies. Because the image distance (lens to retina) is fixed, the focal length must change with object distance to keep the image on the retina. This covers objects from the near point (25 cm) to the far point (infinity).

How marks are earned

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

3. This dynamic change in focal length enables the eye to form a sharp image on the retina for objects from 25 cm to infinity. (1 mark)

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

OR

Option B

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

(a) 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. **Work through marking point 1:** Dispersion occurs because the prism's refractive index varies with wavelength, so different colours refract at different angles. Why: Different wavelengths refract by different amounts in a prism, causing white light to split into colours
2. **Work through marking point 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. Why: Different wavelengths refract by different amounts in a prism, causing white light to split into colours

Topic and concept

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

How marks are earned

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

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

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

Answer

When white light enters the prism, each wavelength refracts according to its refractive index; shorter wavelengths (violet) refract more and longer wavelengths (red) refract less. The two refractions—first when entering and then when emerging—cause the rays to

spread out angularly, separating the colours. This angular separation produces a continuous spectrum of colours, from red at the top to violet at the bottom.

Step by step

1. **Work through marking point 1:** When white light enters the prism, each wavelength refracts according to its refractive index; shorter wavelengths (violet) refract more and longer wavelengths (red) refract less. Why: different wavelengths refract by different amounts at prism surfaces, causing spectrum
2. **Work through marking point 2:** The two refractions—first when entering and then when emerging—cause the rays to spread out angularly, separating the colours. Why: different wavelengths refract by different amounts at prism surfaces, causing spectrum
3. **Work through marking point 3:** This angular separation produces a continuous spectrum of colours, from red at the top to violet at the bottom. Why: different wavelengths refract by different amounts at prism surfaces, causing spectrum

Topic and concept

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

How marks are earned

1. When white light enters the prism, each wavelength refracts according to its refractive index; shorter wavelengths (violet) refract more and longer wavelengths (red) refract less. (1 mark)
2. The two refractions—first when entering and then when emerging—cause the rays to spread out angularly, separating the colours. (1 mark)
3. This angular separation produces a continuous spectrum of colours, from red at the top to violet at the bottom. (1 mark)

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