SHUNYASAARTHI

CLASS X · 2026-27 · MODEL PAPER

Class X Science (Code 086) Model Paper 1

Worked answers & explanations

Maximum marks: 80

Time: 3 hours

Subject code: 086

Practice, understand, improve.

Instructions

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

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

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

Section A

Question 1

1 mark

Mcq

Choose the correct answer.

(a) Roots growing downwards into the soil exhibit which of the following? [1 mark]

A. Negative phototropism

B. Positive geotropism

C. Thigmotropism

D. Photoperiodism

Answer

B. Positive geotropism

Step by step

1. **Select and justify the option:** Roots growing downward show positive geotropism. Why: Plants grow directionally in response to gravity (geotropism).

Topic and concept

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

How marks are earned

1. Roots growing downward show positive geotropism. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.2 Coordination in Plants: Plants grow directionally in response to gravity (geotropism).

Question 2

1 mark

Mcq

Choose the correct answer.

(a) In binary fission of Amoeba, the plane of division is usually [1 mark]

A. fixed perpendicular to the axis

B. always along the long axis

C. random and can be in any plane

D. determined by food availability

Answer

C. random and can be in any plane

Step by step

1. **Select and justify the option:** Amoeba divides by binary fission, and the splitting plane can occur in any orientation across the cell. Why: Amoeba's binary fission can take place in any plane

Topic and concept

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

How marks are earned

1. Amoeba divides by binary fission, and the splitting plane can occur in any orientation across the cell. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.2.1: Amoeba's binary fission can take place in any plane

Question 3

1 mark

Mcq

Choose the correct answer.

(a) Mendel's dihybrid cross of pea plants yielding a 9 : 3 : 3 : 1 phenotypic ratio in the F_2 generation illustrates which principle? [1 mark]

A. law of dominance

B. blending inheritance

C. law of independent assortment

D. law of segregation

Answer

C. law of independent assortment

Step by step

1. **Select and justify the option:** The 9 : 3 : 3 : 1 ratio arises because alleles of different genes assort independently during gamete formation. Why: In a dihybrid cross, independent segregation of two gene pairs leads to a 9 : 3 : 3 : 1 phenotypic ratio.

Topic and concept

Mendel's contribution; laws of inheritance — law of segregation, law of independent assortment. A gene is a DNA segment that codes for a protein affecting a trait; different forms are alleles which can be dominant or recessive.

How marks are earned

1. The 9 : 3 : 3 : 1 ratio arises because alleles of different genes assort independently during gamete formation. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.3: In a dihybrid cross, independent segregation of two gene pairs leads to a 9 : 3 : 3 : 1 phenotypic ratio.

Question 4

1 mark

Mcq

Choose the correct answer.

(a) In which part of the human alimentary canal does salivary amylase begin starch digestion? [1 mark]

A. Mouth

B. Stomach

C. Small intestine

D. Large intestine

Answer

A. Mouth

Step by step

1. **Select and justify the option:** Salivary amylase in the mouth initiates the breakdown of starch into simpler sugars. Why: Saliva contains salivary amylase that acts on starch in the mouth.

Topic and concept

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

How marks are earned

1. Salivary amylase in the mouth initiates the breakdown of starch into simpler sugars. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.5, §5.2.4: Saliva contains salivary amylase that acts on starch in the mouth.

Question 5

1 mark

Mcq

Choose the correct answer.

(a) Which of the following structures constitute the central nervous system? [1 mark]

A. Brain and spinal cord

B. Brain and cranial nerves

C. Spinal cord and spinal nerves

D. Peripheral nerves and muscles

Answer

A. Brain and spinal cord

Step by step

1. **Select and justify the option:** The central nervous system consists of the brain and spinal cord. Why: The brain and spinal cord make up the central nervous system.

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 central nervous system consists of the brain and spinal cord. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.1.2 Human Brain: The brain and spinal cord make up the central nervous system.

Question 6

1 mark

Mcq

Choose the correct answer.

(a) Planaria fragments regenerate into whole organisms because: [1 mark]

A. each fragment contains spores

B. body segments fuse to form new cells

C. specialised cells proliferate and differentiate to rebuild tissues

D. fragments undergo binary fission

Answer

C. specialised cells proliferate and differentiate to rebuild tissues

Step by step

1. **Select option C by linking Planaria regeneration to cell proliferation and differentiation:** When a Planaria is cut, specialised cells in each fragment divide (proliferate) and then differentiate into the different cell types needed, so the missing tissues are rebuilt and a complete organism forms. This matches option C, 'specialised cells proliferate and differentiate to rebuild tissues'. Why: Regeneration is a process in which specialised cells divide and then become different tissue types to replace lost parts, so an option describing proliferation plus differentiation is the one that fits. Option A is wrong because Planaria does not form spores, B is wrong because fusing segments do not make new cells, and D is wrong because binary fission is a separate method in which the parent splits into two without needing to rebuild lost parts.

Topic and concept

Asexual reproduction — fission, fragmentation, regeneration, budding. Regeneration is the ability of an organism to rebuild missing body parts from the cells left in a fragment. In Planaria, specialised cells in each cut piece divide and differentiate into the needed tissues, so each piece can grow into a complete individual. This differs from fission, where an organism simply divides, and from fragmentation, as in Spirogyra, where a filament breaks into pieces that each grow.

How marks are earned

1. Specialised cells in each fragment divide and differentiate to regenerate missing tissues and form a complete organism. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.2.3: Regeneration uses specialised cells to rebuild missing parts

Question 7

1 mark

Mcq

Choose the correct answer.

(a) A hallmark of X-linked inheritance in humans is that the trait: [1 mark]

A. appears more often in males than in females

B. appears equally in both sexes

C. appears only in females

D. appears only in males

Answer

A. appears more often in males than in females

Step by step

1. **Select option A by comparing the X chromosome count in males and females:** Males are XY, so a recessive allele on the X chromosome has no matching allele on the Y chromosome and is expressed. Females are XX, so they need two copies of the recessive allele to show the trait. Red-green colour blindness is an example, and it appears more often in males, so option A is correct. Why: Genes on the X chromosome that have no counterpart on the Y chromosome are expressed in males even with one copy, whereas females can be carriers with a masking dominant allele. This gives a higher frequency of the trait in males. Option B is the nearest error, because it applies to autosomal traits, and C and D are wrong because both sexes can show the trait, though females less often.

Topic and concept

Sex determination in human beings; sex-linked traits (qualitative). X-linked traits are controlled by genes on the X chromosome that the Y chromosome does not carry in matching form. Males (XY) have a single X, so one recessive allele is enough to show the trait, while females (XX) need two copies. Colour blindness is a standard example.

How marks are earned

1. X-linked recessive traits manifest more frequently in males because they have only one X chromosome. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.4: Genes on the X chromosome but not on the Y lead to traits expressed more in males.

Question 8

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): Plants store excess glucose as starch. Reason (R): Starch is insoluble and does not affect cell osmotic pressure. [1 mark]

A. Both A and R true and R explains A

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

C. A true, R false

D. A false, R true

Answer

A. Both A and R true and R explains A

Step by step

1. **Select and justify the option:** Both assertion and reason are true, and the insolubility of starch prevents osmotic imbalance, explaining why plants store glucose as starch. Why: Excess carbohydrates formed in photosynthesis are stored as insoluble starch to avoid osmotic issues.

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. Both assertion and reason are true, and the insolubility of starch prevents osmotic imbalance, explaining why plants store glucose as starch. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch.5, §5.2.1: Excess carbohydrates formed in photosynthesis are stored as insoluble starch to avoid osmotic issues.

Question 9

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): In Mimosa pudica, leaf folding on touch is independent of growth. Reason (R): Plant cells change shape by altering their internal water content. [1 mark]

A. Both A and R true and R explains A

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

C. A true, R false

D. A false, R true

Answer

A. Both A and R true and R explains A

Step by step

1. **Identify the truth of the assertion and reason, then select the option that connects them.:** Assertion (A) is true because Mimosa pudica leaf folding on touch is an immediate movement independent of growth, and Reason (R) is true because the movement occurs when plant cells change shape by altering their internal water content; therefore R explains A and the correct option is A, not B or D. Why: In this touch response, no new growth is needed because a change in water content can rapidly change cell shape, which explains how the leaf folds without being a growth movement.

Topic and concept

Tropic movements in plants. Mimosa pudica shows a touch-induced nastic movement: the leaves fold because cells change shape through changes in internal water content, so the movement is independent of growth. This is why the reason directly supports the assertion in the assertion-reason pair.

How marks are earned

1. Both A and R are true; leaf folding is movement without growth driven by shape changes from water content alteration in cells. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 6, §6.2.1 Immediate Response to Stimulus: Movement in sensitive plants is achieved by cells changing shape via water content changes.

Question 10

2 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Explain why an aquarium set up in a classroom must be cleaned periodically, whereas a natural pond does not require such regular cleaning. [2 marks]

Answer

In a closed aquarium, waste products and uneaten food accumulate, leading to poor water quality and requiring cleaning. A natural pond has natural inflow, outflow and decomposers that recycle waste, preventing similar buildup.

Step by step

1. **Explain why a closed aquarium needs periodic cleaning:** An aquarium is a small, closed, human-made ecosystem. Fish waste and uneaten food accumulate in it, and with few decomposers to break them down, water quality drops (more ammonia and murky water). It therefore has to be cleaned periodically. Wording such as 'waste builds up as the system is not self-sustaining' is equally acceptable. Why: An artificial ecosystem is not self-sustaining, since it lacks the full recycling of matter by decomposers. Without recycling, wastes stay in the water and harm the organisms, so human intervention is needed to restore balance.
2. **Explain why a natural pond does not need regular cleaning:** A natural pond has a balanced set of producers, consumers and decomposers. Decomposers break down wastes and dead matter into nutrients that producers reuse, and there is natural inflow and outflow of water. Waste therefore does not build up, so the pond does not need cleaning by people. It is self-sustaining. Why: A natural ecosystem keeps nutrients cycling among its biotic and abiotic components, with decomposers returning matter to the environment. This is why the system maintains its own balance without outside help.

Topic and concept

Ecosystem and its components. An ecosystem consists of biotic components (living organisms) and abiotic components (water, soil, temperature) that interact. It can be natural, like a pond, or artificial, like an aquarium. A natural pond has producers, consumers and decomposers that recycle matter, while an aquarium is a small closed system that people must maintain.

How marks are earned

1. In a closed aquarium, waste products and uneaten food accumulate, leading to poor water quality and requiring cleaning. (1 mark)
2. A natural pond has natural inflow, outflow and decomposers that recycle waste, preventing similar buildup. (1 mark)

> **Source check:** Check the reasoning against NCERT Class 10 science, Ch. 13, §13.1: An aquarium is a human-made ecosystem that must be cleaned because it is closed.

Question 11

2 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

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

Answer

Mendel's law of segregation states that a pair of alleles for a trait separates during gamete formation so that each gamete receives only one allele. During fertilisation, the separated alleles recombine to restore the allele pair in the offspring.

Step by step

1. **State that alleles separate during gamete formation:** Each trait is controlled by a pair of alleles. In gamete formation this pair separates so that each gamete gets only one allele. For example, a Tt plant forms two kinds of gametes, T and t, in equal numbers. Why: Mendel observed that the recessive trait disappeared in F1 and reappeared in F2. This showed that the factors for a trait stay distinct and do not blend, and that they must separate into different gametes.
2. **State that alleles recombine at fertilisation:** At fertilisation, a gamete carrying one allele from each parent fuses, restoring the pair in the offspring. Selfing Tt × Tt gives TT, Tt, Tt and tt, so the genotype ratio is 1:2:1 and the phenotype ratio is 3:1 (tall:dwarf). Why: Random fusion of the two types of gametes from each parent gives all combinations of alleles, so the recessive trait reappears in about one quarter of the F2 plants. This confirms that separation happened earlier. Other equivalent wording of separation and restoration of the pair is acceptable.

Topic and concept

Mendel's contribution; laws of inheritance — law of segregation, law of independent assortment. Each organism carries two versions (alleles) of a gene for a trait. Mendel's law of segregation says these separate during gamete formation so that each gamete gets one allele, and they come together again at fertilisation. The 3:1 phenotype ratio and 1:2:1 genotype ratio in F2 follow from this.

How marks are earned

1. Mendel's law of segregation states that a pair of alleles for a trait separates during gamete formation so that each gamete receives only one allele. (1 mark)
2. During fertilisation, the separated alleles recombine to restore the allele pair in the offspring. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 8, §8.2.2: Mendel's experiments demonstrated that each trait is controlled by a pair of gene variants, one contributed by each parent.

OR

Option B

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Work through marking point 1:** Alleles are alternative forms of a gene present at the same locus on homologous chromosomes. Why: A gene is a DNA section that codes for a protein influencing a trait, and different forms of a gene are called alleles.
2. **Work through marking point 2:** These alternative forms may exhibit dominant or recessive behaviour in determining a trait. Why: A gene is a DNA section that codes for a protein influencing a trait, and different forms of a gene are called alleles.

Topic and concept

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

How marks are earned

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

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

Question 12

2 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Define life processes and explain why they must continue:** Life processes are the basic maintenance functions that keep the internal order of a living organism and prevent its breakdown. They go on even when an organism is at rest or asleep, because the body still needs energy and repair. Why: Living organisms are organised systems that break down without continuous maintenance, so these functions cannot stop. This is why they are called life processes.
2. **List the main life processes:** The main life processes are nutrition, respiration, transport and excretion. Together they supply energy and materials, carry them through the body, and remove wastes, which allows growth and survival. Other accepted processes, such as control and coordination and reproduction, may also be listed. Why: Each process does a different job: nutrition brings in raw materials, respiration releases energy, transport distributes substances, and excretion removes wastes. Together they sustain the organism. The marking scheme needs the four key processes to be named.

Topic and concept

Living beings; basic concept of nutrition, respiration, transport and excretion. Life processes are the integrated set of functions, namely nutrition, respiration, transport and excretion, that maintain the internal order of living organisms and enable growth. They continue even at rest or during sleep.

How marks are earned

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

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

Question 13

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) List and explain three harmful effects of increased ultraviolet radiation on human health due to ozone layer depletion. [3 marks]

Answer

Increased UV-B exposure can damage skin cells and significantly raise the risk of skin cancer. Higher UV levels can harm the eyes by causing cataracts and other disorders of the lens. It can suppress the immune system by impairing skin and blood cell functions, reducing disease resistance.

Step by step

1. **Explain the skin cancer effect:** CFCs deplete the ozone layer, so more UV-B reaches the Earth's surface. UV-B damages the DNA of skin cells and can cause mutations, which can lead to sunburn and a higher risk of skin cancer. Why: Ozone absorbs harmful UV radiation, so when the layer thins, the protection is reduced. UV-B can alter DNA, and unrepaired DNA damage in skin cells can cause uncontrolled cell division, which is cancer.
2. **Explain the eye damage effect:** Increased UV levels reach the eye and can damage the lens, causing cataracts, in which the lens turns cloudy and vision is impaired. Other disorders of the eye lens and cornea can also occur. Why: The eye is directly exposed to sunlight, and UV radiation damages the proteins of the lens, which makes it opaque. Less ozone means more UV reaches the eye.
3. **Explain the immune suppression effect:** High UV exposure can impair the functions of skin and blood cells that help fight infections. This weakens the immune system and lowers resistance to disease. Why: Immune defence depends on healthy skin and blood cells, and UV damage to these cells reduces their ability to respond to pathogens. The chain is CFCs, then ozone depletion, then more UV-B, then cell damage.

Topic and concept

Ozone layer and its depletion; effect on humans; chlorofluorocarbons. The ozone layer in the stratosphere shields living organisms from harmful UV radiation. CFCs deplete it, so more UV-B reaches the Earth, which damages the DNA and cells of humans and causes skin cancer, cataract and a weaker immune system.

How marks are earned

1. Increased UV-B exposure can damage skin cells and significantly raise the risk of skin cancer. (1 mark)
2. Higher UV levels can harm the eyes by causing cataracts and other disorders of the lens. (1 mark)

3. It can suppress the immune system by impairing skin and blood cell functions, reducing disease resistance. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 13, §13.2.1: Ozone shields UV radiation which otherwise causes skin cancer and biological damage.

Question 14

3 marks

Short Answer

Answer the question with working and reasons where needed.

(a) Describe three different contraceptive methods and briefly explain how each one prevents pregnancy. [3 marks]

Answer

Barrier method – Use of condoms prevents sperm from entering the female reproductive tract, thereby blocking fertilisation, contributing 1 mark. Hormonal method – Oral contraceptive pills contain oestrogen and progesterone that inhibit ovulation and alter cervical mucus, preventing sperm entry, contributing 1 mark. Intrauterine device (IUD) – A small device placed in the uterus creates an environment hostile to sperm and may prevent implantation of the embryo, contributing 1 mark.

Step by step

1. **Describe the barrier method (condom) and its mechanism:** A condom is a physical barrier worn over the penis; it collects semen so that sperm cannot enter the female reproductive tract and reach the egg, so fertilisation cannot occur (1 mark). Why: Fertilisation needs sperm and egg to meet in the oviduct, so any method that physically keeps them apart prevents pregnancy; this is the principle of barrier methods.
2. **Describe the hormonal method (oral pills) and its mechanism:** Oral contraceptive pills contain hormones such as oestrogen and progesterone that inhibit ovulation, so no egg is released for sperm to fertilise, and they also alter cervical mucus, hindering sperm entry (1 mark). Why: Pregnancy needs a released egg, so changing the hormonal signals that control the cycle stops the egg being released. This is a different principle from blocking sperm physically.
3. **Describe a third valid method, the IUD, and its mechanism:** An intrauterine device (IUD such as a copper-T) is placed in the uterus; it makes the uterine environment unfavourable for sperm and may prevent implantation of the embryo (1 mark). Surgical methods (vasectomy, tubectomy), which block the passage of sperm or egg, are equally acceptable for this mark. Why: A device in the uterus acts after sperm enter the tract, by hindering sperm or implantation. Surgical sterilisation blocks gamete passage permanently. Each of these methods interrupts a different stage between gamete release and implantation.

Topic and concept

Reproductive health — need for family planning; contraception methods. Contraceptive methods prevent pregnancy by acting at different stages: they stop sperm reaching the egg (barrier, surgical blocking), stop egg release (hormonal pills), or make the uterus unsuitable for sperm or implantation (IUD). Any three valid methods, each with a correct mechanism, answer this question.

How marks are earned

1. Barrier method – Use of condoms prevents sperm from entering the female reproductive tract, thereby blocking fertilisation, contributing 1 mark. (1 mark)
2. Hormonal method – Oral contraceptive pills contain oestrogen and progesterone that inhibit ovulation and alter cervical mucus, preventing sperm entry, contributing 1 mark. (1 mark)
3. Intrauterine device (IUD) – A small device placed in the uterus creates an environment hostile to sperm and may prevent implantation of the embryo, contributing 1 mark. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 7, §7.7: Various contraception methods include barrier, hormonal and intrauterine techniques.

Question 15

4 marks

Case Based

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

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

Answer

Renu demonstrated photosynthesis.

Step by step

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

Topic and concept

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

How marks are earned

1. Renu demonstrated photosynthesis. (1 mark)

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

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

Answer

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

Step by step

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

Topic and concept

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

How marks are earned

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

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

Attempt one of the final two-mark options.

Option A

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

Answer

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

Step by step

1. **Explain the starch test result using the covered and uncovered parts:** The black paper blocked light from the covered part of Leaf X, so no photosynthesis and no starch formed there, and iodine stayed brown. The uncovered part received light, so its chlorophyll made carbohydrate stored as starch, which turned blue-black with iodine. Control leaf Y, fully lit, turned blue-black all over, confirming that light causes the starch. Why: Photosynthesis needs light absorbed by chlorophyll to convert CO_2 and H_2O into carbohydrate. The leaf was de-starched in darkness first, so any starch detected must have been made during the experiment, and iodine gives blue-black only with starch.
2. **Name the organelle for the light-capturing stage:** The organelle is the chloroplast, which contains the chlorophyll that absorbs light energy in the leaf cells. Why: Chlorophyll is located inside chloroplasts, so the light-capturing step of photosynthesis happens there.

Topic and concept

Autotrophic nutrition; photosynthesis — raw materials, process, outcomes. In photosynthesis, chlorophyll in chloroplasts absorbs sunlight and the plant converts CO_2 and H_2O into carbohydrates, with the excess stored as starch. Starch is therefore found only where light was available, and iodine detects it as blue-black.

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) Explain the roles of saliva in the human digestive process. [2 marks]

Answer

Saliva secreted by salivary glands moistens and lubricates food, facilitating its smooth passage through the alimentary canal. The enzyme salivary amylase in saliva catalyzes the hydrolysis of starch into maltose, initiating chemical digestion in the mouth.

Step by step

1. **State the lubricating role of saliva:** Saliva from the salivary glands wets the chewed food and makes it moist and slippery, so it can be swallowed and move smoothly down the alimentary canal. Why: Dry food particles would be hard to swallow and could scrape the lining. Mixing with saliva during chewing makes a soft, easily moved mass.
2. **State the enzymatic role of saliva:** Saliva contains the enzyme salivary amylase, which breaks down starch into the sugar maltose, so chemical digestion begins in the mouth itself. Why: An enzyme is a biological catalyst that speeds up the breakdown of one kind of food. Amylase acts on starch, so digestion of starch starts before the food reaches the stomach.

Topic and concept

Human digestive system. Digestion in humans starts in the mouth, where teeth crush the food mechanically and saliva mixes with it. Saliva helps in two ways: it lubricates the food, and its amylase starts breaking starch down chemically.

How marks are earned

1. Saliva secreted by salivary glands moistens and lubricates food, facilitating its smooth passage through the alimentary canal. (1 mark)
2. The enzyme salivary amylase in saliva catalyzes the hydrolysis of starch into maltose, initiating chemical digestion in the mouth. (1 mark)

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

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

Answer

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

Step by step

1. **Outline the stomach's structure and function:** The stomach is a muscular, J-shaped bag that stores food and churns it with gastric juice. The juice contains hydrochloric acid, which kills germs and makes the medium acidic, and protein-digesting enzyme (pepsin, secreted as pepsinogen), so protein digestion begins here. Why: Muscular walls churn the food, and the acid medium suits the protein-digesting enzyme and kills pathogens. This explains why the stomach's structure suits its function as a storage and first protein-digesting site.
2. **Outline the small intestine's structure and function:** The small intestine is a long, coiled tube lined with finger-like villi. Bile from the liver (which emulsifies fats) and pancreatic enzymes complete the digestion of carbohydrates, proteins and fats. The villi absorb the digested food into the blood, and fatty acids are taken partly to the lymph. Why: The great length and the villi greatly increase the surface area for absorption, and the rich blood supply carries the nutrients away. The secretions from the liver and pancreas explain why the main chemical digestion is completed here.
3. **Outline the large intestine's structure and function:** The large intestine is a wider, shorter tube that absorbs water from the undigested food. The remaining waste forms semi-solid faeces, which are stored in the rectum and expelled through the anus. Why: Undigested material still carries water, and absorbing it prevents water loss from the body. The rectum stores the waste until it is egested.

Topic and concept

Human digestive system. The alimentary canal has regions specialised for different jobs: the stomach stores food and begins protein digestion, the small intestine completes digestion and absorbs nutrients, and the large intestine absorbs water and passes out the waste.

How marks are earned

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

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

OR

Option B

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

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

Answer

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

Step by step

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

Topic and concept

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

How marks are earned

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

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

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

Answer

Double circulation consists of the pulmonary circuit, where the right side of the heart pumps deoxygenated blood via the pulmonary artery to the lungs for oxygenation. Oxygenated blood returns in pulmonary veins to the left atrium, and the left ventricle then pumps it into the systemic circuit through the aorta to all body tissues. This separation ensures that pulmonary blood flows under lower pressure and systemic blood under higher pressure, optimizing gas exchange and nutrient delivery.

Step by step

1. **Work through marking point 1:** Double circulation consists of the pulmonary circuit, where the right side of the heart pumps deoxygenated blood via the pulmonary artery to the lungs for oxygenation. Why: Blood circulates in two loops—pulmonary and systemic—driven by the heart, while lymph vessels return interstitial fluid to the bloodstream, collectively ensuring material exchange and immune defence.
2. **Work through marking point 2:** Oxygenated blood returns in pulmonary veins to the left atrium, and the left ventricle then pumps it into the systemic circuit through the aorta to all body tissues. Why: Blood circulates in two loops—pulmonary and systemic—driven by the heart, while lymph vessels return interstitial fluid to the bloodstream, collectively ensuring material exchange and immune defence.
3. **Work through marking point 3:** This separation ensures that pulmonary blood flows under lower pressure and systemic blood under higher pressure, optimizing gas exchange and nutrient delivery. Why: Blood circulates in two loops—pulmonary and systemic—driven by the heart, while lymph vessels return interstitial fluid to the bloodstream, collectively ensuring material exchange and immune defence.

Topic and concept

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

How marks are earned

1. Double circulation consists of the pulmonary circuit, where the right side of the heart pumps deoxygenated blood via the pulmonary artery to the lungs for oxygenation. (1 mark)
2. Oxygenated blood returns in pulmonary veins to the left atrium, and the left ventricle then pumps it into the systemic circuit through the aorta to all body tissues. (1 mark)
3. This separation ensures that pulmonary blood flows under lower pressure and systemic blood under higher pressure, optimizing gas exchange and nutrient delivery. (1 mark)

Source check: Check the reasoning against NCERT Science X, Chapter 5, §5.5 BODY FLUIDS AND CIRCULATION: Blood circulates in two loops—pulmonary and systemic—driven by the heart, while lymph vessels return interstitial fluid to the bloodstream, collectively ensuring material exchange and immune defence.

Section B

Question 17

1 mark

Mcq

Choose the correct answer.

(a) Passing the CO_2 evolved from sodium carbonate and HCl through lime water gives a white precipitate because: [1 mark]

A. $CaCO_3$ is formed

B. $Ca(OH)_2$ is formed

C. $Ca(HCO_3)_2$ is formed

D. $CaCl_2$ is formed

Answer

A. $CaCO_3$ is formed

Step by step

1. **Write the two reactions and choose option A:** First, $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$. Then the CO_2 passes into lime water: $CO_2 + Ca(OH)_2 \rightarrow CaCO_3\downarrow + H_2O$. $CaCO_3$ is insoluble and appears as a white precipitate, so A is correct. B is wrong because $Ca(OH)_2$ is the lime water already present and is dissolved. D is wrong because no $CaCl_2$ forms in lime water. C is wrong because $Ca(HCO_3)_2$ is soluble and forms only after excess CO_2 turns the milky solution clear. Why: Metal carbonates react with acids to release CO_2, and CO_2 is an acidic oxide that reacts with the base $Ca(OH)_2$. The insoluble $CaCO_3$ product causes the milkiness. The nearest error is $Ca(HCO_3)_2$, but that is soluble and forms only with excess CO_2.

Topic and concept

Reaction of metal carbonates and metal hydrogencarbonates with acids. Carbonates react with acids to give a salt, water and CO_2. The CO_2 turns lime water milky because it forms insoluble calcium carbonate, which is the standard test for CO_2.

How marks are earned

1. CO_2 reacts with $Ca(OH)_2$ to form insoluble $CaCO_3$, which appears as white precipitate. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 2, §2.1.3: CO_2 yields a white $CaCO_3$ precipitate on passing through lime water.

Question 18

1 mark

Mcq

Choose the correct answer.

(a) Which property of metals is due to their sea of free electrons reflecting light uniformly? [1 mark]

A. Ductility

B. Malleability

C. Metallic lustre

D. Sonority

Answer

C. Metallic lustre

Step by step

1. **Select and justify the option:** The sea of free electrons in a metal reflects light uniformly, giving rise to metallic lustre. Why: Metals have a shining surface (metallic lustre) because free electrons reflect light.

Topic and concept

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

How marks are earned

1. The sea of free electrons in a metal reflects light uniformly, giving rise to metallic lustre. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 3, §3.1.1: Metals have a shining surface (metallic lustre) because free electrons reflect light.

Question 19

1 mark

Mcq

Choose the correct answer.

(a) How many electrons does carbon share when forming methane (CH_4)? [1 mark]

A. Two electrons

B. Four electrons

C. Six electrons

D. Eight electrons

Answer

B. Four electrons

Step by step

1. **Select and justify the option:** Carbon shares four electrons via four covalent bonds to complete its octet, forming methane. Why: Carbon has four valence electrons and forms four covalent bonds, as seen in methane.

Topic and concept

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

How marks are earned

1. Carbon shares four electrons via four covalent bonds to complete its octet, forming methane. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.1: Carbon has four valence electrons and forms four covalent bonds, as seen in methane.

Question 20

1 mark

Mcq

Choose the correct answer.

(a) What is the balanced chemical equation for the reaction Fe + H2O → Fe3O4 + H2? [1 mark]

A. 3Fe + 4H2O → Fe3O4 + 4H2

B. Fe + 4H2O → Fe3O4 + 2H2

C. 3Fe + 4H2O → Fe3O4 + 2H2

D. Fe + 2H2O → Fe3O4 + 2H2

Answer

A. 3Fe + 4H2O → Fe3O4 + 4H2

Step by step

1. **Balance Fe + H_2O → Fe_3O_4 + H_2 by atom counting and choose A:** Balance O first: Fe_3O_4 has 4 O, so use $4H_2O$ (4 O). Then Fe: Fe_3O_4 has 3 Fe, so use 3Fe. Then H: $4H_2O$ has 8 H, so make $4H_2$ (8 H). Result: 3Fe + $4H_2O$ → Fe_3O_4 + $4H_2$. Check: Fe 3 = 3; H 8 = 8; O 4 = 4. B (Fe + $4H_2O$ → Fe_3O_4 + $2H_2$): Fe 1 ≠ 3 and H 8 ≠ 4. C (3Fe + $4H_2O$ → Fe_3O_4 + $2H_2$): Fe is balanced, but H 8 ≠ 4. D (Fe + $2H_2O$ → Fe_3O_4 + $2H_2$): Fe 1 ≠ 3 and O 2 ≠ 4. So only A balances. Why: The law of conservation of mass requires the same number of atoms of each element on both sides. Only the coefficients can be changed, never the subscripts. Balancing oxygen first, since it is in just one reactant and one product, gives a clean order. Option C is the nearest trap, since it balances Fe and O but not H.

Topic and concept

Chemical equations and balancing chemical equations. A chemical equation shows reactants and products by formulas, and a balanced equation must have equal atoms of every element on both sides, because atoms are neither created nor destroyed. Only the coefficients are adjusted to achieve this.

How marks are earned

1. Balancing gives 3Fe + 4H2O → Fe3O4 + 4H2 so that Fe, H and O atoms are equal on both sides. (1 mark)

Source check: Check the reasoning against NCERT Chemistry Class X, Ch.1, §1.1.2: Balanced equations satisfy conservation of mass by having equal numbers of each atom on both sides.

Question 21

1 mark

Mcq

Choose the correct answer.

(a) Carbon dioxide reacts with calcium hydroxide to form soluble calcium hydrogen carbonate on excess CO_2 because: [1 mark]

A. $CaCO_3$ dissolves in CO_2 and water

B. CO_2 reduces $CaCO_3$

C. $Ca(OH)_2$ is converted to CaO

D. CO_2 oxidises $Ca(OH)_2$

Answer

A. $CaCO_3$ dissolves in CO_2 and water

Step by step

1. **Select option A by tracing the two-stage reaction of CO_2 with lime water:** Stage 1: $Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$, so the lime water turns milky because insoluble $CaCO_3$ forms. Stage 2, with excess CO_2: $CaCO_3(s) + H_2O(l) + CO_2(g) \rightarrow Ca(HCO_3)_2(aq)$, so the milkiness clears as soluble calcium hydrogen carbonate forms. The solid $CaCO_3$ therefore dissolves in water containing CO_2, which is option A. Why: CO_2 is an acidic (non-metallic) oxide, so it reacts with the basic $Ca(OH)_2$ in an acid-base reaction. With more CO_2, the same acidic oxide reacts with the $CaCO_3$ salt to form the soluble hydrogen carbonate. No oxidation state changes, so options B, C and D (reduction, CaO formation, oxidation) do not fit.

Topic and concept

Reaction of non-metallic oxides with bases. CO_2 is a non-metallic oxide and is acidic, so it reacts with a base such as calcium hydroxide to give a salt ($CaCO_3$) and water. This is why lime water turns milky. With excess CO_2 and water, the insoluble $CaCO_3$ is converted to soluble $Ca(HCO_3)_2$, and the milkiness disappears.

How marks are earned

1. Excess CO_2 reacts with $CaCO_3$ in water to form soluble $Ca(HCO_3)_2$. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 2, §2.1.3: On excess CO_2, $CaCO_3$ converts to soluble $Ca(HCO_3)_2$ in water.

Question 22

1 mark

Mcq

Choose the correct answer.

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

A. Directional covalent bonds

B. Nondirectional electrostatic attraction between cations and delocalised electrons

C. Hydrogen bonding between layers

D. Ionic bonds between fixed ions

Answer

B. Nondirectional electrostatic attraction between cations and delocalised electrons

Step by step

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

Topic and concept

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

How marks are earned

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

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

Question 23

1 mark

Mcq

Choose the correct answer.

(a) Which functional group is present in ethanol (C_2H_5OH)? [1 mark]

A. Aldehyde

B. Ketone

C. Hydroxyl

D. Carboxyl

Answer

C. Hydroxyl

Step by step

1. **Select and justify the option:** Ethanol contains the hydroxyl (–OH) functional group. Why: Oxygen in ethanol appears as the hydroxyl (–OH) functional group.

Topic and concept

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

How marks are earned

1. Ethanol contains the hydroxyl (–OH) functional group. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 4, §4.2.3: Oxygen in ethanol appears as the hydroxyl (–OH) functional group.

Question 24

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): In Zn(s) + CuSO4(aq) → ZnSO4(aq) + Cu(s), zinc displaces copper from the solution. Reason (R): Zinc is less reactive than copper. [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:** Assertion is true because zinc replaces copper in its salt solution, but Reason is false since zinc is actually more reactive than copper. Why: A more reactive element displaces a less reactive one from its compound, as zinc does to copper.

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. Assertion is true because zinc replaces copper in its salt solution, but Reason is false since zinc is actually more reactive than copper. (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 one from its compound, as zinc does to copper.

Question 25

2 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Write the equation and check that it is balanced:** $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$. Atom count, left to right: Na 1/1, Cl 1/1, H 2/2 (one in HCl, one in NaOH), O 1/1. All counts match, so every coefficient is 1 and no further balancing is needed. Why: An acid and a base neutralise each other to give a salt and water. Balancing means conserving the number of atoms of each element, and the counts show this equation already conserves them.
2. **State a use of the neutralisation reaction:** Use: neutralisation of HCl by NaOH is used to prepare sodium chloride in the laboratory, because evaporating the neutral solution leaves NaCl. Other acceptable uses of the same type of reaction are neutralising excess acid in the stomach with a base (antacid) and treating acidic soil or acidic waste with a base. Why: The reaction removes the acidic and basic properties and leaves a neutral salt solution. This is the basis for making a salt, and the same idea of a base cancelling an acid applies in the other uses. Only one use is needed for the mark.

Topic and concept

Reaction of acids and bases with each other; neutralisation reaction. In neutralisation, H^+ from the acid combines with OH^- from the base to form water, and the remaining ions form a salt. For HCl and NaOH the salt is NaCl. Phenolphthalein turning colourless shows that the base has been used up.

How marks are earned

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

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

Question 26

3 marks

Short Answer

Attempt one option.

Option A

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Define corrosion:** Corrosion is the gradual destruction of a metal by chemical reaction with substances in its surroundings, mainly oxygen and moisture. Examples are the reddish-brown rust on iron and the black coating on silver. Why: The metal is oxidised by air and moisture, so it changes into compounds and loses its strength and lustre. This is why corrosion needs both the metal and an environmental agent.
2. **Describe prevention by coating (painting, oiling):** Painting or oiling the metal surface, or coating it with another material, keeps oxygen and moisture from touching the metal. With no contact there is no reaction, so rusting is prevented. Why: Corrosion needs the metal to be exposed to both air and moisture. A barrier layer removes this exposure, so the reaction cannot start.
3. **Describe prevention by a sacrificial anode (as in galvanisation):** A more reactive metal, such as zinc, is attached to or coated on the iron. Zinc is more reactive, so it oxidises in place of iron and corrodes first. In galvanisation, even if the zinc layer is scratched, the iron stays protected. Why: The more reactive metal loses electrons more easily, so it is oxidised preferentially and protects the less reactive metal. This is the sacrificial idea behind galvanisation.

Topic and concept

Corrosion and its prevention. Corrosion is the slow oxidation of metals in the presence of moisture and air. It is controlled by coatings that block contact with the environment, by sacrificial anodes or galvanisation, and by alloying.

How marks are earned

1. Corrosion is the gradual destruction of metals by chemical reaction with substances in the environment, especially oxygen and moisture. (1 mark)

2. Coating the metal surface with paint or a layer of another material prevents direct contact with oxygen and moisture, thereby preventing corrosion. (1 mark)
3. Attaching a more reactive metal as a sacrificial anode causes that metal to corrode in place of the protected metal. (1 mark)

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

OR

Option B

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

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

Topic and concept

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

How marks are earned

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

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

Question 27

3 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Derive the IUPAC name step by step:** The longest carbon chain has 3 carbons, so the parent is propane. The –OH group replaces the final 'e' with 'ol', giving propanol. Numbering from either end puts –OH on carbon 2 (the middle carbon), so the locant is 2. The name is propan-2-ol. Why: IUPAC naming starts with the parent chain, then the functional group suffix, then the position number. An alcohol takes the suffix 'ol', and the locant shows which carbon carries –OH, which separates propan-2-ol from propan-1-ol.
2. **Draw the structural formula:** The condensed formula is CH_3–CH(OH)–CH_3. The full structure has three carbons in a row: C1 has three H, C2 has one H and one –OH, and C3 has three H. The –OH group is on the middle carbon, with all carbons showing four single bonds. Why: The carbon bonds must satisfy the tetravalency of carbon, so each carbon has four single bonds. The –OH on the middle carbon fits the locant 2 in the name.
3. **Identify the functional group:** The group present is the hydroxyl group (–OH), which puts the compound in the class of alcohols. Why: The functional group is the atom or group that replaces hydrogen in the hydrocarbon chain and gives the compound its characteristic properties. Here the –OH group decides that the compound is an alcohol.

Topic and concept

Nomenclature of carbon compounds; functional groups. A functional group such as –OH replaces hydrogen in a hydrocarbon chain and decides the class, name and properties of the compound. For alcohols the suffix 'ol' marks the –OH group, and a number gives its position on the chain.

How marks are earned

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

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

Question 28

4 marks

Case Based

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

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

Answer

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

Step by step

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

Topic and concept

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

How marks are earned

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

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

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

Answer

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

Step by step

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

Topic and concept

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

How marks are earned

1. The skeletal chemical equation is: CaCO3 → CaO + CO2. (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: CaCO3(s) → CaO(s) + CO2(g). (No additional coefficients are needed.) This reaction is a thermal decomposition reaction.

Step by step

1. **Check that the equation is balanced by counting atoms:** $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$. Left: Ca 1, C 1, O 3. Right: Ca 1, C 1, O 1 + 2 = 3. All counts are equal, so the equation is already balanced and every coefficient is 1. Why: A balanced equation must have the same number of atoms of each element on both sides, by the law of conservation of mass. Since the counts match, adding coefficients would only break the balance.
2. **Identify the type of reaction:** One compound, $CaCO_3$, breaks down into two simpler products, CaO and CO_2, when heated strongly. This is a thermal decomposition reaction, and it is endothermic because heat must be supplied. Why: A decomposition reaction is one in which a single reactant gives two or more simpler products. Heat is the energy source here, so it is thermal decomposition.

Topic and concept

Types of chemical reactions — decomposition. In a decomposition reaction a single compound splits into two or more simpler substances. When heat causes the splitting, as when limestone is heated in a kiln to give quicklime and CO_2, it is a thermal decomposition. Such reactions absorb heat.

How marks are earned

1. The balanced equation is: CaCO3(s) → CaO(s) + CO2(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 CO2 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) State the colour shown by (i) red litmus paper in an acidic solution and (ii) blue litmus paper in a basic solution. [2 marks]

Answer

(i) Red litmus remains red in an acidic solution. (ii) Blue litmus remains blue in a basic solution. Neither paper changes colour in the stated medium.

Step by step

1. **Read the red litmus observation:** Red litmus remains red in an acidic solution; there is no colour change for this paper. Why: Acids turn blue litmus red, but red litmus is already the acid colour.
2. **Read the blue litmus observation:** Blue litmus remains blue in a basic solution; there is no colour change for this paper. Why: Bases turn red litmus blue, but blue litmus is already the base colour.

Topic and concept

Properties of acids and bases using indicators (litmus, methyl orange, phenolphthalein). Litmus distinguishes acids and bases by a change in the opposite-coloured paper: blue turns red in acid and red turns blue in base. The already-matching colour stays unchanged.

How marks are earned

1. State that red litmus remains red, with no colour change, in an acidic solution. (1 mark)
2. State that blue litmus remains blue, with no colour change, in a basic solution. (1 mark)

Source check: Check the reasoning against NCERT Science Class 10, Ch. 2, §2.1.1: Indicators change colour in predictable ways in acidic and basic solutions

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

Answer

Phenolphthalein is an acid-base indicator. It stays colourless in an acidic solution but becomes pink in a basic solution. The different colours in the two media let us identify the base; Class X does not require the indicator's molecular structures.

Step by step

1. **Identify the indicator in acid:** Phenolphthalein is an acid-base indicator and appears colourless in an acidic solution. Why: An indicator has a characteristic colour in a given medium; its acid-side observation here is no visible pink colour.
2. **Identify its colour in base:** When phenolphthalein is added to a basic solution, the solution appears pink. Why: The colour depends on the medium, so a base produces a different visible indicator response from an acid.
3. **Use the colour change to interpret the test:** The change from colourless to pink is the observation used to identify the basic solution. Why: At Class X level the observation and interpretation are required; naming lactone or quinoid structures is not necessary.

Topic and concept

Properties of acids and bases using indicators (litmus, methyl orange, phenolphthalein). Phenolphthalein is a synthetic acid-base indicator: it is colourless in acidic or neutral solution and pink in basic solution, allowing the two media to be distinguished.

How marks are earned

1. State that phenolphthalein is an acid-base indicator and is colourless in acidic solution. (1 mark)
2. State that phenolphthalein becomes pink in a basic solution. (1 mark)
3. Explain that its different colours in acid and base are used to identify the medium; structural terms are not required. (1 mark)

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

OR

Option B

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

(a) Write balanced chemical equations for the neutralisation reactions: (i) sodium hydroxide with hydrochloric acid, (ii) barium hydroxide with sulfuric acid. [2 marks]

Answer

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

Step by step

1. **Work through marking point 1:** $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$. Why: Neutralisation of acid and base yields salt and water
2. **Work through marking point 2:** $Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$. Why: Neutralisation of acid and base yields salt and water

Topic and concept

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

How marks are earned

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

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

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

Answer

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

Step by step

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

3. **Work through marking point 3:** The remaining Na^+ and Cl^- ions remain in solution as sodium chloride. Why: Neutralisation involves H^+ and OH^- combining to form water, leaving a salt

Topic and concept

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

How marks are earned

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

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

Section C

Question 30

1 mark

Mcq

Choose the correct answer.

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

A. –1.5 D

B. –2.0 D

C. +2.0 D

D. +1.5 D

Answer

B. –2.0 D

Step by step

1. **Compute the power from the far point and choose option B:** The far point of 50 cm = 0.50 m. The lens must form a virtual image at the far point, so f = –0.50 m (concave lens). P = 1/f = 1/(–0.50 m) = –2.0 D. Check: the sign is negative and 1/0.5 = 2, so the answer is option B (–2.0 D). Why: A myopic eye cannot see objects beyond its far point, so the corrective lens must make distant objects appear at that point. A concave lens diverges rays and does this, and its focal length equals the far point distance with a negative sign. Options C and D have a positive sign, which is a convex lens, and A has the wrong magnitude (1/0.67 m).

Topic and concept

Defects of vision — myopia, hypermetropia, presbyopia; correction with lenses. Myopia is corrected by a concave lens that diverges parallel rays so the eye lens can focus them on the retina. The lens focal length is the negative of the far point distance, and P = 1/f in metres gives the power in dioptres.

How marks are earned

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

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

Question 31

1 mark

Mcq

Choose the correct answer.

(a) What is the far point of a normal human eye? [1 mark]

A. 25 cm

B. 1 m

C. Infinity

D. Depends on accommodation

Answer

C. Infinity

Step by step

1. **Select and justify the option:** A normal eye can see distant objects up to infinity, making the far point at infinity. Why: The farthest point up to which the eye can see clearly is infinity for a normal eye.

Topic and concept

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

How marks are earned

1. A normal eye can see distant objects up to infinity, making the far point at infinity. (1 mark)

Source check: Check the reasoning against NCERT Science X, Ch. 10, §10.1.1: The farthest point up to which the eye can see clearly is infinity for a normal eye.

Question 32

1 mark

Assertion Reason

Choose the correct answer.

(a) Assertion (A): The resistance of a metallic conductor decreases when its temperature is increased. Reason (R): The resistivity of metals increases with temperature. [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 A and R separately, then pick the option that matches their truth values:** For a metal, R = ρl/A with length l and area A essentially fixed, so resistance R is proportional to resistivity ρ. R (the reason) is true: the resistivity of metals increases with temperature. Then resistance must also increase, so A, which says resistance decreases, is false. A is false and R is true, so the key is D. Why: Resistance of a conductor depends on length, area and the material's resistivity, so a rise in resistivity raises resistance. R is therefore true but contradicts A, so it cannot explain A. This rules out option B, the nearest plausible error, which wrongly treats R as supporting A.

Topic and concept

Resistance of a conductor; factors affecting resistance; resistivity. The resistance of a conductor is R = ρl/A. For a metal of fixed length and area, resistance changes only through resistivity. Resistivity of metals increases as temperature rises, so resistance increases with temperature and does not decrease.

How marks are earned

1. The assertion is incorrect since metallic resistance increases with temperature; the reason is correct that resistivity increases with temperature. (1 mark)

Source check: Check the reasoning against NCERT Class 10 science, Ch. 11, §11.5 Factors affecting resistance: Resistivity of metals increases with temperature, raising resistance.

Question 33

2 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

The near point is the closest distance at which an object is seen distinctly without strain, about 25 cm for a normal young adult eye. The far point is the farthest distinct distance, which is at infinity for a normal eye.

Step by step

1. **Define the near point:** The near point is the nearest object position seen distinctly without strain; for a normal young adult eye, it is about 25 cm from the eye. Why: It is the least distance of distinct vision.
2. **Define the far point:** The far point is the farthest position seen distinctly without strain; for a normal eye it is at infinity. Why: Both the definition and the normal value are needed because the prompt asks for near and far points.

Topic and concept

Human eye; far point, near point; accommodation. A normal eye sees clearly from its near point, about 25 cm, to its far point at infinity. The near point is the closest distinct distance and the far point the farthest distinct distance.

How marks are earned

1. Define the near point as the nearest distance seen distinctly without strain and state about 25 cm. (1 mark)
2. Define the far point as the farthest distance seen distinctly without strain and state infinity for a normal eye. (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

Question 34

2 marks

Short Answer

Attempt one option.

Option A

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. **State the factors that the force on the conductor depends on:** The force on a current-carrying conductor is directly proportional to the magnetic field strength B, the current I in it, and the length l of the conductor within the field. It also depends on the angle θ between the field and the current direction, and the force is largest when the conductor is perpendicular to the field. Why: A stronger field, larger current or longer conductor in the field each gives a larger magnetic force. The angle matters because only the part of the current perpendicular to the field gives force, which is why the force is greatest at right angles.
2. **Write the relationship as an equation and note the Class X extension:** The relationship is F = B I l sin θ. At θ = 90° sin θ = 1, so the maximum force is F = B I l. The direction of the force is given by Fleming's left-hand rule. The sin θ form is an extension beyond the Class X text, which only states that the force is largest when the current is perpendicular to the field. Why: Combining the proportionalities to B, I, l and the angle gives one equation for the magnitude of force. Putting θ = 90° checks that it reduces to the maximum-force case. The left-hand rule fixes the direction, which the equation alone does not give.

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 sin θ. The force grows with B, I and l and is largest when the current is perpendicular to the field. Its 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 $F = B\,I\,l \sin\theta$. (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.

OR

Option B

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Work through marking point 1:** According to Ampère's circuital law, the magnitude of the magnetic field at a distance r from a long straight conductor carrying current I is given by $B = \mu_0 I/(2\pi r)$. Why: The magnetic field lines around a straight current-carrying conductor form concentric circles whose strength decreases with distance from the conductor.
2. **Work through marking point 2:** The SI unit of magnetic field is tesla (T), which is equivalent to $N \cdot A^{-1} \cdot m^{-1}$. Why: The magnetic field lines around a straight current-carrying conductor form concentric circles whose strength decreases with distance from the conductor.

Topic and concept

Magnetic field due to current-carrying conductor — straight wire. A straight conductor carrying current produces magnetic field lines in concentric circles around it, with direction given by the right-hand thumb rule.

How marks are earned

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

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

Question 35

3 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

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

Topic and concept

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

How marks are earned

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

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

Question 36

3 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

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

Topic and concept

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

How marks are earned

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

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

Question 37

3 marks

Short Answer

Answer the question with working and reasons where needed.

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

Answer

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

Step by step

1. **Define potential difference with its formula:** Potential difference between two points is the work done to move a unit positive charge from one point to the other. In symbols V = W/Q. For example, if W = 6 J is done to move Q = 2 C, then V = 6 J / 2 C = 3 V. Why: The definition measures energy transferred per unit charge, not per charge of any size. Dividing work by charge gives a value that depends only on the two points, so it can be compared across circuits.
2. **Explain how a battery maintains the potential difference:** A cell or battery maintains the potential difference between its terminals through chemical action. The chemical reaction supplies the energy that moves charges around the circuit, so current keeps flowing. Without this, the charges would equalise and the flow would stop. Why: Charges flow only when there is a potential difference between two points. The chemical action in the battery keeps that difference constant, so it is the source of the energy per unit charge in the circuit.
3. **Define the SI unit, check it, and name the instrument:** The SI unit is the volt (V). One volt is the potential difference when 1 joule of work is done to move 1 coulomb of charge, so 1 V = 1 J/C. A voltmeter measures it and is connected in parallel across the two points. Why: The unit follows directly from V = W/Q: joule divided by coulomb gives volt. A voltmeter is connected in parallel because the potential difference is measured across the two points, between which the charge moves.

Topic and concept

Electric potential difference and electric current; Ohm's law. Potential difference between two points is the work done per unit charge to move the charge from one point to the other, V = W/Q. Its SI unit is the volt, 1 V = 1 J/C. A battery maintains it.

How marks are earned

1. Potential difference between two points is the work done to move a unit positive charge from one point to the other. (1 mark)

2. This potential difference is maintained by a battery through chemical action that expends energy to move charges. (1 mark)
3. Its SI unit is volt, defined as one joule per coulomb of charge. (1 mark)

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

Question 38

4 marks

Case Based

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

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

Answer

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

Step by step

1. **State the pattern of field lines shown by the iron filings around a bar magnet:** The iron filings align along closed curves that emerge from the north pole of the bar magnet and enter its south pole. Inside the magnet the lines run from south to north, so they form closed loops. The lines never intersect and are crowded near the poles. Why: Each iron filing becomes a small magnet and lines up along the direction of the field at its position, so the filings trace the field lines. Lines crowd near the poles where the field is strongest, and they cannot cross because the field has one direction at each point.

Topic and concept

Magnetic field and field lines; bar magnet. Magnetic field lines of a bar magnet form closed loops that emerge from the north pole and enter the south pole outside the magnet. Iron filings align along them and show the region where the magnetic force acts.

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. **State the pattern shown by iron filings around the straight current-carrying conductor:** The iron filings arrange themselves in concentric circles around the straight conductor, in a plane perpendicular to the wire. The circles are closer together near the wire and farther apart away from it. The direction of the field is given by the right-hand thumb rule. Why: A current produces a magnetic field around the wire, and the filings align along it, so they show circular field lines centred on the wire. The field gets weaker with distance from the wire. The right-hand thumb rule gives the direction of the circles from the direction of the current.

Topic and concept

Magnetic field due to current-carrying conductor — straight wire. A straight conductor carrying current produces magnetic field lines in concentric circles around it, in planes perpendicular to the wire. The field is weaker farther from the wire, and its direction is given by the right-hand thumb rule.

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. **State the field-line shape at the centre of the circular loop:** At the centre of the current-carrying circular loop, the filings show the field lines as straight lines parallel to the axis of the loop, which means they are perpendicular to the plane of the loop. Why: Each small segment of the loop adds its own field, and at the centre these contributions point the same way along the axis. The net field is therefore strongest and most uniform there, so the lines look straight rather than circular.
2. **State the arrangement of field lines inside the solenoid:** Inside the long current-carrying solenoid, the filings show field lines that are parallel, closely spaced and nearly uniform, so the field is almost the same at every point inside. This pattern resembles the field of a bar magnet. Why: The turns of the solenoid are placed side by side, so their fields add up inside. Parallel, evenly spaced lines mean the field has constant direction and strength, which is what 'uniform' means.

Topic and concept

Magnetic field due to current-carrying conductor — circular loop. A current-carrying loop gives a field that is strongest and most uniform at its centre, where the lines are straight and perpendicular to the plane of the loop. A long solenoid is a set of many such turns, so inside it the lines are parallel and closely spaced, giving a nearly uniform field. Outside it the pattern resembles that of a bar magnet.

How marks are earned

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

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

OR

Option B

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

Answer

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

Step by step

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

Topic and concept

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

How marks are earned

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

Source check: Check the passage facts and NCERT Science X, Ch. 12, §12.1 Magnetic Field and Field Lines against both steps.

Question 39

5 marks

Long Answer

Attempt one option.

Option A

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

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

Answer

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

Step by step

1. **Identify the defect from the near point:** A person who cannot see objects closer than 1 m clearly has a near point of 1 m. The normal near point is 25 cm, and 1 m = 100 cm, which is greater than 25 cm. The defect is therefore hypermetropia (farsightedness). Why: In hypermetropia the focal point for near objects lies behind the retina, so close objects cannot be focused. The nearest clearly seen point moves farther away, which matches a near point of 1 m. This differs from myopia, where the far point is too close.
2. **Name the corrective lens:** The defect is corrected with a convex (converging) lens. It is chosen so that an object at 25 cm gives a virtual image at 1 m, which the eye can focus. Using $f = 1/(1/v - 1/u)$ with $u = -25$ cm and $v = -100$ cm gives $f = +33.3$ cm. So $P = 1/0.333$ m $\approx +3$ D, a positive power, which agrees with a convex lens. Why: The eye lens is too weak, or the eyeball too short, so extra converging power is needed. A convex lens converges the rays before they enter the eye. The image then appears at the eye's near point and falls on the retina. A concave lens would diverge the rays and make the problem worse.

Topic and concept

Defects of vision — myopia, hypermetropia, presbyopia; correction with lenses.
Hypermetropia is the defect in which close objects form images behind the retina, so near vision is blurred. It arises from insufficient lens power or a shortened eyeball. The near point moves beyond 25 cm, here to 1 m. A convex lens adds converging power and corrects it.

How marks are earned

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

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

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

Answer

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

Step by step

1. **State the causes of myopia:** Myopia occurs when the eyeball is too long or the eye lens has excessive curvature. Parallel rays from distant objects then converge before reaching the retina. Why: A long eyeball or a strongly curved lens makes the eye's converging power too great for its length. The rays are brought to a focus in front of the retina. This is the key difference from hypermetropia.
2. **State the effect on vision:** The image of a distant object forms in front of the retina instead of on it, so distant objects look blurred. Nearby objects can still be seen clearly. Why: A clear image needs the focus to fall exactly on the retina. If the focus lies in front of it, the rays spread out again and the retinal image is blurred. The person's far point is closer than infinity.
3. **Explain the correction with a concave lens:** A concave lens of suitable power is placed in front of the eye. It diverges the incoming parallel rays so that the eye lens can focus them exactly on the retina. This restores clear distance vision. Its focal length equals the far point distance with a negative sign. For example, if the far point is 50 cm, then f = −50 cm = −0.5 m, so P = 1/f = −2 D. Why: The concave lens reduces the converging power so that the focus moves back onto the retina. It makes distant objects appear to come from the far point, which the eye can focus. The negative sign of f and P shows a diverging lens.

Topic and concept

Defects of vision — myopia, hypermetropia, presbyopia; correction with lenses. Myopia is caused by an elongated eyeball or excessive lens curvature, so the image of a distant object forms in front of the retina. It is corrected by a concave lens of suitable power. This lens diverges parallel rays so that the eye lens focuses them on the retina and clear distant vision is restored.

How marks are earned

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

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

OR

Option B

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

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

Answer

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

Step by step

1. **Work through marking point 1:** Accommodation is the ability of the eye lens to change its focal length by altering its curvature through the action of ciliary muscles. Why: ciliary muscles change lens curvature to adjust focal length
2. **Work through marking point 2:** For near objects, ciliary muscles contract, making the lens thicker and decreasing its focal length, and for distant objects the muscles relax, making the lens thinner and increasing its focal length. Why: ciliary muscles change lens curvature to adjust focal length

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

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

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

Answer

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

Step by step

1. **Work through marking point 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. Why: ciliary muscle contraction makes lens thicker for near focus and relaxation makes it thinner for distant focus
2. **Work through marking point 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. Why: ciliary muscle contraction makes lens thicker for near focus and relaxation makes it thinner for distant focus
3. **Work through marking point 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. Why: ciliary muscle contraction makes lens thicker for near focus and relaxation makes it thinner for distant focus

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 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