

COMPETISHUN SCIENCE · CODE NO. 086**Sample Question Paper with Answers, Solutions and Marking Scheme Class X · 2026-27****Max. Marks: 80****Time Allowed: 3 hours**

General Instructions: (i) This question paper consists of 39 questions in 3 sections. Section A is Biology, Section B is Chemistry and Section C is Physics. (ii) All questions are compulsory. However, an internal choice is provided in some questions. A student is expected to attempt only one of the alternatives in these questions.

SECTION A — BIOLOGY**Question 1****1 Mark**

During photosynthesis, what happens to carbon dioxide and water as glucose is formed?

- A. Carbon dioxide gains hydrogen, while water loses electrons.
- B. Carbon dioxide loses oxygen, while water gains oxygen.
- C. Carbon dioxide is oxidised, while water is reduced.
- D. Both carbon dioxide and water undergo reduction.

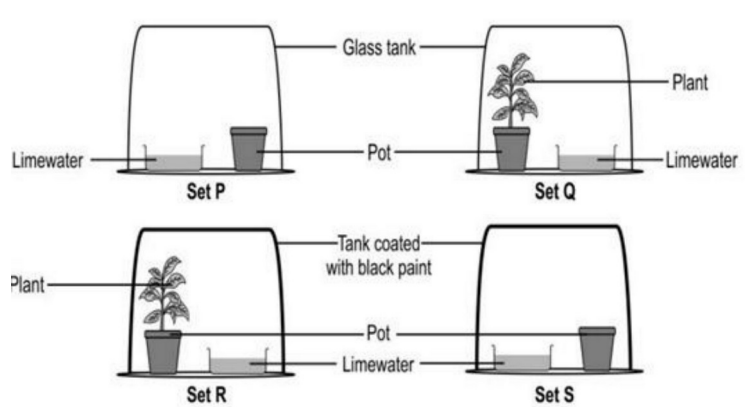
Answer and Solution A. Carbon dioxide gains hydrogen, while water loses electrons.

Gain of hydrogen is reduction, so carbon dioxide is reduced to glucose. Water loses electrons (and hydrogen), so water is oxidised to oxygen.

MARKING SCHEME Correct option — 1

Question 2**1 Mark**

Lime water turns cloudy in the presence of a gas, which is a by-product of respiration. Shown below are four setups kept in sunlight for 24 hours. In which setup is lime water expected to be the cloudiest?



- A. P
- B. Q
- C. R
- D. S

For visually impaired students

Which of the following statements is incorrect concerning the experiment to show that sunlight is necessary for photosynthesis?

- A. The leaf should be destarched before conducting the experiment.
- B. The leaf kept in darkness will show the presence of starch.
- C. The leaf exposed to sunlight will show the presence of starch.
- D. Starch is the end product of photosynthesis.

Answer and Solution C. R

Set R has a plant inside a tank coated with black paint, so no light reaches it. Photosynthesis stops but respiration continues, so carbon dioxide accumulates and the lime water turns cloudiest. In P and S there is no plant, and in Q the plant also photosynthesises and uses up the carbon dioxide.

For visually impaired students B. The leaf kept in darkness will show the presence of starch.

MARKING SCHEME Correct option — 1

Question 3

1 Mark

During urine formation, tubular reabsorption and secretion take place in the kidneys. Which of the following sets correctly indicates both the substances that are reabsorbed in the kidneys?

- A. Glucose and salts
- B. Glucose and starch
- C. Glycogen and salts
- D. Glycogen and starch

Answer and Solution A. Glucose and salts

Glucose and most salts are selectively reabsorbed from the nephron tubule back into the blood. Starch and glycogen are not present in the glomerular filtrate at all.

MARKING SCHEME Correct option — 1

Question 4

1 Mark

In a controlled experiment, the anthers of a mustard plant's flowers were carefully removed in the bud stage before they matured. The bud was covered with a paper bag.

What will be the most likely result for these flowers?

- A. They will still produce seeds and fruit through self-pollination.
- B. They will attract more insects and produce larger flowers but no fruit.
- C. They will not produce any seeds or fruits.
- D. They will produce seeds and fruits that are genetically identical to the parent.

Answer and Solution C. They will not produce any seeds or fruits.

Removing the anthers (emasculation) takes away the source of pollen, and the paper bag prevents pollen from any other flower reaching the stigma. With no pollination there is no fertilisation, so no seeds or fruits are formed.

MARKING SCHEME Correct option — 1

Question 5

1 Mark

The Vas deferens and the Oviduct are both targets for surgical contraception (Vasectomy and Tubectomy respectively). Analysing the process of reproduction, what common biological event is prevented by blocking both these structures?

- A. The production of gametes (sperm and egg).
- B. The implantation of the fertilized egg into the uterine wall.
- C. The successful meeting and fusion of the male and the female gametes.
- D. The release of hormones - testosterone and estrogen.

Answer and Solution C. The successful meeting and fusion of the male and the female gametes.

Both operations only block the passage of the gametes. Gametes are still produced and hormones are still released, but sperm and egg can no longer meet, so fertilisation is prevented.

MARKING SCHEME Correct option — 1

Question 6**1 Mark**

The male gamete of an apple plant has seventeen chromosomes. What is the number of chromosomes in the female gamete and in the cells of the adult plant respectively?

- A. 17, 17
- B. 17, 34
- C. 34, 34
- D. 34, 51

Answer and Solution B. 17, 34

Both gametes are haploid and carry the same number of chromosomes, so the female gamete also has 17. Fusion of the two gametes gives the diploid adult plant $17 + 17 = 34$ chromosomes.

MARKING SCHEME Correct option — 1

Question 7**1 Mark**

A fish living in a pond ecosystem feeds on small aquatic insects (larvae). These insect larvae, in turn, feed on green algae and small photosynthetic bacteria.

In this specific food chain, what is the trophic level classification of fish?

- A. Producer
- B. Primary Consumer
- C. Secondary Consumer
- D. Tertiary Consumer

Answer and Solution C. Secondary Consumer

The food chain is: algae and photosynthetic bacteria (producers) → insect larvae (primary consumers) → fish. The fish therefore occupies the third trophic level and is a secondary consumer.

MARKING SCHEME Correct option — 1

The following two questions consist of two statements — Assertion (A) and Reason (R). Answer these questions by selecting the appropriate option given below:

- A. Both A and R are true, and R is the correct explanation of A.
- B. Both A and R are true, and R is not the correct explanation of A.
- C. A is true but R is false.
- D. A is false but R is true.

Question 8**1 Mark**

Assertion (A): The rate of breathing in aquatic organisms is much lower than in the terrestrial organisms.

Reason (R): The amount of oxygen dissolved in water is less as compared to the amount of oxygen in air.

Answer and Solution D. A is false but R is true.

Water holds far less dissolved oxygen than air, so R is true. Precisely because of this, aquatic organisms must breathe faster, not slower, than terrestrial organisms — so A is false.

MARKING SCHEME Correct option — 1

Question 9**1 Mark**

Assertion (A): In an ecosystem, 1% of energy is available for transfer from one trophic level to the next.

Reason (R): An average of 10% of the food eaten by organisms is available for flow in the form of chemical energy.

Answer and Solution D. A is false but R is true.

By the ten per cent law, about 10% (not 1%) of the energy is passed on to the next trophic level, so A is false while R states the law correctly.

MARKING SCHEME Correct option — 1

Question 10

2 Marks

- A. Due to narrowing of the bile duct, the bile secretion from the liver to the small intestine was obstructed. How will the process of digestion be affected?
- B. How does the length of the intestine depend on the nature of food habit in different animals?

Answer and Solution

- A. Bile juice from the liver makes the food alkaline, which is necessary for the pancreatic enzymes to act. In addition, bile salts break fats into smaller globules, increasing the efficiency of enzyme action. If the bile duct is obstructed, it leads to improper digestion of fats.
- B. Herbivores eating grass need a longer small intestine to allow the cellulose to be digested. Meat is easier to digest, hence carnivores like tigers have a shorter small intestine.

MARKING SCHEME A — 0.5 + 0.5 · B — 1 = 2

Question 11

2 Marks

Students to attempt either option A or B.

- A. Which parts of the brain perform certain actions for which we do not have any thinking control? What are such actions called, give two examples.

OR

- B. How is the information of touch in the 'sensitive plant' controlled and coordinated?

Answer and Solution (Option A)

The actions on which we do not have any thinking control are controlled by the mid-brain and hind-brain. These are called involuntary actions. Examples (any two): blood pressure, salivation and vomiting.

Answer and Solution (Option B)

The information of touch is communicated by electrical-chemical means from cell to cell. Plant cells change shape by changing the amount of water in them, resulting in swelling or shrinking, thus changing shapes and causing movement.

MARKING SCHEME Either option — 2

Question 12

2 Marks

What changes are observed in the uterus subsequent to implantation of the young embryo in a human female?

Answer and Solution

- The uterine lining thickens and is richly supplied with blood vessels to nourish the embryo.
- A placental connection is developed between the uterus and the embryo.

MARKING SCHEME 2 marks — suggested distribution: 1 for each value point

Question 13

3 Marks

How do muscles move at the cellular level and respond when processed messages are received from the brain?

Answer and Solution

- When a nerve impulse reaches the muscle, the muscle cells move by changing their shape so that they shorten.

- Muscle cells have special proteins that change both their shape and their arrangement in the cell in response to nervous electrical impulses.
- When this happens, the new arrangement of these proteins gives the muscle cells a shorter form.

MARKING SCHEME 3 marks — suggested distribution: 1 for each value point

Question 14

3 Marks

Study the food chain given below:

Phytoplankton → Zooplankton → Small fishes → Large fish

- In the given food chain, the amount of energy available at the fourth trophic level is 10 kJ, what will be the energy available at the producer level?
- Is it possible to have three more trophic levels in the above food chain? Justify.
- Which of these trophic levels will have the maximum amount of pesticide, if it had washed down in the water body from agricultural fields. Why?

Answer and Solution

- 10 000 kJ
By the ten per cent law only one-tenth of the energy passes to the next trophic level, so moving back from the fourth level: 10 kJ → 100 kJ → 1000 kJ → 10 000 kJ at the producer level.
- No. The loss of energy at each step is so much that very little usable energy will be left.
- Large fish, due to biological magnification of the pesticide along the food chain.

MARKING SCHEME 3 marks — suggested distribution: A 1, B 1, C 1

Question 15

4 Marks

In order to study patterns of inheritance, Neha had performed typical Mendelian experiments with pea plants in the field. In experiment one, she crossed a pea plant having white flowers (vv) with another pea plant bearing violet flowers (VV). In another experiment, in addition to the colour of the flower she also focussed on the height of the pea plant. This time she crossed a pea plant having violet flowers and tall height (VVTT) with another pea plant having white flowers and short height (vvtt).

What percentage is expected for the following traits as a result of these experiments? Give a reason.

- Violet flowers in F_1 and F_2 generation in experiment one? (1)
- Tall height plants with white flowers in F_2 generation in experiment two? (1)
Attempt either sub-part C or D.
- Percentage of medium height plants with light violet flowers in F_1 and F_2 generations in experiment two? Give a reason.

OR

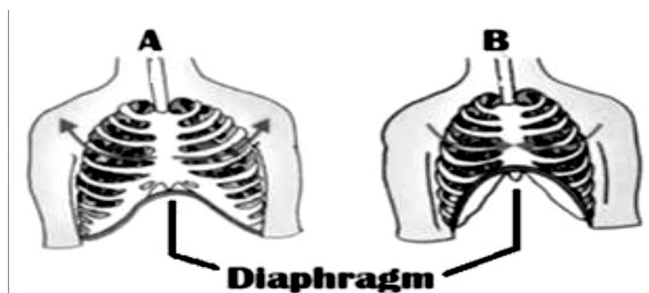
- Percentage of short height plants with white flowers in F_1 and F_2 generations in experiment two? (2)

Answer and Solution

- In experiment one, in F_1 all plants (100%) will have violet (Vv) flowers, and in F_2 , 75% (3/4) of the plants will have violet flowers (1/4 VV and 2/4 Vv), because violet colour of the flower is a dominant trait in the pea plant.
- 3/16 or 18.75% of the pea plants will have tall height and white flowers (vvTT / vvTt) — a combination of a dominant and a recessive trait.
- In pea plants no half-way characteristics are produced, because even a single copy of T or V produces the same result as two copies of T or V. Thus no plants with medium height and light violet flowers will be produced in the F_1 or F_2 generation (zero percent).
- In the F_1 generation all plants will have only dominant traits, so no plant with short height and white flowers (recessive traits) will be produced (zero percent). In the F_2 generation 1/16 or 6.25% of the plants will have short height with white flowers (vvtt), as both these traits are recessive.

MARKING SCHEME A — 1 · B — 1 · C or D — 2 = 4**Question 16****5 Marks***Attempt either option A or B.***A.** Observe the structure of hearts A, B and C shown below and answer the following questions.

- I. Which of the hearts depicted above is present in both birds and mammals and how are they able to maintain their body temperature? Give reason for your answer.
- II. Which of the hearts depicted above is present in fishes, how does circulation of blood take place in them?

OR**B.**

- I. Observe both the diagrams A and B. Which diagram indicates inhalation? Describe how it occurs.
- II. If diffusion were to move oxygen in our body, it is estimated that it would take 3 years for a molecule of oxygen to get to our toes from our lungs. Then, how is oxygen delivered to all parts of our body?

For visually impaired students

- A. I.** How many chambers are present in the hearts of birds and mammals and how are they able to maintain their body temperature? Give reason for your answer.
- A. II.** How many chambers are present in the heart of fishes, how does circulation of blood take place in them?

OR

- B. I.** Describe the process of inhalation and also mention how are the lungs designed in human beings to maximise the area for exchange of gases?
- B. II.** If diffusion were to move oxygen in our body, it is estimated that it would take 3 years for a molecule of oxygen to get to our toes from our lungs, then how is oxygen delivered to all parts of our body?

Answer and Solution (Option A)

- I. C — four-chambered heart.

The separation of the right side and the left side of the heart is useful to keep oxygenated and deoxygenated blood from mixing. Such separation allows a highly efficient supply of oxygen to the body. This is useful in animals that have high energy needs, such as birds and mammals, which constantly use energy to maintain their body temperature.

- II. A — two-chambered heart.

The blood is pumped to the gills, is oxygenated there, and passes directly to the rest of the body. Thus blood goes only once through the heart in the fish during one cycle of passage through the body.

Answer and Solution (Option B)

- I. A depicts inhalation.
 - Ribs get lifted.
 - Diaphragm is flattened.
 - The chest cavity becomes larger.
 - Air is sucked in.
- II. In human beings, the respiratory pigment haemoglobin has a very high affinity for oxygen. This pigment is present in the red blood corpuscles. This oxygen-rich blood is then pumped by the heart to the rest of the body.

For visually impaired students

- A. I. Four chambers are present. The separation of the right and the left side of the heart keeps oxygenated and deoxygenated blood from mixing, allowing a highly efficient supply of oxygen. This is useful in birds and mammals, which constantly use energy to maintain their body temperature.
- A. II. Two chambers are present. The blood is pumped to the gills, is oxygenated there, and passes directly to the rest of the body, so blood goes only once through the heart during one cycle.
- B. I. Ribs get lifted, the diaphragm is flattened, the chest cavity becomes larger and air is sucked in. The exchange of gases takes place on the surface provided by the alveoli, whose walls are supplied with an extensive network of blood vessels; the large number of alveoli maximises the area for gaseous exchange.
- B. II. Haemoglobin in the red blood corpuscles has a very high affinity for oxygen; this oxygen-rich blood is pumped by the heart to the rest of the body.

MARKING SCHEME Option A: I — 1 + 2 · II — 1 + 1 = 5 | Option B: I — 1 + (0.5 × 4) · II — 2 = 5

SECTION B — CHEMISTRY

Question 17

1 Mark

Chameleons contain crystals that reflect light and produce colour. Adjusting the spacing between these crystals, they can alter the wavelengths of light reflected, thus changing their skin colour. Based on the above information, we can infer that the change in colour by chameleons is a:

- A. chemical change because change in colour takes place.
- B. chemical change because wavelength of reflected light changes.
- C. physical change because the space between crystals is adjusted.
- D. physical change because light is reflected by crystals.

Answer and Solution C. physical change because the space between crystals is adjusted.

No new substance is formed in this process; only the spacing between the crystals changes, which alters the wavelength of the light reflected.

MARKING SCHEME Correct option — 1

Question 18

1 Mark

Rishita summarizes the chlor-alkali process in the following table.

Option	Product	Formed	Use
I	Hydrogen	At cathode	Used as a fuel
II	Chlorine	At anode	Used to make margarines
III	Sodium Hydroxide	Near cathode	To make soap

Option	Product	Formed	Use
IV	Sodium Hydroxide	Near anode	To make bleaching powder

Identify the options that are correctly matched.

- A. I, II and III
- B. I and III
- C. II and IV
- D. I, II, III and IV

Answer and Solution B. I and III

II and IV are incorrect: chlorine is produced at the anode, but it is not used to make margarine, and sodium hydroxide is deposited near the cathode, not the anode.

MARKING SCHEME Correct option — 1

Question 19

1 Mark

Manjeet wants to wash clothes, but the water available is hard. He compares the action of soap and detergent in hard water, to decide which one to use for washing his clothes. He observes:

- Soap forms scum in hard water.
- Detergent produces lather easily in hard water.

Which of the following inferences is correct?

- A. Ca^{2+} and Mg^{2+} ions react with soap, forming insoluble compounds, whereas detergents do not form such insoluble salts.
- B. Soap is acidic, and detergents are basic.
- C. Soap reacts with Na^+ ions in hard water to form scum while detergents do not react with Na^+ ions.
- D. Detergents form lather easily because they are ionic compounds and react with Ca^{2+} and Mg^{2+} ions while soaps do not react with hard water.

Answer and Solution A. Ca^{2+} and Mg^{2+} ions react with soap, forming insoluble compounds, whereas detergents do not form such insoluble salts.

Hard water contains calcium and magnesium ions. These form insoluble calcium and magnesium salts of fatty acids with soap, seen as scum. The calcium and magnesium salts of detergents remain soluble, so detergents lather freely.

MARKING SCHEME Correct option — 1

Question 20

1 Mark

Which of the following salts contain water of crystallisation:

- (i) Plaster of Paris (ii) Washing soda (iii) Baking soda (iv) Gypsum

- A. (i), (ii) and (iii)
- B. (i), (iii) and (iv)
- C. (ii), (iii) and (iv)
- D. (i), (ii) and (iv)

Answer and Solution D. (i), (ii) and (iv)

- Plaster of Paris is $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$
- Washing soda is $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
- Baking soda is NaHCO_3 — it has no water of crystallisation
- Gypsum is $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$

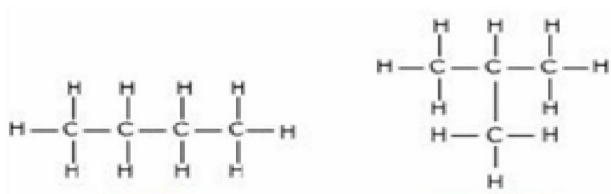
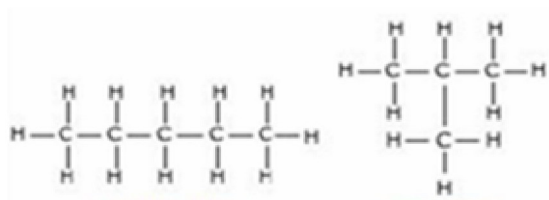
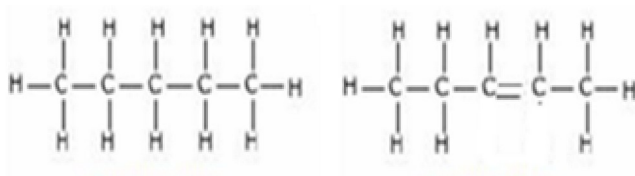
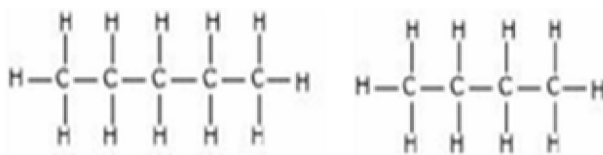
MARKING SCHEME Correct option — 1

Question 21

1 Mark

Which of the following pair of compounds are isomers?

- A.

**B.****C.****D.****For visually impaired students**

The unsaturated hydrocarbon with three carbon atoms is:

- A.** propene
- B.** propane
- C.** pentane
- D.** pentene

Answer and Solution A.

The two compounds in pair A are butane and 2-methylpropane. They have the same molecular formula (C_4H_{10}) but different structural formulae, so they are isomers. In the other pairs the two structures have different molecular formulae.

For visually impaired students A. Propene — it has three carbon atoms and a carbon-carbon double bond, so it is unsaturated.

MARKING SCHEME Correct option — 1**Question 22****1 Mark**

A food label is given below. E304 and E307b are added to the flavoured biscuits.



Which of the following is added to food packets for the same reason?

- A. salt
- B. vinegar
- C. nitrogen
- D. vanilla

For visually impaired students

In the food industry nitrogen is used as a/an

- A. preservative.
- B. oxidising agent.
- C. antioxidant.
- D. colouring agent.

Answer and Solution C. nitrogen

On the label, E304 and E307b are antioxidants. Nitrogen, being unreactive, keeps oxygen away from the food and so also acts as an antioxidant.

For visually impaired students C. antioxidant

MARKING SCHEME Correct option — 1

Question 23

1 Mark

Electrical wires made of aluminium

- A. corrode easily as aluminium is a very reactive metal.
- B. corrode easily because porous flaky aluminium oxide is formed.
- C. do not corrode easily as aluminium oxide forms a protective layer.
- D. do not corrode easily as aluminium is less reactive than metals like sodium, magnesium and zinc.

Answer and Solution C. do not corrode easily as aluminium oxide forms a protective layer.

Aluminium reacts with air to form a thin, hard, non-porous layer of aluminium oxide on its surface. This layer sticks firmly to the metal and prevents further corrosion.

MARKING SCHEME Correct option — 1

The following question consists of two statements — Assertion (A) and Reason (R). Answer this question by selecting the appropriate option given below:

- A. Both A and R are true, and R is the correct explanation of A.
- B. Both A and R are true, and R is not the correct explanation of A.
- C. A is true but R is false.
- D. A is false but R is true.

Question 24**1 Mark**

Assertion (A): Onion extract loses its smell, when it is added to baking soda solution whereas it retains its smell when added to lemon juice.

Reason (R): Onion acts as an olfactory indicator.

Answer and Solution B. Both A and R are true, and R is not the correct explanation of A.

Both statements are true. However, R only names onion as an olfactory indicator; it does not explain why the smell is lost specifically in a basic medium (baking soda solution) and retained in an acidic one (lemon juice).

MARKING SCHEME Correct option — 1

Question 25**2 Marks**

Carbon forms millions of compounds whereas silicon, which is just below it in the Periodic Table, forms a few compounds. Explain the reason for the difference in their ability to form compounds.

Answer and Solution

Carbon forms millions of compounds because it has a small atomic size; therefore it forms strong and stable C–C bonds, showing extensive catenation. Silicon, being larger in size, forms weaker Si–Si bonds and cannot show catenation to the same extent, so it forms fewer compounds.

MARKING SCHEME 2 marks — suggested distribution: carbon (small size, strong C–C bonds, catenation) 1, silicon (larger size, weak Si–Si bonds) 1

Question 26**3 Marks**

Attempt either option A or B.

- A.** An organic compound “X” with formula C_2H_6O is used to blend with petrol in order to reduce the dependence on fossil fuels and lower down the harmful emissions from the cars. It is also used as a solvent in medicines such as tincture iodine, cough syrups and many tonics.
- Draw the electron dot structure of “X”.
 - Write the name and formula of the next homologue of “X”.
 - Write the reaction of “X” with acetic acid to form a sweet smelling substance.

OR

- B.** Ramya performs an experiment in the following two steps:
- Step 1: Heats ethanol with conc. H_2SO_4 at $170^\circ C$ to get product A.
- Step 2: Passes hydrogen gas over product A, using Ni as a catalyst and gets product B.
- Name the products A and B.
 - Write the reactions involved in both the steps.

For visually impaired students

Attempt either option A or B.

- A.** An organic compound “X” with formula C_2H_6O is used to blend with petrol in order to reduce the dependence on fossil fuels and lower down the harmful emissions from the cars. It is also used as a solvent in medicines such as tincture iodine, cough syrups and many tonics.
- Name the compound “X”.
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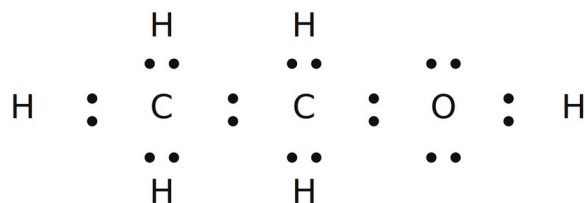
OR

- B.** Ramya performs an experiment in the following two steps:
- Step 1: Heats ethanol with conc. H_2SO_4 at $170^\circ C$ to get product A.
- Step 2: Passes hydrogen gas over product A, using Ni as a catalyst and gets product B.

- (i) Name the products A and B.
 (ii) Write the reactions involved in both the steps.

Answer and Solution (Option A)

- (i) "X" is ethanol, C_2H_5OH . Its electron dot structure is:



- (ii) Next homologue: propanol, C_3H_7OH
 (iii) Esterification with acetic acid gives the sweet-smelling ester ethyl ethanoate:



reaction condition: *conc. H_2SO_4*

Answer and Solution (Option B)

- (i) Product A — ethene; Product B — ethane
 (ii) Step 1 — dehydration of ethanol:



Step 2 — hydrogenation of ethene:



MARKING SCHEME Option A: (i) — 1 · (ii) — 0.5 + 0.5 · (iii) — 1 = 3 | Option B: (i) — 0.5 + 0.5 · (ii) — 1 + 1 = 3

Question 27**3 Marks**

Give reason for the following:

- A.** A solution of sports electrolyte drink conducts electricity, but coconut oil does not.
B. Milkiness disappears when excess of carbon dioxide is passed through lime water.
C. An iron bridge near the sea rusts much faster than an iron bridge located in a dry hilly region.

Answer and Solution

- A.** A sports drink contains ions (electrolytes) which help conduct electricity. Coconut oil does not contain ions, so it cannot conduct electricity.
B. Lime water turns milky due to the formation of insoluble calcium carbonate ($CaCO_3$). When excess CO_2 is passed, the calcium carbonate reacts further to form soluble calcium hydrogen carbonate, causing the milkiness to disappear.
C. Air near the sea contains high moisture (humidity), which speeds up rusting. In a dry hilly region moisture is low, so rusting occurs much more slowly.

MARKING SCHEME 1 mark for each part = 3

Question 28**4 Marks**

Aavya and Vihan are studying the properties of metals in school. They decide to design and conduct an experiment to test the relative conduction of heat by metals. They use the apparatus (Figure) with rods of five different metals — aluminium, silver, copper, iron and zinc — attached to a central point. This central point is heated using a burner. The metal rods are of equal length and thickness. They observe that the candles at the end of the rods fall at different times. (Study the graph.)



Figure 1 — Apparatus

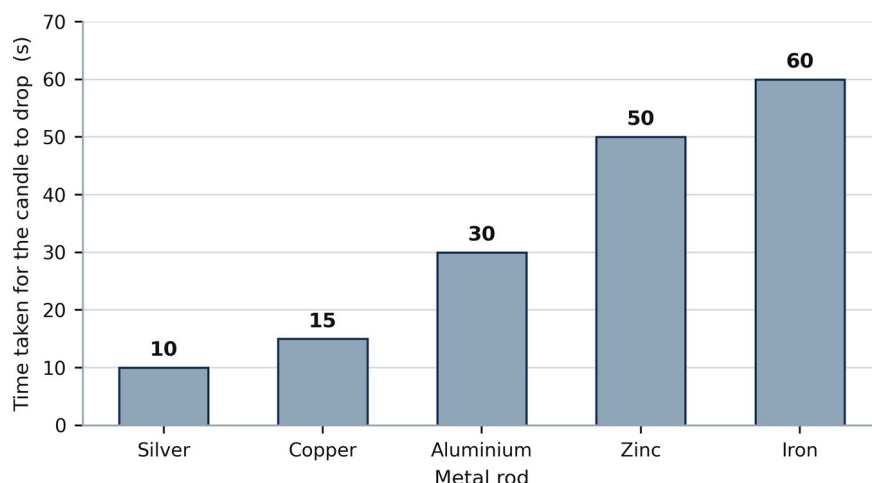


Figure 2 — Time taken for the candle to drop

- A.** On the basis of the graph obtained, which metal is the best conductor of heat?
- B.** Gold is a better conductor of heat than aluminium but it is not as good as copper. The time taken for the candle to drop if one of the rods were made of gold would have been:
(i) 15 s (ii) 20 s (iii) 35 s (iv) 10 s

Attempt either sub-part C or D.

- C.** The length of all the metal rods is increased by 20% without any change in the thickness. Will the time required for the candles to drop be affected? How and why?

OR

- D.** Mayank tries the experiment with an apparatus similar to Figure 1. He ensures the length of all metal rods is the same. However, the thickness of rods is not the same in his apparatus. Will the inference he draws on the basis of his experiment be correct? Justify your answer.

For visually impaired students

Rods of equal length and thickness made of five different metals — A, B, C, D and E — are used. A heat sensor is attached at one end of each rod; the other end is heated and the time required for the heat sensor to beep is noted. The sensor at the end of rod B beeps in 10 seconds, rod C in 15 seconds, rod A at 30 seconds, rod E in 50 seconds and rod D in 60 seconds.

- A.** On the basis of the experimental result, which metal is the best conductor of heat?
- B.** Metal G is a better conductor of heat than metal A but it is not as good as metal C. The time taken for the sensor to beep if one of the rods were made of G would have been: (i) 15 s (ii) 20 s (iii) 35 s (iv) 10 s
- C.** The length of all the metal rods is increased by 20% without any change in the thickness. Will the time required for the sensor to beep be affected? How and why?

OR

- D.** Mayank tries the experiment with little variation. He keeps the length of all the rods of the same length, but, the thickness of rods is not the same. Will the inference he draws on the basis of his experiment be correct? Justify your answer.

Answer and Solution

- A.** Silver — its candle drops first, in 10 s, so it conducts heat fastest.
- B.** (ii) 20 s — gold lies between copper (15 s) and aluminium (30 s), so its time must lie between these two values.
- C.** Yes, the time required for the candles to drop will increase for all the metals, but the order in which they fall will remain the same. In conduction, particles vibrate and transfer heat to one another; heat now has to travel a longer distance, so conduction from one end to the other takes more time.
- D.** No, if the thickness of the rods is changed the inference will not be correct. The dimensions of the rods have to be the same for a fair comparison. A thicker rod will take more time to conduct heat.

For visually impaired students A — Metal B. B — (ii) 20 s. C and D as above, with “sensor beeping” in place of “candle dropping”.

MARKING SCHEME A — 1 · B — 1 · C or D — 2 = 4

Question 29**5 Marks**

Attempt either option A or B.

A.

- I.** Refer to the dialogue between Alisha, Drishti and Bhushan in the chemistry lab. They are discussing rusting of iron and formation of ammonia gas. Who all do you agree with and why?

Alisha: The formation of ammonia by reaction of nitrogen with hydrogen is a reduction reaction.

Drishti: Both rusting of iron and formation of ammonia are redox reactions.

Bhushan: Rusting of iron is an oxidation reaction.

- II.** Assess the following chemical equations. Identify the error(s) and rewrite the equation after correction.
- (i) $\text{MgCl}_2 + \text{AgNO}_3 \rightarrow \text{AgCl}_2 + \text{MgNO}_3$
- (ii) $\text{Al} + \text{H}_2\text{SO}_4 \rightarrow \text{Al}_2\text{SO}_4 + \text{H}_2\text{O}$

OR**B.**

- I.** Refer to the dialogue between Daljeet and Avik in the chemistry lab. They have learnt about decomposition reactions. Who has understood decomposition reactions correctly? Justify your answer.

Daljeet: During a decomposition reaction, a substance decomposes to give two simpler compounds. MgCO_3 decomposes on heating to magnesium oxide and carbon dioxide.

Avik: No, during a decomposition reaction, a substance decomposes to give two elements. Water on electrolysis gives hydrogen and oxygen, both are elements.

- II.** Analyse the observations given in the following two cases. Are these observations correct? Give reasons to support your answer.
- (i) Iron filings are added to an aqueous solution of magnesium sulphate. Observation: The colourless solution turns greenish due to formation of iron sulphate.
- (ii) Aluminium metal is added to dilute sulphuric acid. Observation: Brisk effervescence is seen due to evolution of a gas.

Answer and Solution (Option A)

- I.** Drishti is correct. (Alisha and Bhushan are only partially correct.) Oxidation and reduction go hand in hand. In the formation of ammonia, nitrogen is reduced while hydrogen is oxidised. In the rusting of iron, iron is oxidised while oxygen is reduced. Both are therefore redox reactions.
- II.** The errors are in the formulae of the products and in the balancing:
- (i) $\text{MgCl}_2 + 2\text{AgNO}_3 \rightarrow 2\text{AgCl} + \text{Mg}(\text{NO}_3)_2$
- (ii) $2\text{Al} + 3\text{H}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{H}_2$

Answer and Solution (Option B)

- I. Both have understood decomposition only partially. A decomposition reaction is one in which a single substance breaks down into simpler substances. The single substance undergoing decomposition has to be a compound, while the products formed can be either elements or compounds. MgCO_3 decomposes on heating to magnesium oxide and carbon dioxide; even though both products are compounds, it is decomposition. Water on electrolysis gives hydrogen and oxygen, both of which are elements; this is also a decomposition reaction.
- II. (i) Incorrect observation — iron is less reactive than magnesium, so it cannot displace magnesium from magnesium sulphate and no reaction takes place.
 (ii) Hydrogen gas is formed, which produces only a few bubbles. Brisk effervescence is observed when carbon dioxide is formed.

MARKING SCHEME Option A: I — 1 + 2 · II — 1 + 1 = 5 | Option B: I — 2 + 1 · II — 1 + 1 = 5

SECTION C — PHYSICS**Question 30****1 Mark**

A student wants to determine the focal length of a convex lens using sunlight. Which of the following practical procedures will give the most accurate result?

- A. Move the lens close to a wall and measure the blurred circle.
 B. Hold the lens above a sheet of paper and adjust until the smallest, brightest spot is formed.
 C. Measure the thickness of the lens with a scale.
 D. Look through the lens at a distant object.

Answer and Solution B. Hold the lens above a sheet of paper and adjust until the smallest, brightest spot is formed.

Sunlight reaches the lens as a parallel beam, so it converges at the principal focus. The sharpest, brightest spot marks the focus, and the distance of the paper from the lens is then the focal length.

MARKING SCHEME Correct option — 1

Question 31**1 Mark**

An electrical appliance rated 1000 W is operated at 250 V. What current does it draw?

- A. 0.25 A
 B. 2.5 A
 C. 4.0 A
 D. 10 A

Answer and Solution C. 4.0 A

Using $P = VI$:

$$I = P/V = (1000 \text{ W})/(250 \text{ V}) = 4.0 \text{ A}$$

MARKING SCHEME Correct option — 1

The following question consists of two statements — Assertion (A) and Reason (R). Answer this question by selecting the appropriate option given below:

- A. Both A and R are true, and R is the correct explanation of A.
 B. Both A and R are true, and R is not the correct explanation of A.
 C. A is true but R is false.
 D. A is false but R is true.

Question 32**1 Mark**

Assertion (A): The apparent depth of a coin in water is less than its real depth.

Reason (R): Light bends away from the normal when it travels from water to air.

Answer and Solution A. Both A and R are true, and R is the correct explanation of A.

Rays from the coin bend away from the normal as they leave the denser water for the rarer air. To the eye these emergent rays appear to come from a point nearer the surface, so the coin seems to be at a smaller depth.

MARKING SCHEME Correct option — 1

Question 33

2 Marks

- A. State Snell's Law of refraction.
- B. Define the refractive index of a material with respect to another material giving the mathematical expression.

Answer and Solution

- A. The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant, for light of a given colour and for the given pair of media.

$$(\sin i)/(\sin r) = \text{constant}$$

- B. Consider a ray of light travelling from medium 1 into medium 2. Let v_1 be the speed of light in medium 1 and v_2 the speed of light in medium 2. The refractive index of medium 2 with respect to medium 1 is the ratio of the speed of light in medium 1 to the speed of light in medium 2:

$$n_{21} = v_1/v_2 \quad (\text{speed in medium 1} \div \text{speed in medium 2})$$

MARKING SCHEME A — 1 · B — 1 = 2

Question 34

2 Marks

Attempt either option A or B.

A.

- I. State Joule's Law of heating.
- II. What happens to the heat produced in a conductor if the resistance is doubled while keeping other variables constant?

OR

B.

- I. Define resistivity.
- II. Justify with an example why resistivity is an intrinsic property of a material.

Answer and Solution (Option A)

- I. Joule's law of heating: the heat produced in a resistor is
 - (i) directly proportional to the square of the current for a given resistance,
 - (ii) directly proportional to the resistance for a given current, and
 - (iii) directly proportional to the time for which the current flows through the resistor.

$$H = I^2 R t$$

where I is the current, R the resistance and t the time.

- II. If the resistance is doubled while the current and time are unchanged:

$$H' = I^2 (2R) t = 2I^2 R t = 2H$$

That is, the heat produced is doubled.

Answer and Solution (Option B)

- I. The resistivity (ρ) of a material is the resistance of a conductor of that material having unit length and unit cross-sectional area. Since $R = \rho L/A$,

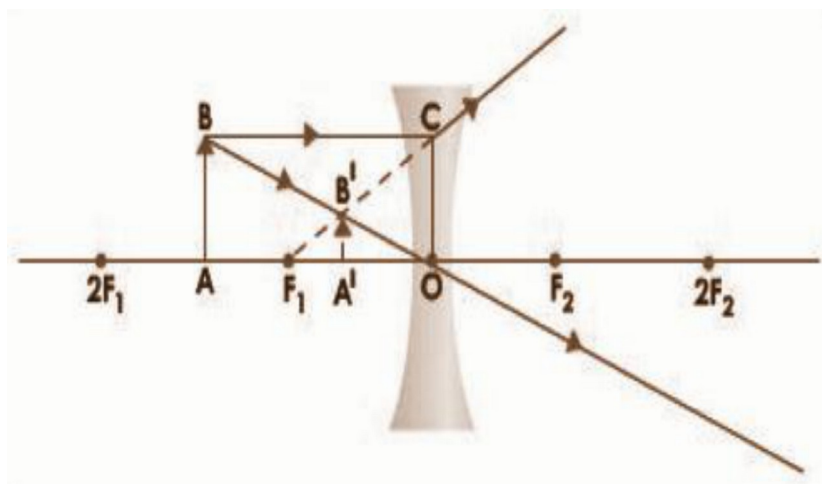
$$\rho = RA/L$$

where R is the resistance of a wire of length L and cross-sectional area A .

- II. Resistivity depends only on the material (and its temperature), not on the dimensions of the sample. For example, two copper wires of different lengths and thicknesses have different resistances, but both give the same value of ρ when it is computed as RA/L .

MARKING SCHEME Either option: I — 1 · II — 1 = 2**Question 35****3 Marks**

A concave lens forms an image that is $\frac{1}{3}$ rd the size of the object, as shown in the diagram. If the object is placed 24 cm in front of the lens, determine:

*Not to scale*

- A. the type of lens.
- B. the image distance.
- C. the focal length of the lens.

For visually impaired students

A student places an object 24 cm from a convex lens of focal length 12 cm. Calculate the image position and determine whether the image is real or virtual.

Answer and Solution

- A. The lens is a concave (diverging) lens, as stated in the question. Object distance $u = -24$ cm (the object is in front of the lens).
- B. Magnification is

$$m = h_i/h_o = v/u$$

A concave lens always forms an erect, diminished, virtual image, so $m = +1/3$. Therefore

$$v = mu = \frac{1}{3} \times (-24 \text{ cm}) = -8 \text{ cm}$$

The image is formed 8 cm from the lens, on the same side as the object — it is virtual.

- C. Using the lens formula

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Substituting $v = -8$ cm and $u = -24$ cm:

$$\frac{1}{f} = \frac{1}{(-8)} - \frac{1}{(-24)} = -\frac{1}{8} + \frac{1}{24} = \frac{(-3 + 1)}{24} = -\frac{2}{24} = -\frac{1}{12}$$

$$f = -12 \text{ cm}$$

The negative sign confirms that the lens is diverging.

For visually impaired students Object 24 cm from a convex lens of focal length 12 cm:

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{12} + \frac{1}{(-24)} = \frac{(2 - 1)}{24} = \frac{1}{24}$$

$v = +24$ cm — the image is real and is formed on the opposite side of the lens.

MARKING SCHEME A — 1 · B — 1 · C — 1 = 3 | Visually impaired version: working — 2 · nature of image — 1 = 3

Question 36**3 Marks**

- A. State the Right-Hand Thumb Rule and describe how it helps determine the direction of magnetic field around a current-carrying conductor.
- B. Explain how the magnetic field changes with distance from the conductor.

Answer and Solution

- A.** Right-hand thumb rule: imagine that you are holding a current-carrying straight conductor in your right hand such that the thumb points in the direction of the current. Then your fingers wrap around the conductor in the direction of the magnetic field lines. So, if the thumb of the right hand points along the conventional current, the curled fingers give the direction of the magnetic field lines around the conductor. This is how the direction of the field at any point is found.
- B.** The magnetic field produced by a long straight current-carrying conductor at a point is directly proportional to the current and inversely proportional to the distance r of that point from the conductor:

$$B \propto I/r$$

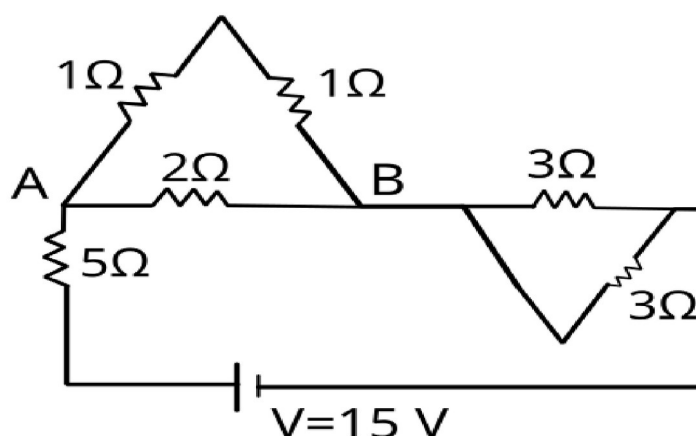
So the field becomes weaker as we move away from the conductor, and the concentric field circles are drawn farther apart.

MARKING SCHEME A — 1 + 1 · B — 1 = 3

Question 37

3 Marks

The figure shows a circuit with a 15 V battery connected to several resistors. Using the given circuit diagram:



- A.** Find the total current supplied by the battery.
B. Calculate the potential difference between points A and B.

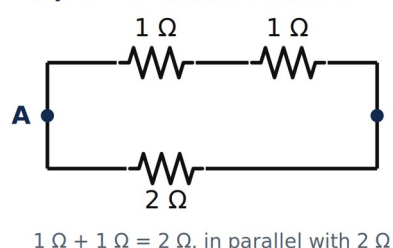
For visually impaired students

A 15 V battery is connected in series with three resistors of 2 Ω, 3 Ω and 5 Ω. Calculate:

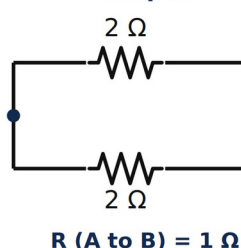
- A.** The total resistance in the circuit.
B. The total current supplied by the battery.
C. The voltage drop across the 3 Ω resistor.

Answer and Solution

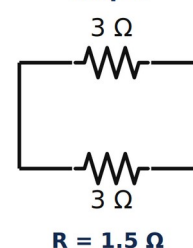
Step 1 — between A and B



Step 2



Step 3



Reducing the network step by step

- A.** Between A and B, the two 1 Ω resistors are in series ($1\ \Omega + 1\ \Omega = 2\ \Omega$) and this combination is in parallel with the 2 Ω resistor:

$$1/R_{a^b} = 1/2 + 1/2 = 1 \quad R_{a^b} = 1 \, \Omega$$

The two $3 \, \Omega$ resistors on the right are also in parallel:

$$1/R = 1/3 + 1/3 = 2/3 \quad R = 1.5 \, \Omega$$

The $5 \, \Omega$ resistor, the $1 \, \Omega$ combination and the $1.5 \, \Omega$ combination are now in series:

$$\text{Total resistance } R_s = 5 \, \Omega + 1 \, \Omega + 1.5 \, \Omega = 7.5 \, \Omega$$

Applying Ohm's law to the whole circuit:

$$I = V/R_s = (15 \, \text{V})/(7.5 \, \Omega) = 2 \, \text{A}$$

- B.** The whole current of $2 \, \text{A}$ flows through the section between A and B, whose resistance is $1 \, \Omega$:

$$V_{a^b} = I \times R_{a^b} = 2 \, \text{A} \times 1 \, \Omega = 2 \, \text{V}$$

For visually impaired students

A. Total resistance $= 2 \, \Omega + 3 \, \Omega + 5 \, \Omega = 10 \, \Omega$

B. $I = V/R = 15/10 = 1.5 \, \text{A}$

C. Voltage across the $3 \, \Omega$ resistor $= I \times 3 \, \Omega = 1.5 \times 3 = 4.5 \, \text{V}$

MARKING SCHEME A — 2 · B — 1 = 3 | Visually impaired version: A — 1 · B — 1 · C — 1 = 3

Question 38

4 Marks

A school has installed an automatic electromagnetic door-locking system at the main entrance. The locking mechanism uses a solenoid controlled by a switch at the security desk. When electricity flows through the solenoid, it creates a magnetic field strong enough to pull an iron bolt, unlocking the door. As soon as the switch is turned off, the magnetic field disappears, and a spring pushes the bolt back, locking the door.

- A.** Why is an iron core kept inside the solenoid in this locking mechanism?
B. How can we determine the magnetic poles in this solenoid?

Attempt either subpart (C) or (D).

- C.** If the current in the solenoid is increased from $1 \, \text{A}$ to $2 \, \text{A}$, explain how the magnetic effect changes and its effect on unlocking the door.

OR

- D.** If the source of the current is fixed, how can we increase the magnetic field in the solenoid?

For visually impaired students

A student places a small magnetic compass on a wooden table and aligns it so that the compass needle points naturally toward North-South. She then stretches a straight charging cable above the compass so that the wire is parallel to the compass needle. When the phone charger is switched on and current begins to flow through the wire, the compass needle deflects away from its North-South position.

- A.** What causes the compass needle to deflect when current flows through the wire?
B. What happens to the compass needle when the current in the wire is switched off?
C. Explain how the amount of current in the wire affects the magnitude of deflection of the compass needle.

OR

- D.** When the direction of current is reversed, the compass deflects in the opposite direction. Explain how the Right-Hand Thumb Rule accounts for this change.

Answer and Solution

- A.** An iron core placed inside the solenoid concentrates and amplifies the magnetic field, producing a stronger pulling force on the bolt.
B. By using the right-hand thumb rule: curl the fingers of your right hand in the direction of the current in the turns; the thumb then points towards the north pole of the solenoid. Alternatively, bring a bar magnet with a known north pole towards one end of the solenoid — repulsion indicates that this end is the north pole.

- C. If the current increases, the magnetic field B inside the solenoid also increases, because the field is directly proportional to the current. As the magnetic field increases, a stronger magnetic pull acts on the bolt and the door is unlocked more effectively.
- D. Increase the number of turns N of the coil, reduce the length of the coil, or insert a soft iron core. (Any two points.)

For visually impaired students

- A. The compass needle is influenced by the magnetic field developed around the current-carrying conductor, hence it shows a deflection.
- B. It aligns itself again with the Earth's magnetic field, in the north-south direction.
- C. The deflection increases as the current increases, because the magnetic field around a current-carrying conductor is directly proportional to the current flowing through it.
- D. When the direction of the current is reversed, the fingers of the right hand curl the opposite way, so the direction of the magnetic field is reversed. The compass needle, being a tiny magnet, aligns with the new field and therefore deflects in the opposite direction.

MARKING SCHEME A — 1 · B — 1 · C or D — 2 = 4

Question 39

5 Marks

Attempt either option A or B.

A.

- I. What is meant by accommodation of the human eye?
- II. What is the near point of a normal eye and what does it signify?
- III. Name which type of lens is used to correct the defect in which a person cannot see distant objects clearly.
- IV. Draw a diagram to show how the choice of your lens in (III) helps to see distant objects clearly.

OR

B.

- I. What is dispersion of light?
- II. Which colour of light deviates the least during dispersion through a prism?
- III. State why the sky appears dark to an astronaut in outer space.
- IV. Draw a simple labelled diagram to show how white light splits into different colours while passing through a glass prism.

For visually impaired students

A.

- I. What is meant by hypermetropia (long-sightedness)?
- II. What is the far point of a normal human eye and what does it signify?
- III. Name the type of lens used to correct hypermetropia.
- IV. Explain why a hypermetropic eye is unable to focus nearby objects on the retina.

OR

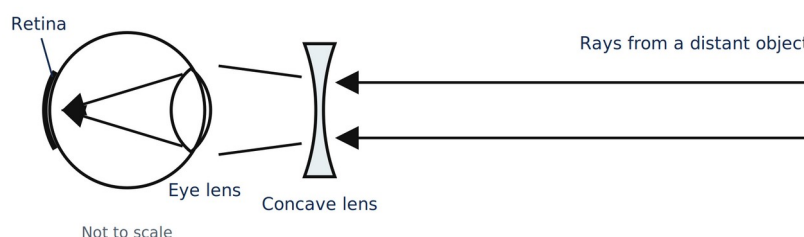
B.

- I. Why does Earth's atmosphere exhibit Tyndall's effect?
- II. Which colour of light has the shortest wavelength?
- III. Why do danger/stop signs use red colour?
- IV. State why the sky appears blue even though sunlight is white.

Answer and Solution (Option A)

- I. Accommodation is the ability of the eye lens to change its focal length, so that objects at different distances are focused sharply on the retina.

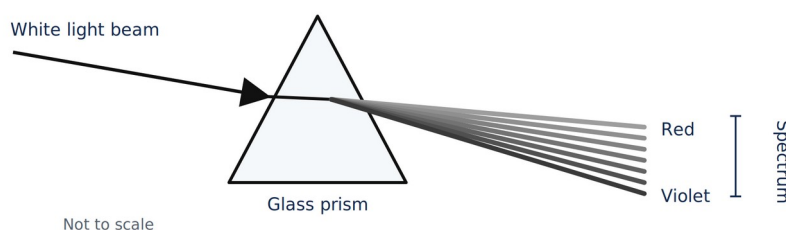
- II. The near point is the nearest point at which an object can be seen distinctly — about 25 cm for a normal eye. It signifies the closest distance at which comfortable, clear vision is possible.
- III. A diverging (concave) lens is used; this defect is myopia or short-sightedness.
- IV. Correction of myopia by a concave lens:



The concave lens diverges the parallel rays from a distant object so that the eye lens can bring them to a focus on the retina. Not to scale.

Answer and Solution (Option B)

- I. Dispersion is the splitting of white light into its component colours, because light of different wavelengths is refracted through different angles.
- II. Red light deviates the least, as it has the longest wavelength.
- III. There is no atmosphere in outer space to scatter sunlight, so no scattered light reaches the astronaut's eyes from the surroundings and the sky appears dark.
- IV. Dispersion of white light by a glass prism:



White light entering the prism is split into the spectrum from red (least deviated) to violet (most deviated). Not to scale.

For visually impaired students

- A. I. Hypermetropia is a defect of vision in which a person can see distant objects clearly but cannot see nearby objects clearly.
- A. II. The far point of a normal human eye is at infinity. It signifies that a normal eye can see objects clearly even when they are extremely far away.
- A. III. A convex (converging) lens is used to correct hypermetropia.
- A. IV. A hypermetropic eye cannot focus nearby objects on the retina because the eyeball is too short, or the eye lens is not converging enough. As a result the image of a nearby object forms behind the retina instead of on it. A convex lens increases the convergence of light so that the image forms on the retina.
- B. I. The Earth's atmosphere is a heterogeneous mixture of minute particles — smoke, tiny water droplets, suspended dust and molecules of air. When a beam of light strikes these fine particles, the path of the beam becomes visible. This scattering of light by colloidal particles gives rise to the Tyndall effect.
- B. II. Violet light has the shortest wavelength.
- B. III. Red light is the least scattered by air because it has the longest wavelength, so it remains visible over long distances even in fog, smoke or dust. Hence red is chosen for alert and stop signals.
- B. IV. Sunlight is white, but when it enters the atmosphere the smaller particles of air scatter the shorter wavelengths (blue and violet) much more strongly than the longer ones. Our eyes are more sensitive to blue than to violet, so the sky appears blue.

MARKING SCHEME Either option: I — 1 · II — 1 · III — 1 · IV — 2 = 5