

SCIENCE - CODE NO. 086
SAMPLE QUESTION PAPER - 1 : STEP-BY-STEP SOLUTIONS & 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** (Q.1-16, 30 marks), **Section B is Chemistry** (Q.17-29, 25 marks) and **Section C is Physics** (Q.30-39, 25 marks).
- (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 such questions.
- (iii) Multiple choice and Assertion-Reason questions carry 1 mark each. Other questions carry 2, 3, 4 (case/source-based) or 5 marks, as indicated against each question.
- (iv) Answers should be brief and to the point. Draw neat, labelled diagrams wherever required.
- (v) Use of calculators is not permitted.

SECTION - A (BIOLOGY)

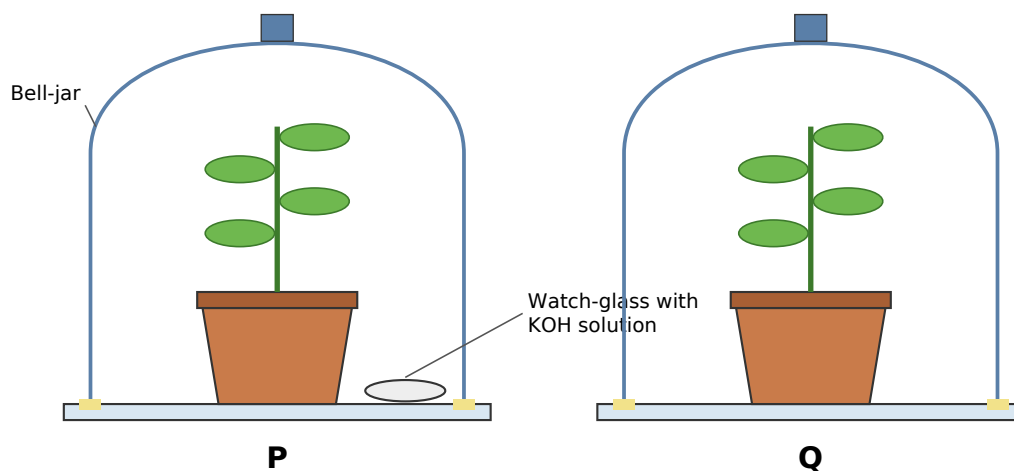
Questions 1 to 16

- 1.** A sprinter develops painful muscle cramps at the end of a 100 m race. Which substance has accumulated in the muscle cells, and why? **1**
- A. Ethanol - formed in mitochondria in the presence of oxygen
 - B. Lactic acid - formed from pyruvate due to lack of oxygen
 - C. Pyruvate - formed because glucose was not broken down
 - D. Carbon dioxide - formed due to excess oxygen

Solution:

Ans: B - During sudden activity, muscle cells lack oxygen, so pyruvate is converted into lactic acid; its build-up causes cramps. [1]

2. Two de-starched potted plants, P and Q, are set up as shown in the figure and kept in sunlight for two hours. A leaf from each plant is then tested with iodine solution. Which observation is correct? 1



Both set-ups sealed air-tight with vaseline and kept in sunlight

- A. Both leaves turn blue-black.
- B. Leaf of P turns blue-black; leaf of Q does not.
- C. Leaf of Q turns blue-black; leaf of P does not.
- D. Neither leaf turns blue-black.

Solution:

Ans: C - KOH absorbs CO_2 in bell-jar P, so plant P cannot photosynthesise and makes no starch; plant Q makes starch. This shows CO_2 is necessary for photosynthesis. [1]

3. The stomatal pore opens when 1
- A. guard cells lose water and shrink
 - B. guard cells absorb water and swell
 - C. epidermal cells divide rapidly
 - D. the plant needs to lose less water

Solution:

Ans: B - Guard cells swell when water flows into them, opening the pore; they shrink to close it. [1]

4. The blood sugar level of a person remains very high even after a meal low in sugar. The gland and the hormone most likely involved are 1
- A. thyroid - thyroxin
 - B. pancreas - insulin
 - C. adrenal - adrenaline
 - D. pituitary - growth hormone

Solution:

Ans: B - Insulin from the pancreas regulates blood sugar; if not secreted in proper amounts, blood sugar rises (diabetes). [1]

5. A gardener wants new rose plants that bear flowers early and are exactly like an excellent parent plant. The best method is 1
- A. growing plants from seeds obtained by cross-pollination
 - B. vegetative propagation such as layering or grafting
 - C. spore formation
 - D. fragmentation of the parent plant

Solution:

Ans: B – Vegetatively propagated plants flower earlier and are genetically similar to the parent, keeping all its characteristics. [1]

6. A normal human egg cell contains 1
- A. 22 autosomes + X
 - B. 22 autosomes + Y
 - C. 44 autosomes + XX
 - D. 23 autosomes + X

Solution:

Ans: A – Gametes carry one chromosome of each pair: 22 autosomes + one sex chromosome; the mother (XX) gives only X. Total 23. [1]

7. Which step was taken worldwide to protect the ozone layer? 1
- A. Banning the use of all plastic bags
 - B. Making it mandatory to manufacture CFC-free refrigerators
 - C. Increasing the use of chemical fertilisers
 - D. Burning garbage instead of dumping it

Solution:

Ans: B – After the 1987 UNEP agreement to freeze CFC production, CFC-free refrigerators were made mandatory. [1]

The following question(s) consist of two statements – Assertion (A) and Reason (R). Answer 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.
8. **Assertion (A):** Plants raised by vegetative propagation can bear flowers and fruits earlier than plants produced from seeds. 1
- Reason (R):** Vegetative propagation produces offspring showing a large amount of variation.
- Solution:**
- Ans: C** – A is true. R is false: vegetatively propagated plants are genetically similar to the parent; sexual reproduction creates more variation. [1]
9. **Assertion (A):** In fishes, blood goes through the heart only once during one cycle of passage through the body. 1
- Reason (R):** The fish heart has two chambers; blood pumped to the gills is oxygenated there and passes directly to the rest of the body.
- Solution:**
- Ans: A** – Both true and R explains A (single circulation). [1]

10. A person eats a meal rich in fats.

2

A. Name the two juices that act on these fats in the small intestine and state the role of each.

B. What are the end-products of fat digestion?

Solution:

A. Bile juice (from the liver): makes the food alkaline and its bile salts **emulsify** large fat globules into smaller ones, increasing the efficiency of enzyme action. [$\frac{1}{2}$] **Pancreatic juice**: contains **lipase**, which breaks down emulsified fats. [$\frac{1}{2}$]

B. Intestinal juice finally converts fats into **fatty acids and glycerol**. [1]

11. Students to attempt either option A or B.

2

A. The flow chart shows the sequence of events when a hand touches a hot vessel.

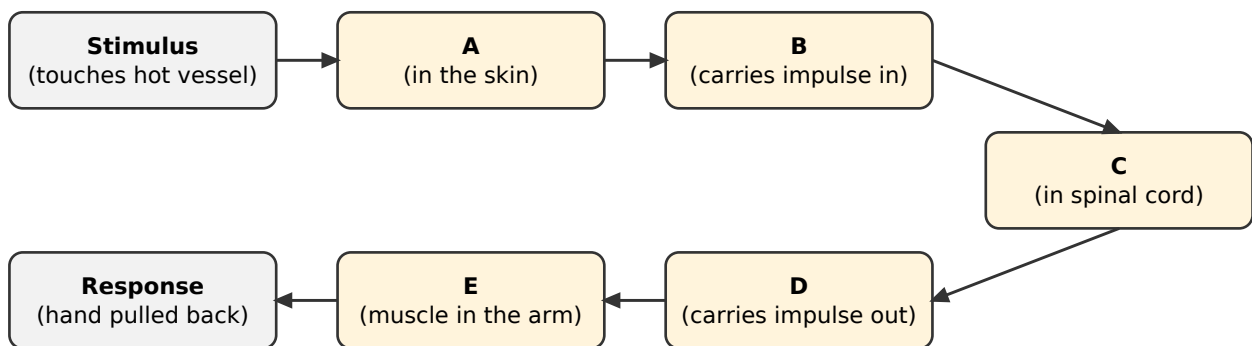


Figure: Sequence of events in a reflex action

(i) Name the parts labelled B and D. (ii) Why is this pathway formed in the spinal cord rather than in the brain?

OR

B. Name the plant hormone responsible for each of the following: (i) bending of a shoot towards light, (ii) promoting cell division in fruits and seeds, (iii) wilting of leaves, (iv) growth of the stem along with auxin.

Solution:

A. (i) B = **sensory neuron** (carries impulse from the receptor); D = **motor neuron** (carries impulse to the muscle). [$\frac{1}{2}$ + $\frac{1}{2}$]

(ii) Nerves from all over the body meet in a bundle in the **spinal cord** on their way to the brain; connecting input and output nerves there gives a **quick response** without waiting for the slower thinking process of the brain (this pathway is a reflex arc). [1]

OR

B. (i) **Auxin** (ii) **Cytokinin** (iii) **Abscisic acid** (iv) **Gibberellin**. [$\frac{1}{2}$ $\times$ 4]

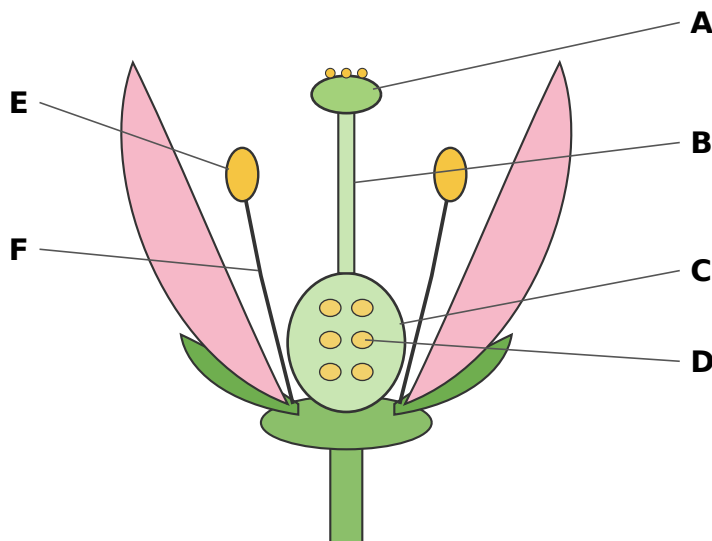


Figure: Longitudinal section of a flower

A. Name the parts labelled A and C. Which labelled parts together form the stamen?

B. What do the parts labelled D and C develop into after fertilisation?

Solution:

A. A = **stigma**; C = **ovary**. [$\frac{1}{2}$] The stamen is formed by **E (anther)** and **F (filament)**. [$\frac{1}{2}$]

B. The ovule (D) develops a tough coat and becomes the **seed**; the ovary (C) grows and ripens into the **fruit**. [$\frac{1}{2} + \frac{1}{2}$]

13. A. How do water and minerals reach the top of a tall tree during the day and at night? **3**

B. How is food transported in plants? Why does this process need energy, unlike transport in xylem?

Solution:

A. Root cells take up ions actively, creating a concentration difference, so water moves in from the soil and is pushed up as a column (**root pressure** – important at night). [$\frac{1}{2}$] During the day, evaporation of water from leaves through stomata (**transpiration**) creates a **suction (transpiration pull)** that pulls water up from the root xylem – the major driving force. [1]

B. Food (e.g. sucrose) is transported by **translocation** in the **phloem**, through sieve tubes with companion cells, upward and downward. [$\frac{1}{2}$]

Sucrose is transferred into phloem using energy from **ATP**; this raises the osmotic pressure so water moves in, and the pressure pushes the material to tissues with less pressure. Xylem transport is largely explained by simple physical forces. [1]

14. Study the food chain: Grass → Grasshopper → Frog → Snake → Eagle. **3**

A. If the frogs obtain 500 J of energy, how much energy was available at the grass level, and how much will reach the eagle?

B. What happens to the rest of the energy at each level?

C. Why is the flow of energy in this chain unidirectional?

Solution:

A. By the 10% law, frog (3rd level) = 500 J → grasshopper = 5000 J → grass = **50 000 J**. Snake = 50 J → eagle = **5 J**. [1]

B. It is lost as **heat** to the environment and used in **digestion and doing work**; only about 10% goes into growth and is available to the next level. [1]

C. The energy passed to a higher level never returns to the previous level (energy captured by autotrophs does not revert to the solar input). [1]

15. Case study: Ravi crossed a pure-breeding tall pea plant (TT) with a pure-breeding short pea plant (tt). All the F_1 plants were then self-pollinated, and he obtained 800 plants in the F_2 generation. **4**

A. What will the F_1 plants look like? Give a reason. **(1)**

B. How many of the 800 F_2 plants are expected to be short? **(1)**

Attempt either sub-part C or D.

C. How many of the tall F_2 plants are expected to be pure-breeding (TT)? Show your working with a checkerboard. **(2)**

OR

D. If an F_1 plant is crossed with the short parent (tt), what percentage of the progeny will be tall? Show your working. **(2)**

Solution:

A. All F_1 plants are **tall (Tt)**, because tallness is **dominant**; a single copy of T is enough. There are no medium-height plants. [1]

B. F_2 ratio tall : short = 3 : 1, so short = $\frac{1}{4} \times 800 = \mathbf{200 \text{ plants}}$. [1]

C. $Tt \times Tt \rightarrow TT : Tt : tt = 1 : 2 : 1$ (checkerboard: gametes T, t $\times$ T, t give TT, Tt, Tt, tt). $TT = \frac{1}{4} \times 800 = \mathbf{200 \text{ plants}}$ (one-third of the 600 tall plants). [2]

OR

D. $Tt \times tt$: gametes T, t $\times$ t $\rightarrow$ Tt, tt in a 1 : 1 ratio. Tall (Tt) = **50%**. [2]

16. Students to attempt either option A or B.

A. I. Describe how urine is formed in a nephron, mentioning the role of the Bowman's capsule and the tubule. **(3)**

II. How does an artificial kidney work? State one way in which it differs from a natural kidney. **(2)**

OR

B. I. List the three events that occur during photosynthesis. **(1½)**

II. How do desert plants manage photosynthesis while keeping their stomata closed during the day? **(1)**

III. Describe an activity to show that chlorophyll is essential for photosynthesis. **(2½)**

Solution:

A. I. Each nephron has a cluster of thin-walled capillaries associated with the cup-shaped **Bowman's capsule**, which collects the **filtrate** from blood. [1] As the filtrate flows along the tubule, useful substances – **glucose, amino acids, salts and a major amount of water** – are **selectively re-absorbed**. [1] The amount of water re-absorbed depends on excess water in the body and the dissolved waste to be excreted; the remaining fluid (urine) passes into the ureter. [1]

II. It has tubes with a **semi-permeable lining** suspended in a tank of dialysing fluid (same osmotic pressure as blood, no nitrogenous wastes). The patient's blood passes through the tubes; wastes diffuse into the fluid and purified blood is returned. [1] Difference: **no re-absorption** takes place. [1]

OR

B. I. (i) Absorption of light energy by chlorophyll; (ii) conversion of light energy to chemical energy and splitting of water into hydrogen and oxygen; (iii) reduction of carbon dioxide to carbohydrates. [$\frac{1}{2} \times 3$]

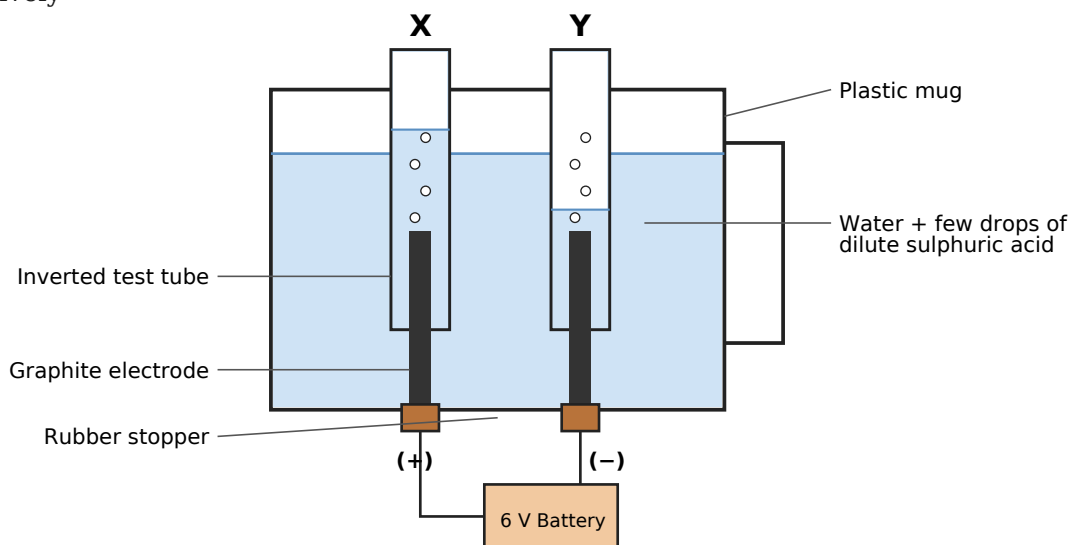
II. They take up CO_2 at **night** and prepare an intermediate, which is acted upon by the energy absorbed by chlorophyll during the day. [1]

III. Keep a potted plant with **variegated leaves** in the dark for 3 days (to destarch), then in sunlight for 6 hours. Pluck a leaf and trace its green areas. Boil it in water, then in **alcohol** on a water bath to remove chlorophyll. Dip it in dilute **iodine** solution and rinse. Only the parts that were green turn **blue-black**, showing starch was made only where chlorophyll was present. [$2\frac{1}{2}$]

SECTION - B (CHEMISTRY)

Questions 17 to 29

17. The figure shows the electrolysis of water containing a few drops of dilute sulphuric acid. The gas collected in test tube Y and the ratio of volumes of gases in Y and X are respectively 1



- A. hydrogen; 2 : 1
B. oxygen; 2 : 1
C. hydrogen; 1 : 2
D. oxygen; 1 : 2

Solution:

Ans: A - Tube Y is over the negative electrode (cathode), where hydrogen is liberated. $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$, so $\text{H}_2 : \text{O}_2 = 2 : 1$ by volume. [1]

18. An aqueous solution of a salt turns red litmus blue and has a pH of about 9. The salt is most likely 1
- A. sodium chloride
B. ammonium chloride
C. sodium carbonate
D. potassium nitrate

Solution:

Ans: C - Sodium carbonate is a salt of a strong base and a weak acid, so its solution is basic ($\text{pH} > 7$). NaCl and KNO_3 are neutral; NH_4Cl is acidic. [1]

19. The oxide of a metal M reacts with dilute hydrochloric acid as well as with sodium hydroxide solution to form a salt and water. M is 1
- A. sodium
B. magnesium
C. aluminium
D. copper

Solution:

Ans: C - Aluminium oxide is amphoteric: $\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$; $\text{Al}_2\text{O}_3 + 2\text{NaOH} \rightarrow 2\text{NaAlO}_2 + \text{H}_2\text{O}$. [1]

20. Which one of the following is **not** a property of ionic compounds? 1

- A. They have high melting and boiling points.
- B. They conduct electricity in the molten state.
- C. They are soluble in kerosene and petrol.
- D. They are generally hard and brittle solids.

Solution:

Ans: C – Ionic compounds are generally soluble in water and insoluble in kerosene and petrol. [1]

21. The IUPAC name and the functional group of $\text{CH}_3\text{-CH}_2\text{-CHO}$ are 1

- A. propanol – alcohol
- B. propanal – aldehyde
- C. propanone – ketone
- D. propanoic acid – carboxylic acid

Solution:

Ans: B – Three carbon atoms (prop-) with the -CHO group (suffix ‘-al’). [1]

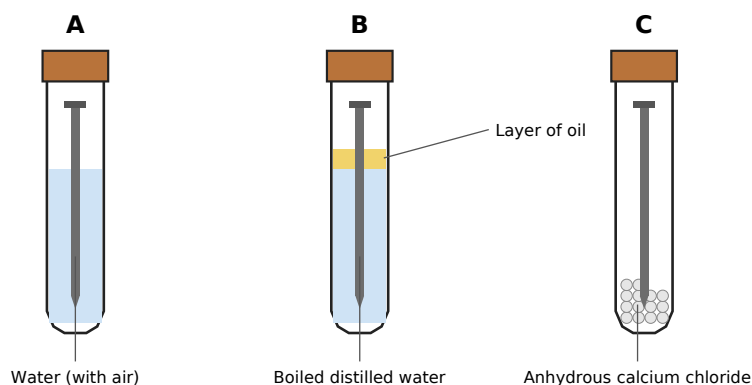
22. When zinc granules are warmed with sodium hydroxide solution, the products are 1

- A. zinc hydroxide and oxygen
- B. sodium zincate and hydrogen
- C. zinc oxide and water
- D. sodium zincate and oxygen

Solution:

Ans: B – $2\text{NaOH(aq)} + \text{Zn(s)} \rightarrow \text{Na}_2\text{ZnO}_2\text{(s)} + \text{H}_2\text{(g)}$. [1]

23. Clean iron nails are kept in three test tubes A, B and C as shown and left for a few days. 1
In which test tube(s) will the nail rust?



- A. A only
- B. B only
- C. C only
- D. A and B

Solution:

Ans: A – Rusting needs both air and water. In B, boiled water and the oil layer keep out air; in C, anhydrous CaCl_2 keeps the air dry. Only in A are both present. [1]

The following question(s) consist of two statements – Assertion (A) and Reason (R). Answer by selecting the appropriate option given below:

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- 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.

- 24. Assertion (A):** While diluting concentrated sulphuric acid, the acid should be added slowly to water with constant stirring. **1**

Reason (R): The process of dissolving an acid in water is highly endothermic.

Solution:

Ans: C – A is true. R is false: dissolving an acid in water is highly **exothermic**; adding water to acid can make the mixture splash out and cause burns. [1]

- 25.** Write balanced chemical equations with state symbols for the following and identify the type of each reaction: **2**

- A. Lead nitrate powder is heated strongly.
- B. Silver nitrate solution is added to sodium chloride solution.

Solution:

A. $2\text{Pb}(\text{NO}_3)_2(\text{s}) \xrightarrow{\text{Heat}} 2\text{PbO}(\text{s}) + 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$ – **thermal decomposition** (brown fumes of NO_2). [$\frac{1}{2} + \frac{1}{2}$]

B. $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{NaNO}_3(\text{aq})$ – **double displacement (precipitation)** reaction; white precipitate of AgCl. [$\frac{1}{2} + \frac{1}{2}$]

- 26.** Students to attempt either option A or B. **3**

A. An organic compound X ($\text{C}_2\text{H}_4\text{O}_2$) turns blue litmus red and gives brisk effervescence with sodium hydrogencarbonate.

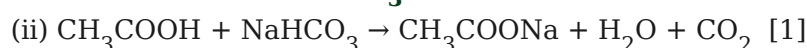
- (i) Identify X. (ii) Write the equation for its reaction with sodium hydrogencarbonate.
- (iii) Write the reaction of X with ethanol in the presence of an acid, and name the type of product formed.

OR

B. (i) Write the structural formula of ethene. (ii) Vegetable oils are converted into vanaspathi ghee using hydrogen. Name this type of reaction and the catalyst used. (iii) Why are oils containing unsaturated fatty acids preferred for cooking?

Solution:

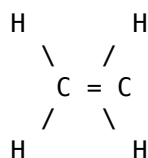
A. (i) X = **ethanoic acid (acetic acid), CH_3COOH** . [1]



Product: a sweet-smelling **ester** (esterification). [1]

OR

B. (i) Structural formula of ethene (C_2H_4):



[1 mark]

(ii) **Addition reaction (hydrogenation)**; catalyst: **nickel** (or palladium). [1]

(iii) Animal fats contain saturated fatty acids, which are said to be **harmful for health**; oils with **unsaturated** fatty acids are considered healthier. [1]

27. Give reasons for the following:

3

- A. Dry hydrogen chloride gas does not change the colour of dry blue litmus paper.
- B. An iron nail dipped in copper sulphate solution becomes brownish and the blue colour of the solution fades.
- C. Aluminium is more reactive than iron, yet aluminium utensils do not corrode easily.

Solution:

- A.** H^+ ions are produced from HCl **only in the presence of water**; dry HCl gives no $H^+(aq)$ ions, so it shows no acidic behaviour. [1]
- B.** Iron is more reactive than copper and **displaces** it: $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$. Brown copper deposits on the nail and pale green $FeSO_4$ forms, so the blue colour fades. [1]
- C.** Aluminium gets covered with a thin **protective layer of aluminium oxide**, which prevents further corrosion. [1]

28. **Case study:** Students placed small pieces of five metals P, Q, R, S and T (calcium, copper, iron, magnesium and sodium, in random order) in water under their teacher's supervision and recorded the observations:

4

Metal	Observation
P	Reacts violently with cold water; the hydrogen evolved catches fire.
Q	Reacts with cold water less violently; the metal starts floating.
R	No reaction with cold water; reacts with hot water and starts floating.
S	No reaction with cold or hot water; reacts with steam to form a black oxide (Fe_3O_4).
T	No reaction even with steam.

- A. Identify metal P. Why is it stored under kerosene? **(1)**
 - B. Arrange P, Q, R, S and T in decreasing order of reactivity and identify T. **(1)**
- Attempt either sub-part C or D.
- C. Write balanced chemical equations for the reactions of Q with cold water and S with steam. **(2)**

OR

- D. Why do metals Q and R start floating? Why is metal T suitable for making water pipes and vessels? **(2)**

Solution:

- A.** P = **sodium**. It reacts so vigorously with oxygen and moisture that it catches fire in the open, so it is kept under kerosene. [$\frac{1}{2} + \frac{1}{2}$]
- B.** $P (Na) > Q (Ca) > R (Mg) > S (Fe) > T$. T = **copper**. [$\frac{1}{2} + \frac{1}{2}$]
- C.** $Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$ [1]
 $3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$ [1]

OR

- D.** Bubbles of **hydrogen gas stick to the surface** of the metal and make it float. [1] Copper does not react with water (even steam), so it is not corroded by it; it is also a good conductor of heat. [1]

29. Students to attempt either option A or B.

A. I. How is bleaching powder manufactured? Write the equation and give two of its uses. (2)

II. How is washing soda obtained from baking soda? Write the equations involved and give two uses of washing soda. (2)

III. What is meant by water of crystallisation? (1)

OR

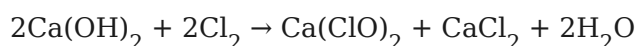
B. I. Zinc is obtained from zinc blende (ZnS) and calamine (ZnCO₃). Name the process used to convert each ore into zinc oxide and write the equations. (2)

II. Write the equation for the thermite reaction and state one use of it. (1½)

III. In the electrolytic refining of copper, what are used as the anode, the cathode and the electrolyte? What is anode mud? (1½)

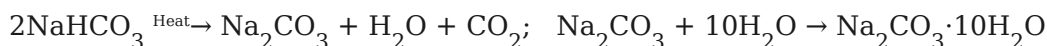
Solution:

A. I. By the action of chlorine on **dry slaked lime**:



Uses (any two): bleaching cotton and linen / wood pulp / washed clothes; oxidising agent in chemical industries; making drinking water free from germs. [1 + 1]

II. Heating baking soda gives sodium carbonate, which is recrystallised:

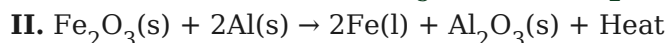


Uses (any two): glass, soap and paper industries; manufacture of borax; domestic cleaning; removing permanent hardness of water. [1 + 1]

III. The fixed number of water molecules present in one formula unit of a salt, e.g. CuSO₄·5H₂O. [1]

OR

B. I. ZnS - **roasting** (heating strongly in excess air): $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$. ZnCO₃ - **calcination** (heating strongly in limited air): $\text{ZnCO}_3 \rightarrow \text{ZnO} + \text{CO}_2$. [1 + 1]



Use: joining railway tracks or cracked machine parts. [1 + ½]

III. Anode - **impure copper**; cathode - thin strip of **pure copper**; electrolyte - **acidified copper sulphate solution**. Insoluble impurities that settle at the bottom of the anode are called **anode mud**. [1 + ½]

SECTION - C (PHYSICS)

Questions 30 to 39

30. The figure shows the path of a ray of light through a triangular glass prism ABC. Which option correctly names the emergent ray and the angle of deviation? 1

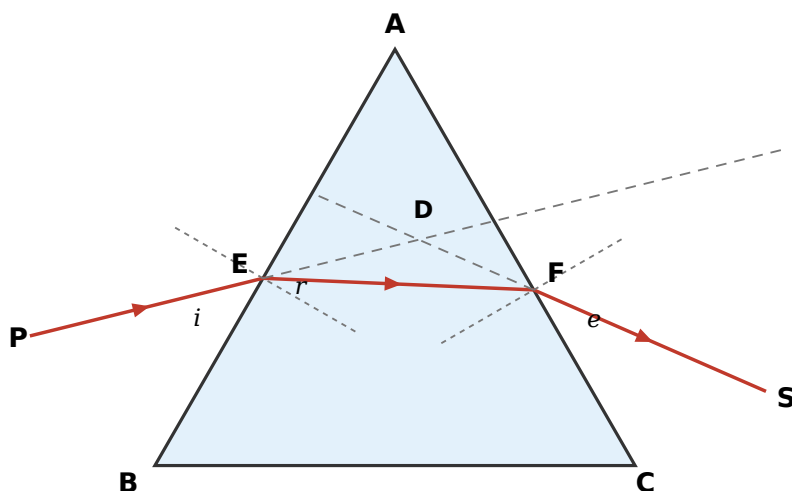


Figure: Refraction of light through a triangular glass prism

- A. EF and $\angle D$ B. FS and $\angle D$
C. FS and $\angle e$ D. PE and $\angle i$

Solution:

Ans: B - PE is the incident ray, EF the refracted ray and FS the emergent ray; $\angle D$, between the extended incident ray and the emergent ray, is the angle of deviation. [1]

31. Resistors of $4\ \Omega$ and $12\ \Omega$ are connected in parallel across a $6\ \text{V}$ battery. The current drawn from the battery is 1
- A. $0.375\ \text{A}$ B. $0.5\ \text{A}$
C. $2\ \text{A}$ D. $3\ \text{A}$

Solution:

Ans: C - $1/R = 1/4 + 1/12 = 4/12 \rightarrow R = 3\ \Omega$; $I = V/R = 6/3 = 2\ \text{A}$. [1]

The following question(s) consist of two statements - Assertion (A) and Reason (R). Answer by selecting the appropriate option given below:

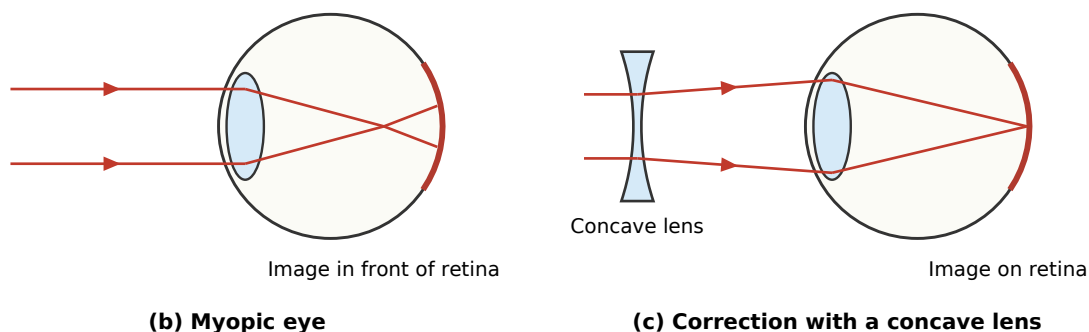
- A. Both A and R are true, and R is the correct explanation of A.
B. Both A and R are true, and R is not the correct explanation of A.
C. A is true but R is false.
D. A is false but R is true.
32. **Assertion (A):** A star seen near the horizon appears slightly higher than its actual position. 1

Reason (R): The earth's atmosphere bends starlight towards the normal.

Solution:

Ans: A - Atmospheric refraction in a medium of gradually changing refractive index bends the light towards the normal, raising the apparent position. [1]

33. The figure shows (b) the eye of a student who cannot see the blackboard clearly from the last bench, and (c) its correction. The doctor prescribes a lens of power -1.25 D . 2



- A. Name the defect and state one possible cause of it.
 B. Find the focal length of the prescribed lens and state its nature.

Solution:

A. Myopia (near-sightedness) – the image of a distant object forms in front of the retina.
 Cause (any one): excessive curvature of the eye lens / elongation of the eyeball. [$\frac{1}{2} + \frac{1}{2}$]
B. $f = 1/P = 1/(-1.25)\text{ m} = -0.8\text{ m} = -80\text{ cm}$; negative $\rightarrow$ concave (diverging) lens. [1]

34. Students to attempt either option A or B. 2
 A. I. Why should a fuse wire have a suitable (relatively low) melting point? II. An electric heater rated 1.5 kW is used on a 220 V line. Which fuse – 2 A , 5 A or 10 A – should be used? Justify.

OR

B. I. Why is the metallic body of an electric press connected to the earth wire? II. What is short-circuiting and what happens to the current at that time?

Solution:

A. I. When an unduly high current flows, the fuse wire must **heat up and melt quickly** (Joule heating) to break the circuit before the appliance or wiring is damaged. [1]
II. $I = P/V = 1500/220 \approx 6.8\text{ A}$; a 5 A fuse would melt during normal use, so a 10 A fuse should be used. [1]

OR

B. I. The earth wire provides a **low-resistance path** for any leakage current, keeping the body at the earth's potential, so the user does not get a severe shock. [1]
II. When the live and neutral wires come into **direct contact** (damaged insulation or a fault), the current in the circuit **increases abruptly** – short-circuiting. [1]

35. An object 10 cm tall is placed 30 cm in front of a concave mirror of focal length 20 cm . 3
 Find the position, size and nature of the image.

Solution:

Given: $f = -20\text{ cm}$, $u = -30\text{ cm}$, $h = +10\text{ cm}$.

Mirror formula: $1/v = 1/f - 1/u = -1/20 + 1/30 = (-3 + 2)/60 = -1/60 \rightarrow v = -60\text{ cm}$ (60 cm in front of the mirror). [$1\frac{1}{2}$]

$m = -v/u = -(-60)/(-30) = -2$; $h' = m \times h = -2 \times 10 = -20\text{ cm}$. [1]

Nature: **real, inverted and enlarged** (twice the size). [$\frac{1}{2}$]

36. A wire of length 0.5 m and area of cross-section 0.25 mm^2 has a resistance of 200Ω . 3

A. Calculate the resistivity of its material.

B. Using the values given - copper $1.62 \times 10^{-8} \Omega \text{ m}$, manganin $44 \times 10^{-6} \Omega \text{ m}$, nichrome $100 \times 10^{-6} \Omega \text{ m}$ - identify the material and state why it is used in heating elements.

Solution:

A. $A = 0.25 \text{ mm}^2 = 0.25 \times 10^{-6} \text{ m}^2 = 2.5 \times 10^{-7} \text{ m}^2$. $\rho = RA/l = (200 \times 2.5 \times 10^{-7})/0.5 = 1 \times 10^{-4} \Omega \text{ m} = 100 \times 10^{-6} \Omega \text{ m}$. [2]

B. The material is **nichrome**. Alloys like nichrome have **high resistivity** and **do not oxidise (burn) readily at high temperatures**. [$\frac{1}{2} + \frac{1}{2}$]

37. In the circuit shown, a 9 V battery is connected to a resistor $R_1 = 3 \Omega$ in series with two 6Ω resistors (R_2 and R_3) connected in parallel between points P and Q. 3

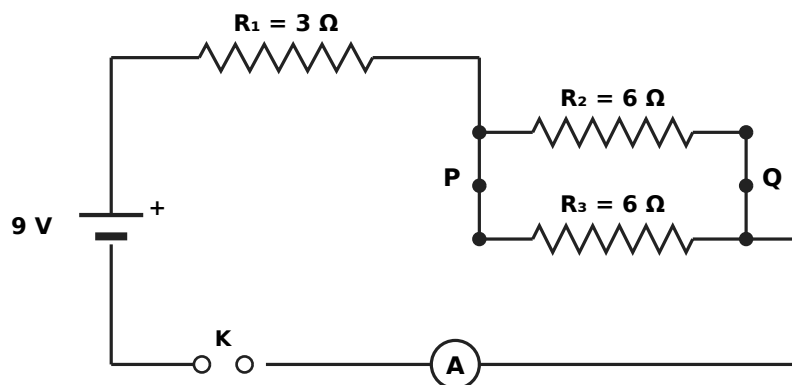


Figure: Circuit for Question 37

A. Find the total resistance of the circuit and the current shown by the ammeter.

B. Calculate the potential difference between P and Q and the current through R_2 .

Solution:

A. $R_2 \parallel R_3$: $1/R_p = 1/6 + 1/6 = 2/6 \rightarrow R_p = 3 \Omega$. Total $R = 3 + 3 = 6 \Omega$. $I = 9/6 = 1.5 \text{ A}$. [$1\frac{1}{2}$]

B. $V_{PQ} = I \times R_p = 1.5 \times 3 = 4.5 \text{ V}$; $I_2 = 4.5/6 = 0.75 \text{ A}$ (half the total current, since $R_2 = R_3$). [$1\frac{1}{2}$]

- 38. Case study:** Meera placed a lit candle at different distances in front of a convex lens and moved a screen on the other side to get a sharp image. Her readings are given below. **4**

Observation	1	2	3	4
Object distance (cm)	60	40	30	15
Image distance on screen (cm)	30	40	60	No image on screen

- A. Using observation 2, find the focal length of the lens. **(1)**
 B. Find the magnification in observation 3 and state the nature of the image. **(1)**
 Attempt either sub-part C or D.
 C. Why was no image obtained on the screen in observation 4? Find the position and nature of the image in this case and give one use of this arrangement. **(2)**

OR

- D. Find the power of the lens. If a concave lens of power -2 D is placed in contact with it, what is the power and focal length of the combination? **(2)**

Solution:

A. When $u = v$ (40 cm), the object is at $2F$, so $2f = 40\text{ cm} \rightarrow f = 20\text{ cm}$. [Check: $1/40 - 1/(-40) = 1/20$.] [1]

B. $u = -30\text{ cm}$, $v = +60\text{ cm}$: $m = v/u = 60/(-30) = -2 \rightarrow$ **real, inverted, enlarged**. [$\frac{1}{2} + \frac{1}{2}$]

C. The candle (15 cm) is **within the focal length**, so the image is virtual and forms on the same side as the object. $1/v = 1/f + 1/u = 1/20 - 1/15 = (3 - 4)/60 = -1/60 \rightarrow v = -60\text{ cm}$; $m = v/u = (-60)/(-15) = +4 \rightarrow$ **virtual, erect, enlarged**. [$1\frac{1}{2}$] Use: **magnifying glass**. [$\frac{1}{2}$]

OR

D. $P = 1/f = 1/0.20\text{ m} = +5\text{ D}$. [1] Combination: $P = +5 + (-2) = +3\text{ D}$; $f = 1/3\text{ m} \approx 33.3\text{ cm}$ (converging). [1]

39. Students to attempt either option A or B.

A. I. State Fleming's left-hand rule. **(1)**

II. A beam of electrons moves horizontally towards the north through a magnetic field directed vertically upward. In which direction will the beam be deflected? Explain. **(1½)**

III. List three properties of magnetic field lines. **(1½)**

IV. Why are household appliances connected in parallel? **(1)**

OR

B. I. Distinguish between myopia and hypermetropia in terms of where the image is formed. **(1)**

II. The near point of a hypermetropic eye is 1 m. Find the power of the lens needed to correct it (near point of normal eye = 25 cm). **(2)**

III. Explain how a rainbow is formed and state why it is always seen opposite to the Sun. **(2)**

Solution:

A. I. Stretch the thumb, forefinger and middle finger of the left hand mutually perpendicular. If the **forefinger** points along the **magnetic field** and the **middle finger** along the **current**, the **thumb** gives the direction of **force (motion)** on the conductor. [1]

II. The direction of current is opposite to the flow of electrons, i.e. towards the **south**. [½]
Left hand: forefinger pointing up (field), middle finger pointing south (current) → the thumb points towards the **west**. The beam is deflected towards the **west**. [1]

III. Any three: they emerge from the north pole and merge at the south pole (closed curves; inside the magnet S → N); crowding shows a stronger field; no two field lines intersect; direction is that in which a compass north pole points. [½ × 3]

IV. Each appliance gets the **same potential difference (220 V)** and can be switched on/off independently; failure of one does not stop the others. [1]

OR

B. I. Myopia: image of a distant object forms **in front of the retina**. Hypermetropia: image of a nearby object forms **behind the retina**. [½ + ½]

II. Lens must form a virtual image at 100 cm of an object at 25 cm: $u = -25$ cm, $v = -100$ cm.
 $1/f = 1/v - 1/u = -1/100 + 1/25 = 3/100 \rightarrow f = 100/3$ cm $\approx +33.3$ cm = $1/3$ m. $P = 1/f = +3$ D (convex lens). [2]

III. Tiny water droplets act like small prisms: sunlight is **refracted and dispersed** on entering, **reflected internally**, and **refracted again** on leaving, so different colours reach the eye. [1½] Light must be reflected back from droplets in front of the observer, so the Sun has to be **behind** the observer – the rainbow forms opposite to the Sun. [½]