Science (086)

CBSE Class 10 Board Examination 2027 – Practice Paper No. 2

Model Answer Paper

Time: 3 hours **Max. Marks: 80**

Model answers show one correct method; any other correct method gets full marks.

SECTION A – BIOLOGY (Q.1 to Q.7) Multiple choice questions. Select the correct option. (1 mark each) **[7]**

1 While slicing vegetables, Aarav cut his finger. The bleeding stopped after a few minutes because the blood clotted and sealed the cut. Which cells circulating in the blood help to plug such leaks?

(A) Red blood cells (B) White blood cells
(C) Platelets (D) Cells lining the veins

Answer (1 mark)
(C) Platelets.
The blood has platelet cells which circulate around the body and plug leaks by helping to clot the blood at the point of injury, so that loss of blood and loss of pressure are avoided.

2 Arteries have thick, elastic walls because:

(A) they carry blood from the organs back to the heart at low pressure (B) the blood in them emerges from the heart under high pressure
(C) materials are exchanged between the blood and the body cells through their walls (D) they have valves that prevent the backward flow of blood

Answer (1 mark)
(B) The blood in them emerges from the heart under high pressure.
Arteries carry blood away from the heart to the organs; since this blood is under high pressure, their walls are thick and elastic. (A) and (D) describe veins, and (C) describes capillaries.

3 A potted money-plant kept near a window has its shoot bending towards the light coming in through the window. This happens because the plant hormone auxin:

(A) diffuses towards the shady side of the shoot and makes the cells there grow longer (B) collects on the side of the shoot facing the light and makes the cells there grow faster
(C) is destroyed on the shady side, so the cells there stop growing (D) causes the cells on the side facing the light to wilt

Answer (1 mark)
(A) Auxin, synthesised at the shoot tip, diffuses towards the shady side of the shoot when light comes from one side. This concentration of auxin stimulates the cells on the side away from light to grow longer, so the shoot bends towards the light (phototropism).

4 Which one of the following pairs of an organism and its method of asexual reproduction is **incorrectly** matched?

(A) Amoeba – binary fission (B) Plasmodium – multiple fission
(C) Spirogyra – fragmentation (D) Planaria – budding

Answer (1 mark)
(D) Planaria – budding.
Planaria reproduces by regeneration: if its body is cut into pieces, each piece grows into a

complete organism. Budding is seen in Hydra and yeast. The other three pairs are correct.

5 Mrs. Joshi placed a leaf of Bryophyllum on moist soil in a pot. After a few days, tiny plants grew from the notches along the margin of the leaf. This method of producing new plants is:

(A) spore formation
(B) fragmentation
(C) sexual reproduction
(D) vegetative propagation

Answer (1 mark)
(D) Vegetative propagation.
The buds produced in the notches along the leaf margin of Bryophyllum fall on the soil and develop into new plants. A new plant develops from a vegetative part (leaf), not from a seed.

6 Pea plants having round, yellow seeds (RRYY) were crossed with pea plants having wrinkled, green seeds (rryy). The F_1 plants were self-pollinated. Which types of seeds appeared in the F_2 generation that were seen **neither** in the parents **nor** in the F_1?

(A) Round yellow and wrinkled green
(B) Round green and wrinkled yellow
(C) Round green only
(D) None; the F_2 had only the parental types

Answer (1 mark)
(B) Round green and wrinkled yellow.
All F_1 seeds are round and yellow (RrYy). In the F_2, the traits for seed shape and seed colour are inherited independently, so new combinations – round green and wrinkled yellow – appear along with the parental types.

7 Which one of the following pairs consists **only** of human-made (artificial) ecosystems?

(A) Crop-field and aquarium
(B) Forest and pond
(C) Lake and garden
(D) Pond and crop-field

Answer (1 mark)
(A) Crop-field and aquarium.
Forests, ponds and lakes are natural ecosystems, while gardens, crop-fields and aquariums are human-made (artificial) ecosystems. Options (C) and (D) each contain one natural ecosystem.

Q.8 – Q.9 Assertion–Reason. Each question has two statements – Assertion (A) and Reason (R). Select the appropriate option (A), (B), (C) or (D) given below the question. (1 mark each) **[2]**

8 **Assertion (A):** Transport of materials in plants is relatively slow compared with transport in animals.
Reason (R): Plants do not move, and a large proportion of a plant body consists of dead cells, so plants have low energy needs.

(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.

Answer (1 mark)
(A) Both A and R are true, and R is the correct explanation of A.
Because plants do not move and have many dead cells in their tissues, their energy needs are low, so they can manage with relatively slow transport systems.

9 **Assertion (A):** The tendril of a pea plant coils around a support that it touches.
Reason (R): The part of the tendril in contact with the support grows faster than the part away from it.

(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.

Answer (1 mark)
(C) A is true but R is false.
The part of the tendril in contact with the support does **not** grow as rapidly as the part away from it; the faster growth of the outer side makes the tendril circle around the support and cling to it.

Q.10 – Q.12 Answer the following questions. (2 marks each) **[6]**

10 After the birth of her first child, Mrs. Shaikh's doctor advised her to use a copper-T so that her next pregnancy is delayed by a few years.
(a) Where in the body is a copper-T placed? State one problem it may cause.
(b) Prenatal sex determination has been prohibited by law in India. Why was such a law needed?

Answer (2 marks)
(a) A copper-T (or loop) is placed in the uterus to prevent pregnancy. It can cause side effects due to irritation of the uterus.
(b) Methods of finding the sex of the foetus were being misused for illegal sex-selective abortion of female foetuses (female foeticide). Because of this, the child sex ratio is declining at an alarming rate in some sections of society, while a healthy society needs a balanced female-male sex ratio.

Marking: (a) Uterus – ½ mark; side effect due to irritation of the uterus – ½ mark · (b) Misuse for sex-selective abortion of female foetuses – ½ mark; declining child sex ratio / need to maintain female-male ratio – ½ mark

Examiner tip: In (b), write both the misuse (female foeticide) and its effect on the sex ratio; one of them alone earns only ½ mark.

11 **Attempt either option A or B.**
A. A potted plant was kept inside a sealed, transparent glass jar fitted with a carbon dioxide sensor in the school laboratory. The level of carbon dioxide in the jar rose during the night and fell during the day. Explain both these observations.
OR
B. (a) A farmer wants his sugarcane stems to grow taller, while a plant-tissue laboratory wants the cells of its plant tissue to divide faster. Name the plant hormone useful in each case.
(b) The roots of a tree growing near a leaking underground water pipe were found to have grown towards the pipe. Name this movement. Is it a growth-dependent movement?

Answer (2 marks)
A. **At night** there is no photosynthesis, but the plant continues to respire and release carbon dioxide; so CO_2 elimination is the main gas exchange and the CO_2 level in the jar rises.
During the day the plant carries out photosynthesis, which uses up the CO_2 produced in respiration as well as CO_2 from the air in the jar; there is no CO_2 release, and oxygen release is the main event. So the CO_2 level falls.
OR
B. (a) Sugarcane stem: **gibberellins** (help in the growth of the stem). Faster cell division: **cytokinins** (promote cell division).

(b) **Hydrotropism** (movement of roots towards water). Yes – it is a tropic movement, a directional movement caused by growth of the root towards the stimulus.

Marking: A: Night – no photosynthesis, respiration releases CO_2 – 1 mark · A: Day – photosynthesis uses up CO_2 (including that from respiration) – 1 mark · OR B: (a) gibberellins – ½ mark; cytokinins – ½ mark · OR B: (b) hydrotropism – ½ mark; yes, growth-dependent (tropic) – ½ mark

Examiner tip: In A, remember that plants respire both by day and by night; only photosynthesis stops at night.

12 In pea plants, the trait for tall plants (T) is dominant over the trait for dwarf plants (t). Meena has a tall pea plant and wants to find out whether it is pure-breeding (TT) or not (Tt). She crosses it with a dwarf pea plant.

(a) What results should she expect if her tall plant is (i) TT and (ii) Tt? Show both crosses.

(b) The cross gave both tall and dwarf plants. If Meena's tall plant is instead self-pollinated and 400 plants are obtained, how many of them are expected to be tall, and how many of these tall plants are expected to be pure-breeding (TT)?

Answer (2 marks)

(a) (i) TT (tall) × tt (dwarf)

Gametes: T × t

Offspring: all Tt – **all plants tall**.

(ii) Tt (tall) × tt (dwarf)

Gametes: T, t × t

Offspring: Tt (tall) : tt (dwarf) = 1 : 1 – **about half tall and half dwarf**.

(b) Since dwarf plants appeared, Meena's plant is **Tt**. On self-pollination: Tt × Tt → 1 TT : 2 Tt : 1 tt.

Tall plants (TT + Tt) = ¾ × 400 = **300**.

Pure-breeding tall plants (TT) = ¼ × 400 = **100** (i.e. one-third of the tall plants).

Marking: (a) TT × tt giving all tall – ½ mark; Tt × tt giving 1 : 1 tall : dwarf – ½ mark · (b) Tt × Tt giving 1 TT : 2 Tt : 1 tt – ½ mark; 300 tall and 100 TT – ½ mark

Examiner tip: Show the gametes and offspring for each cross. In (b), many students count all 300 tall plants as pure-breeding; only the TT plants (¼ of the total) are.

Q.13 – Q.14 Answer the following questions. (3 marks each) **[6]**

13 A student looked at a drop of pond water under a microscope and observed an Amoeba and a Paramoecium feeding.

(a) Describe how Amoeba takes in and digests its food.

(b) How is the way Paramoecium takes in food different from that of Amoeba?

(c) Mushrooms and Cuscuta (amar-bel) also cannot make their own food. How does each of them obtain its food?

Answer (3 marks)

(a) Amoeba takes in food using temporary finger-like extensions of the cell surface which fuse over the food particle, forming a food vacuole. Inside the food vacuole, complex substances are broken down into simpler ones, which then diffuse into the cytoplasm. The undigested material is moved to the surface of the cell and thrown out.

(b) Paramoecium has a definite shape, and food is taken in at a **specific spot**. Food is moved to this spot by the movement of **cilia**, which cover the entire surface of the cell. (Amoeba can take in food at any point on its surface.)

(c) **Mushrooms** (fungi) break down the food material (dead and decaying organic matter) outside the body and then absorb it.

Cuscuta is a parasite: it derives its nutrition from the host plant without killing it.

Marking: (a) Finger-like extensions forming a food vacuole – ½ mark; digestion in the vacuole and diffusion into cytoplasm – ½ mark · (b) Definite shape / food taken in at a specific spot – ½ mark; moved by cilia – ½ mark · (c) Mushrooms: break down food outside the body and absorb it – ½ mark; Cuscuta: parasite, takes food from host plant without killing it – ½ mark

Examiner tip: Do not call mushrooms parasites – they break down dead organic matter outside the body and absorb it; Cuscuta takes its food from a living host.

14 Thirteen-year-old Sunil is much shorter than all his classmates. After some tests, the doctor said that his body has been producing too little of a hormone since early childhood.
(a) Name the hormone and the condition caused by its deficiency in childhood.
(b) Name the gland that secretes this hormone. How does the hormone reach the organs on which it acts?
(c) Sunil's elder brother and sister are going through the changes associated with puberty. Name the hormones responsible for these changes in boys and in girls, and the glands that secrete them.

Answer (3 marks)
(a) **Growth hormone**; its deficiency in childhood leads to **dwarfism**.
(b) The **pituitary gland**. It is an endocrine gland: it secretes the hormone directly into the blood, which carries it to the organs (target organs) on which it acts.
(c) Boys – **testosterone**, secreted by the **testes**.
Girls – **oestrogen**, secreted by the **ovaries**.

Marking: (a) Growth hormone – ½ mark; dwarfism – ½ mark · (b) Pituitary – ½ mark; secreted directly into blood and carried to target organs – ½ mark · (c) Testosterone and testes – ½ mark; oestrogen and ovaries – ½ mark

Examiner tip: In (b), the key phrase is 'secreted directly into the blood' – endocrine glands have no ducts.

Q.15 Case-based question. (4 marks) **[4]**

15 In a paddy field in the Konkan region, the following feeding relationships were observed: paddy plants are eaten by grasshoppers and by rats; grasshoppers are eaten by frogs; frogs and rats are eaten by snakes; snakes and rats are eaten by eagles.
(A) Name the producer in this field and the organisms that are at the second trophic level. (1)
(B) In one season, the paddy plants in a part of the field received 5,00,000 kJ of energy from sunlight. How much of this energy will be converted into food energy by the paddy plants, and about how much will reach the frogs through the grasshoppers? (1)
Attempt either sub-part C or D.
(C) A farmer observed that the number of eagles in the area is far smaller than the number of grasshoppers. Explain why. (2)
OR
(D) After the harvest, the farmer used to burn the leftover paddy straw. His daughter suggests that he should instead put the straw in a pit along with cow-dung. Is paddy straw biodegradable? Which organisms will act on the straw in the pit, and how will this help the paddy field? (2)

Answer (4 marks)
(A) Producer: **paddy plants**. Second trophic level (herbivores / primary consumers): **grasshoppers and rats**.
(B) Green plants convert about 1% of the sunlight energy falling on them into food energy: 1% of 5,00,000 kJ = **5,000 kJ**.
About 10% passes to each next level: grasshoppers get 10% of 5,000 = 500 kJ; frogs get 10% of 500 = **50 kJ**.
(C) At each trophic level a great deal of energy is lost as heat and used in the organism's own life processes; only about 10% of the food eaten is made available to the next level.

Grasshoppers are at the second trophic level, while eagles are at the top of the food web – at the third level when they eat rats and at the fifth level when they eat snakes that have eaten frogs – so very little energy reaches the eagles. This energy can support only a small number of eagles. In general, there are a greater number of individuals at the lower trophic levels.

OR

(D) Yes, paddy straw is biodegradable. Decomposers – **bacteria and fungi** – will act on it. They break down the complex organic substances in the straw into simple inorganic substances, which go into the soil and are used up again by the plants. This replenishes the soil naturally (manure), instead of the straw being wasted by burning.

Marking: (A) Paddy plants – ½ mark; grasshoppers and rats – ½ mark · (B) 5,000 kJ – ½ mark; 50 kJ – ½ mark · (C) Energy lost at each level / only about 10% passed on – 1 mark; eagles at the top (higher) trophic levels, so little energy and few individuals – 1 mark · OR (D) Biodegradable – ½ mark; bacteria and fungi – ½ mark; complex organic substances broken into simple inorganic substances that return to the soil for plants – 1 mark

Examiner tip: In (B) apply the 1% rule for producers first, and only then the 10% rule from one consumer level to the next.

Q.16 Long answer question. (5 marks) **[5]**

16 **Attempt either option A or B.**

A. With reference to excretion in human beings:

I. Trace the path of urine from the organ where it is formed to the point where it leaves the body. (1)

II. In which part of a nephron is blood first filtered? Name any three substances present in the initial filtrate. (1)

III. The initial filtrate contains glucose, but the urine of a healthy person does not. Explain why. (1)

IV. On a hot day in May, Kabir played cricket for three hours, sweated a lot and passed only a small amount of dark yellow urine. On a cool day in January, after drinking plenty of water, he passed a large amount of pale urine. Explain how his kidneys bring about this difference. (2)

OR

B. With reference to reproduction in flowering plants:

I. In Riya's garden, a hibiscus flower has both stamens and a pistil, while each flower of a papaya plant has either stamens or a pistil. What are these two types of flowers called? (1)

II. A honeybee carries pollen from a flower of one guava tree to a flower of another guava tree. Name this type of pollination, and the part of the flower on which the pollen must land. (1)

III. Describe the events that follow, from the landing of the pollen grain to the formation of the zygote. (2)

IV. A soaked gram (chana) seed was cut open. Name the parts of the embryo that develop into (a) the root and (b) the shoot. What is the role of the cotyledons? (1)

Answer (5 marks)

A. I. Kidneys (urine formed) → ureters → urinary bladder (stored) → urethra (released).

II. In the **glomerulus** – the cluster of thin-walled blood capillaries inside the cup-shaped **Bowman's capsule**. The initial filtrate contains (any three) glucose, amino acids, salts, water and urea.

III. As the filtrate flows along the tubule of the nephron, useful substances such as glucose, amino acids, salts and a major amount of water are **selectively re-absorbed** into the blood. In a healthy person all the glucose is re-absorbed, so none is left in the urine.

IV. The amount of water re-absorbed in the tubules depends on how much excess water there is in the body and on how much dissolved waste is to be excreted.

In May, Kabir lost much water as sweat, so there was little excess water: his kidneys re-absorbed more water, and he passed a small amount of concentrated (dark yellow) urine.

In January, he had drunk plenty of water and lost little as sweat, so there was excess water: less water was re-absorbed, and he passed a large amount of dilute (pale) urine.

OR

B. I. Hibiscus – **bisexual** flower; papaya – **unisexual** flower.

II. **Cross-pollination** (transfer of pollen from one flower to the flower of another plant). The pollen must land on the **stigma**.

III. After the pollen lands on a suitable stigma, a pollen tube grows out of the pollen grain and travels through the style to reach the ovule in the ovary. The male germ-cell is carried through the pollen tube to the female germ-cell (egg) in the ovule. The male and female germ-cells fuse (fertilisation) to form the zygote.

IV. (a) Radicle – develops into the root; (b) plumule – develops into the shoot. The cotyledons store food for the growing embryo (seedling).

Marking: A: I correct sequence kidney–ureter–bladder–urethra – 1 mark (½ if one step missing) · A: II glomerulus/Bowman's capsule – ½ mark; any three substances – ½ mark · A: III selective re-absorption of glucose in the tubule – 1 mark · A: IV water re-absorption depends on excess water in body – 1 mark; May: more re-absorbed, less concentrated urine – ½ mark; January: less re-absorbed, more dilute urine – ½ mark · OR B: I bisexual and unisexual – ½ + ½ mark · OR B: II cross-pollination – ½ mark; stigma – ½ mark · OR B: III pollen tube through style to ovule – 1 mark; fusion of male and female germ-cells forming zygote – 1 mark · OR B: IV radicle and plumule – ½ mark; cotyledons store food – ½ mark

Examiner tip: In A-IV link both observations to how much water is re-absorbed in the tubules; in B-III name the pollen tube, the style and the ovule in the correct order.

SECTION B – CHEMISTRY (Q.17 to Q.23) Multiple choice questions. Select the correct option. (1 mark each) **[7]**

17 Green crystals of ferrous sulphate were heated strongly in a dry boiling tube. The crystals first lost water and then decomposed, leaving a brown solid, and a smell of burning sulphur was noticed. The gases given off in the decomposition step are:

(A) sulphur dioxide and sulphur trioxide
(B) sulphur dioxide only
(C) oxygen and sulphur dioxide
(D) hydrogen sulphide and sulphur trioxide

Answer (1 mark)

(A) Sulphur dioxide and sulphur trioxide.

$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$ (on heating)

The brown solid is ferric oxide; this is a thermal decomposition reaction.

18 Zinc granules were warmed with sodium hydroxide solution in a test tube. A gas was given off which burnt with a pop sound when a burning candle was brought near it. The gas and the salt formed are:

(A) oxygen and zinc hydroxide
(B) hydrogen and zinc oxide
(C) no gas is formed, as zinc does not react with a base
(D) hydrogen and sodium zincate

Answer (1 mark)

(D) Hydrogen and sodium zincate.

$2NaOH(aq) + Zn(s) \rightarrow Na_2ZnO_2(s) + H_2(g)$

Hydrogen burns with a pop sound.

19 Which one of the following metals does not react with either cold or hot water, but reacts with steam to form the metal oxide and hydrogen?

(A) Potassium
(B) Calcium
(C) Iron
(D) Copper

Answer (1 mark)
(C) Iron.
$3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$. Potassium reacts violently and calcium less violently with cold water; copper does not react with water even as steam.

20 Which one of the following pairs of compounds belongs to the same homologous series?

(A) C_2H_6 and C_2H_4 (B) CH_3OH and CH_3CHO

(C) C_3H_8 and C_4H_{10} (D) C_2H_5OH and CH_3COOH

Answer (1 mark)
(C) C_3H_8 (propane) and C_4H_{10} (butane). Both are alkanes (general formula C_nH_{2n+2}) and differ by a $–CH_2–$ unit. The other pairs have different functional groups or belong to different series.

21 Aqueous solutions of four salts are tested with pH paper. The solution of which salt will have a pH greater than 7?

(A) Sodium chloride (B) Ammonium chloride

(C) Sodium carbonate (D) Sodium sulphate

Answer (1 mark)
(C) Sodium carbonate. It is the salt of a strong base (NaOH) and a weak acid (carbonic acid), so its solution is basic (pH > 7). NaCl and Na_2SO_4 (strong acid + strong base) are neutral, and NH_4Cl (strong acid + weak base) is acidic.

22 When the equation $a\ Al + b\ O_2 \rightarrow c\ Al_2O_3$ is balanced with the smallest whole numbers, the values of *a*, *b* and *c* are respectively:

(A) 4, 3, 2 (B) 2, 3, 1

(C) 2, 1, 1 (D) 4, 2, 2

Answer (1 mark)
(A) 4, 3, 2: $4Al + 3O_2 \rightarrow 2Al_2O_3$. Check: Al 4 = 2 × 2; O 3 × 2 = 6 = 2 × 3.

23 A pair of silver anklets kept in a drawer for a few months became black. The black coating is due to the formation of:

(A) silver oxide, by reaction with oxygen in the air (B) silver sulphide, by reaction with sulphur (compounds) in the air

(C) silver carbonate, by reaction with carbon dioxide in the air (D) silver chloride, by reaction with moisture in the air

Answer (1 mark)
(B) Silver sulphide. Silver articles become black after some time when exposed to air because silver reacts with sulphur in the air (as hydrogen sulphide) to form a coating of silver sulphide. This is an example of corrosion.

Q.24 Assertion–Reason. Each question has two statements – Assertion (A) and Reason (R). Select the appropriate option (A), (B), (C) or (D) given below the question. (1 mark) **[1]**

24 **Assertion (A):** Ethanoic acid is a weak acid compared with hydrochloric acid.
Reason (R): An aqueous solution of ethanoic acid turns blue litmus red.

(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.

Answer (1 mark)

(B) Both A and R are true, and R is not the correct explanation of A.

Carboxylic acids such as ethanoic acid are weak acids because, unlike mineral acids such as HCl, they are not completely ionised in water, so they give fewer H^+ ions. Turning blue litmus red only shows that the solution is acidic; a strong acid does the same, so R does not explain why ethanoic acid is weak.

Q.25 Answer the following question. (2 marks) **[2]**

25 Two test tubes contain a little absolute ethanol.

(a) In the first tube, the teacher drops a small piece of sodium, about the size of a grain of rice. What will be observed? Write the balanced chemical equation for the reaction.

(b) The second tube is warmed gently in a water bath and a 5% solution of alkaline potassium permanganate is added drop by drop; its colour disappears at first. Name the organic compound formed, and state the role of alkaline potassium permanganate in this reaction.

Answer (2 marks)

(a) Bubbles of a colourless gas are given off (effervescence). The gas is **hydrogen**, which burns with a pop sound.

$2Na + 2CH_3CH_2OH \rightarrow 2CH_3CH_2O^-Na^+$ (sodium ethoxide) + H_2

(b) Ethanol is oxidised to **ethanoic acid** (CH_3COOH). Alkaline potassium permanganate acts as an **oxidising agent**: it adds oxygen to ethanol and is itself used up, so its colour disappears.

Marking: (a) Effervescence / hydrogen gas – ½ mark; balanced equation – ½ mark · (b) Ethanoic acid – ½ mark; oxidising agent – ½ mark

Examiner tip: Balance the sodium reaction with 2Na and $2CH_3CH_2OH$ for one H_2; and write 'oxidising agent', not 'catalyst', for potassium permanganate.

Q.26 – Q.27 Answer the following questions. (3 marks each) **[6]**

26 **Attempt either option A or B.**

A. Copper glance (Cu_2S) is an ore of copper. Copper is obtained from it simply by heating it in air, without using carbon.

(i) Write the balanced chemical equation for the first step, in which part of the copper sulphide changes into copper(I) oxide.

(ii) Write the balanced chemical equation for the next step, in which the copper(I) oxide reacts with the remaining copper sulphide to give copper metal.

(iii) Zinc oxide has to be heated with carbon to obtain zinc, but copper is obtained from its ore by heating alone. Explain this difference using the activity series.

OR

B. The iron grill of an old house in Satara, left unpainted for many years, has a brown, flaky coating on it, while a galvanised iron bucket and a stainless steel kitchen sink in the same house still look shiny.

(i) Name the brown, flaky substance and state the two conditions needed for it to form.

(ii) What is galvanisation? A galvanised article remains protected from rusting even when its coating gets scratched. Why?

(iii) Stainless steel is an alloy of iron. Name the two other metals mixed with iron to make it, and state why stainless steel is preferred over pure iron for a kitchen sink.

Answer (3 marks)

A. (i) $2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$ (on heating in air)

(ii) $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$ (on heating)

(Check: Cu 4 + 2 = 6; O 2 = 2; S 1 = 1.)

(iii) Copper is **low in the activity series**; metals low in the series are very unreactive, and their oxides can be reduced to the metal by heating alone (here by the sulphide itself). Zinc is in the **middle** of the activity series; its oxide is more stable and must be reduced with a reducing agent such as carbon.

OR

B. (i) **Rust** (hydrated iron oxide). Iron rusts only when both **air (oxygen)** and **water (moisture)** are present.

(ii) Galvanisation is a method of protecting steel and iron from rusting by coating them with a thin layer of **zinc**. Zinc is more reactive than iron, so even when the coating is broken, zinc (not iron) reacts with air and moisture and the iron stays protected.

(iii) **Nickel and chromium**. Pure iron is very soft and stretches easily when hot, and it rusts; stainless steel is hard and does not rust.

Marking: A: (i) correct formulae – ½ mark; balanced – ½ mark · A: (ii) correct formulae – ½ mark; balanced – ½ mark · A: (iii) copper low in activity series, oxide reduced by heat alone – ½ mark; zinc in middle, needs carbon as reducing agent – ½ mark · OR B: (i) rust – ½ mark; air and moisture both – ½ mark · OR B: (ii) zinc coating – ½ mark; zinc more reactive, so it corrodes in place of iron – ½ mark · OR B: (iii) nickel and chromium – ½ mark; hard and does not rust – ½ mark

Examiner tip: In A, count every atom on both sides; the coefficients 2, 3, 2, 2 and 2, 1, 6, 1 are where marks are usually lost.

27 Fishermen at a lake near an industrial town found many dead fish in the lake after the first heavy rains of the monsoon. Students tested the lake water and found its pH to be 4.8, while the water of a lake far away from the town had a pH of 7.2.

(a) What is meant by acid rain? Why is it harmful to the fish in the lake?

(b) Why did the students use a universal indicator and not litmus paper to test the lake water?

(c) The marble (calcium carbonate) steps of a temple near the town have become rough and pitted. Write the balanced chemical equation for the reaction of calcium carbonate with dilute nitric acid present in the rain water, and name the gas given off.

Answer (3 marks)

(a) When the pH of rain water is less than 5.6, it is called **acid rain**. When acid rain flows into the lake it lowers the pH of the water. Living organisms can survive only in a narrow range of pH change, so the survival of aquatic life (fish) becomes difficult.

(b) Litmus only tells whether a solution is acidic or basic. A universal indicator is a mixture of several indicators that shows different colours at different concentrations of hydrogen ions, so it gives the **pH value** – that is, how strongly acidic the water is.

(c) $CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$

The gas given off is **carbon dioxide**.

Marking: (a) pH of rain water less than 5.6 – ½ mark; lowers pH of lake, aquatic life survives only in a narrow pH range – ½ mark · (b) Litmus tells only acid/base; universal indicator gives the pH (strength) – 1 mark · (c) Balanced equation – ½ mark; carbon dioxide – ½ mark

Examiner tip: Balance the nitric acid ($2HNO_3$) and write the salt as $Ca(NO_3)_2$; unbalanced equations lose the ½ mark.

Q.28 Case-based question. (4 marks) **[4]**

28 In a school laboratory in Kolhapur, students took 10 mL of distilled water in test tube X and 10 mL of water from a village well in test tube Y. They added five drops of the same soap solution to each and shook both tubes for the same time. Tube X had a 4 cm high column of foam, while tube Y had very little foam and a white, curdy solid floating in it.

(A) Which water sample is hard? Name the ions that make water hard. (1)

(B) A soap molecule has two ends with different properties. Which end dissolves in water, and which end dissolves in oil? (1)

Attempt either sub-part C or D.

(C) The students have three more samples of well water, P, Q and R, and want to find out which is the hardest using only the soap solution. Describe how they should carry out the test so that the comparison is fair, and how they will decide which sample is the hardest. (2)

OR

(D) The students boiled some of the well water with a little washing soda, let the solid formed settle, and repeated the soap test with the clear water. What change will they observe compared with tube Y? Explain. (2)

Answer (4 marks)

(A) The well water in tube Y is hard. Hardness is caused by **calcium and magnesium ions** (Ca^{2+}, Mg^{2+}) from their salts dissolved in water; these react with soap to form the insoluble curdy solid (scum).

(B) The **ionic end** ($–COO^-Na^+$) is hydrophilic and dissolves in water; the long **hydrocarbon chain (tail)** is hydrophobic and dissolves in oil.

(C) Take the **same volume** (say 10 mL) of each sample in three identical test tubes. Add the same soap solution drop by drop to each, shaking each tube for the same time after every few drops, until a foam column of the same height (say 1 cm) is formed. Count the number of drops needed. The sample that needs the **largest number of drops** of soap solution (or forms the most scum) is the hardest.

OR

(D) The treated water will give **much more foam and little or no scum**, like distilled water. Washing soda is used for removing permanent hardness of water: the calcium and magnesium ions are removed as an insoluble solid that settles down, so they are no longer present to react with the soap.

Marking: (A) Tube Y hard – ½ mark; calcium and magnesium ions – ½ mark · (B) Ionic end in water – ½ mark; hydrocarbon tail in oil – ½ mark · (C) Same volume and same soap solution, same shaking (fair test) – 1 mark; counting drops for a fixed foam height, most drops = hardest – 1 mark · OR (D) More foam / little or no scum – 1 mark; washing soda removes the Ca^{2+} and Mg^{2+} ions (permanent hardness) – 1 mark

Examiner tip: In (C), say what is kept the same (volume, soap solution, shaking) – a test is fair only when one thing changes.

Q.29 Long answer question. (5 marks) **[5]**

29 **Attempt either option A or B.**

A.

I. A student heated some brown copper powder in a china dish; it slowly turned black. She then passed hydrogen gas over the heated black substance, and it turned brown again.

(a) Write the balanced chemical equations for both these changes. (1)

(b) In the second change, which substance is oxidised and which is reduced? Give a reason for each. (1)

(c) The black substance also dissolves in dilute hydrochloric acid to give a blue-green solution. Write the balanced chemical equation for this reaction. What does it show about the nature of metal oxides? (1)

II. A little white silver chloride was spread on a watch glass and kept in sunlight. After some time it turned grey.

(a) Write the balanced chemical equation for this change and name the type of reaction. (1)

(b) Give one practical use of such reactions. (1)

OR

B.

I. Blue crystals of a salt X were heated in a dry boiling tube. Drops of water collected near the mouth of the tube and the crystals turned into a white powder.

(a) Name X and write the chemical formula of its blue crystals. Where does the water come from, although the crystals looked dry? (1)

(b) After cooling, a few drops of water were added to the white powder. What will be observed? (1)

(c) Name one other salt that contains water of crystallisation, and write its formula showing the number of water molecules. (1)

II. (a) The municipal water works of a town adds bleaching powder to drinking water. Why is it added? Write the chemical equation for the manufacture of bleaching powder. (1)

(b) Give two other uses of bleaching powder. (1)

Answer (5 marks)

A. I. (a) $2Cu + O_2 \rightarrow 2CuO$ (on heating; black copper(II) oxide)

$CuO + H_2 \rightarrow Cu + H_2O$ (on heating; brown copper is formed again)

(b) **Copper(II) oxide is reduced**, because it loses oxygen; **hydrogen is oxidised**, because it gains oxygen (to form water).

(c) $CuO + 2HCl \rightarrow CuCl_2 + H_2O$

The metal oxide reacts with an acid to give a salt (copper(II) chloride, which gives the blue-green colour) and water, just as a base does. So metal oxides are **basic in nature**.

II. (a) $2AgCl(s) \rightarrow 2Ag(s) + Cl_2(g)$ (in sunlight)

It is a **decomposition reaction caused by light** (photolytic decomposition); the grey colour is due to silver.

(b) Such reactions (decomposition of silver chloride / silver bromide by light) are used in **black and white photography**.

OR

B. I. (a) X is **copper sulphate**; the blue crystals are $CuSO_4.5H_2O$. The crystals contain **water of crystallisation** – a fixed number of water molecules (five) in one formula unit of the salt – which is driven off on heating, leaving white anhydrous copper sulphate.

(b) The **blue colour** of the crystals reappears, as the salt takes up water again.

(c) Any one: washing soda, $Na_2CO_3.10H_2O$; gypsum, $CaSO_4.2H_2O$.

II. (a) It is added for **disinfecting** drinking water to make it free of germs.

$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$ (chlorine acting on dry slaked lime)

(b) Any two: bleaching cotton and linen in the textile industry; bleaching wood pulp in paper factories; bleaching washed clothes in laundry; as an oxidising agent in many chemical industries.

Marking: A: I (a) $2Cu + O_2 \rightarrow 2CuO$ – ½ mark; $CuO + H_2 \rightarrow Cu + H_2O$ – ½ mark · A: I (b) CuO reduced (loses oxygen) – ½ mark; H_2 oxidised (gains oxygen) – ½ mark · A: I (c) balanced equation – ½ mark; metal oxides are basic – ½ mark · A: II (a) balanced equation – ½ mark; decomposition by light – ½ mark · A: II (b) black and white photography – 1 mark · OR B: I (a) copper sulphate, $CuSO_4.5H_2O$ – ½ mark; water of crystallisation removed on heating – ½ mark · OR B: I (b) blue colour returns – 1 mark · OR B: I (c) correct salt with correct formula – 1 mark (½ if the number of water molecules is wrong) · OR B: II (a) disinfecting water – ½ mark; equation – ½ mark; (b) two uses – ½ + ½ mark

Examiner tip: In A-I(b), the substance that gains oxygen is oxidised and the one that loses oxygen is reduced – name both. In B-I(a), the dot in $CuSO_4.5H_2O$ shows water of crystallisation; the crystals are not 'wet'.

SECTION C – PHYSICS (Q.30 to Q.31) Multiple choice questions. Select the correct option. (1 mark each) **[2]**

30 A glass block (refractive index 1.52) is kept at the bottom of an aquarium filled with water (refractive index 1.33). A ray of light travelling in the water strikes the top surface of the glass block obliquely. On entering the glass, the ray:

(A) speeds up and bends away from the normal

(B) slows down and bends away from the normal

(C) passes straight through without any change in speed

(D) slows down and bends towards the normal

Answer (1 mark)

(D) Glass is optically denser than water (1.52 > 1.33), so light travels more slowly in glass. A ray going obliquely from a rarer to a denser medium slows down and bends towards the normal.

31 Which one of the following changes will **NOT** increase the strength of the magnetic field at a point near a long straight wire carrying a current?

(A) Increasing the current in the wire

(B) Bringing the point closer to the wire

(C) Reversing the direction of the current in the wire

(D) Increasing the current and also bringing the point closer to the wire

Answer (1 mark)

(C) Reversing the direction of the current only reverses the direction of the magnetic field; its strength stays the same. The field is stronger when the current is larger and when the point is closer to the wire.

Q.32 Assertion–Reason. Each question has two statements – Assertion (A) and Reason (R). Select the appropriate option (A), (B), (C) or (D) given below the question. (1 mark) **[1]**

32 **Assertion (A):** An object placed between the optical centre and the principal focus of a convex lens forms a real and inverted image.

Reason (R): For an object placed between the optical centre and the principal focus of a convex lens, the magnification is positive and greater than 1.

(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.

Answer (1 mark)

(D) A is false but R is true.

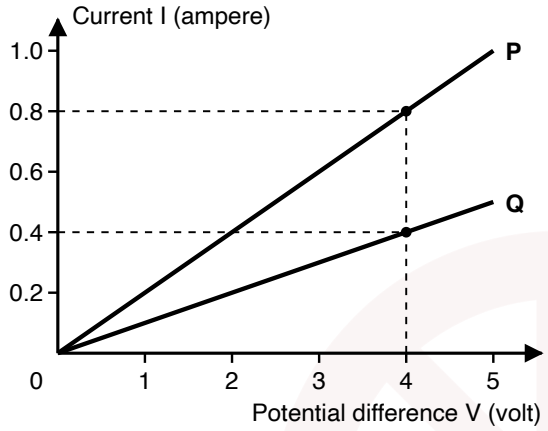
For an object between O and F_1, a convex lens forms a **virtual, erect and enlarged** image on the same side as the object. Since the image is erect and enlarged, the magnification is positive and greater than 1, so R is true.

Q.33 – Q.34 Answer the following questions. (2 marks each) **[4]**

33 The graph shows how the current I through two wires P and Q changes with the potential difference V applied across them. Both wires are made of the same material and have the same length. (For P, I = 0.8 A at V = 4 V; for Q, I = 0.4 A at V = 4 V.)

(a) Find the resistance of each wire.

(b) Which of the two wires is thicker? Give a reason.



Answer (2 marks)

(a) Both graphs are straight lines through the origin, so R = V/I for each wire.

R_P = 4 V / 0.8 A = **5 Ω**; R_Q = 4 V / 0.4 A = **10 Ω**

(b) Wire **P** is thicker. R = ρl/A; for the same material (same ρ) and the same length, resistance is inversely proportional to the area of cross-section. P has the smaller resistance, so it has the larger area of cross-section (it is thicker – its area is twice that of Q).

Marking: (a) R_P = 5 Ω – ½ mark; R_Q = 10 Ω – ½ mark · (b) P is thicker – ½ mark; R ∝ 1/A for same material and length – ½ mark

Examiner tip: The steeper line on an I–V graph (current on the vertical axis) has the smaller resistance; do not read the slope as resistance.

34 **Attempt either option A or B.**

A. Two resistors of 5 Ω and 20 Ω are available, along with a 10 V battery of negligible resistance.

I. The two resistors are connected in parallel across the battery. Find the power used in each resistor.

II. The same resistors are now connected in series across the same battery. Find the power used in each resistor. Which resistor produces more heat in this arrangement?

OR

B. A circular coil of 10 turns carries a current. A small compass needle placed at the centre of the coil gets deflected.

I. How will the magnetic field at the centre of the coil change if (a) the number of turns is increased to 30, keeping the current the same, and (b) the current is halved, keeping the number of turns the same?

II. Near the wire, the magnetic field lines of a circular coil are concentric circles, but at the centre of the coil they appear as almost straight lines. Explain why.

Answer (2 marks)

A. I. In parallel each resistor has the full 10 V across it; $P = V^2/R$.

5 Ω: P = 100/5 = **20 W**; 20 Ω: P = 100/20 = **5 W**.

II. In series R = 5 + 20 = 25 Ω, so I = 10/25 = 0.4 A; $P = I^2R$.

5 Ω: P = 0.16 × 5 = **0.8 W**; 20 Ω: P = 0.16 × 20 = **3.2 W**.

In series the **20 Ω** resistor produces more heat (the same current flows through both, and $H = I^2Rt$). (In parallel it was the 5 Ω resistor.)

OR

B. I. (a) The field produced by a coil of n turns is n times that of a single turn, because the current in each turn is in the same direction and the fields add up; so the field becomes **3 times** as strong. (b) The field is directly proportional to the current, so it becomes **half**.

II. Close to the wire, the field lines are concentric circles around each part of the wire, and the circles become larger as we move away from the wire. By the time we reach the centre of the coil, the arcs of these big circles appear as straight lines. Also, every section of the coil produces field lines in the same direction within the loop.

Marking: A: I 20 W and 5 W – ½ + ½ mark · A: II 0.8 W and 3.2 W – ½ mark; 20 Ω produces more heat in series – ½ mark · OR B: I 3 times – ½ mark; half – ½ mark · OR B: II circles grow larger away from the wire, so at the centre the arcs look straight / all sections give field in the same direction – 1 mark

Examiner tip: Use $P = V^2/R$ when the voltage is the same (parallel) and $P = I^2R$ when the current is the same (series).

Q.35 – Q.37 Answer the following questions. (3 marks each) **[9]**

35 For a science exhibition, Omkar wants to use a convex lens of focal length 12 cm to throw a sharp image of a glowing LED, 1.5 cm high, on a white screen. He wants the image to be 3 times as tall as the LED.

(a) At what distance from the lens should he place the LED?

(b) At what distance from the lens should he place the screen?

(c) Find the height of the image and state its nature.

Answer (3 marks)

The image is obtained on a screen, so it is real and inverted: m = –3. For a lens, m = v/u, so v = –3u.

Lens formula: 1/v – 1/u = 1/f, with f = +12 cm.

1/(–3u) – 1/u = 1/12 → –4/(3u) = 1/12 → u = –48/3 = **–16 cm**.

(a) The LED should be placed **16 cm in front of the lens** (on the left).

(b) v = –3u = –3 × (–16) = **+48 cm**: the screen should be 48 cm behind the lens, on the other side. (Check: 1/48 – 1/(–16) = 1/48 + 3/48 = 4/48 = 1/12 ✓)

(c) h′ = m × h = –3 × 1.5 = **–4.5 cm**. The image is 4.5 cm high, **real, inverted** and enlarged.

Marking: (a) Using m = v/u = –3 with the lens formula – 1 mark; u = –16 cm – ½ mark · (b) v = +48 cm – ½ mark · (c) h′ = –4.5 cm – ½ mark; real, inverted, enlarged – ½ mark

Examiner tip: For an image on a screen the magnification is negative; taking m = +3 gives a wrong (virtual) answer.

36 On a winter morning, Ira placed a glass prism on a sunny windowsill and saw a band of colours on the opposite wall.

(a) What is this band of colours called? Ira noticed that the band was much wider on the far wall than on a notebook held close to the prism. Explain why.

(b) Ira then placed a second, identical prism in an inverted position close to the first, so that the band of colours passed through it. What will she see on the wall now? What does this show about sunlight?

(c) Later that evening, after a rain shower, she saw a rainbow. In which direction with respect to the Sun must she look to see it, and what acts like the tiny prisms that form it?

Answer (3 marks)

(a) The band of colours is called a **spectrum** (formed by dispersion of white light). The different colours bend through different angles with respect to the incident beam as they pass through the prism (red the least, violet the most), so they come out of the prism travelling in slightly different directions. The farther they travel, the more they spread apart, so the band is wider on the far wall than on a notebook close to the prism.

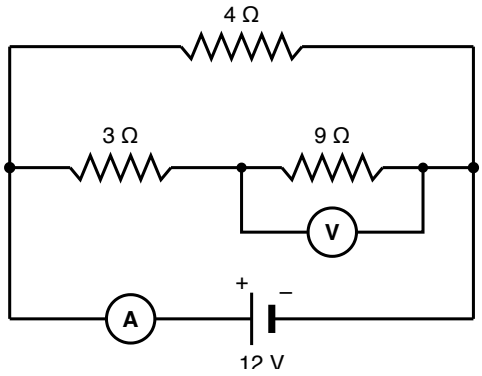
(b) A beam of **white light** will emerge from the second prism and she will see white light on the wall: the second (inverted) prism recombines all the colours. This shows that sunlight (white light) is made up of seven colours.

(c) A rainbow is always formed in the direction **opposite to the Sun**, so with the evening Sun in the west she must look towards the east (with the Sun behind her). Tiny **water droplets** in the air act like small prisms: they refract and disperse the sunlight, reflect it internally, and finally refract it again as it comes out.

Marking: (a) Spectrum (dispersion) – ½ mark; colours bend through different angles, so they emerge in different directions and spread apart with distance – ½ mark · (b) White light seen / colours recombine – ½ mark; sunlight is made of seven colours – ½ mark · (c) Opposite to the Sun (Sun behind the observer) – ½ mark; water droplets act as prisms – ½ mark

Examiner tip: In (c), the observer must have the Sun behind; writing 'towards the Sun' is a common mistake.

37 In the circuit shown, a 12 V battery is connected through an ammeter A to two branches in parallel: one branch has a 4 Ω resistor, and the other has a 3 Ω and a 9 Ω resistor in series. A voltmeter V is connected across the 9 Ω resistor. Neglect the resistance of the battery, the ammeter and the connecting wires, and assume that the voltmeter draws no current.
(a) Find the equivalent resistance of the circuit.
(b) Find the reading of the ammeter and the current in each branch.
(c) Find the reading of the voltmeter.



Answer (3 marks)
(a) Resistance of the lower branch = 3 + 9 = 12 Ω (series).
This is in parallel with 4 Ω: 1/R = 1/4 + 1/12 = (3 + 1)/12 = 4/12 → R = **3 Ω**.
(b) Ammeter reading I = V/R = 12/3 = **4 A**.
Each branch has the full 12 V across it:
Current in 4 Ω branch = 12/4 = **3 A**; current in the 3 Ω + 9 Ω branch = 12/12 = **1 A**. (Check: 3 + 1 = 4 A.)
(c) Voltmeter reading = p.d. across 9 Ω = IR = 1 × 9 = **9 V**.
Marking: (a) 12 Ω for series branch – ½ mark; R = 3 Ω – ½ mark · (b) 4 A – ½ mark; 3 A and 1 A – ½ mark · (c) 9 V – 1 mark
Examiner tip: Branches in parallel share the same potential difference (12 V), not the same current.

Q.38 Case-based question. (4 marks) **[4]**

38 The science club of a school in Solapur made a solar cooker. They lined the inside of a large bowl-shaped dish with a shiny reflecting sheet, so that the dish works as a concave mirror of radius of curvature 1.2 m. They point the dish towards the Sun and place a cooking pot in front of it.
(A) At what distance from the dish should the cooking pot be placed? Why? (1)
(B) A student suggests making the cooker with a convex mirror of the same size instead. Would it work? Give a reason. (1)
Attempt either sub-part C or D.
(C) In the evening, a student placed a candle flame 0.75 m in front of the dish. Using the mirror formula, find the position of the image of the flame and its magnification, and state the nature of the image. (2)
OR
(D) Draw a ray diagram to show the formation of the image of a candle flame placed between the centre of curvature C and the principal focus F of the dish. State the position and nature of the image. (2)

Answer (4 marks)
(A) Focal length f = R/2 = 1.2/2 = **0.6 m (60 cm)**. The pot should be placed at the principal focus, 0.6 m in front of the dish. Rays from the distant Sun are parallel to the principal axis; after reflection from a concave mirror they converge at the principal focus, so the heat is

concentrated on the pot.

(B) **No.** A convex mirror makes the parallel rays from the Sun diverge after reflection (they only appear to come from a focus behind the mirror), so the sunlight would spread out instead of being concentrated on the pot.

(C) Using the sign convention: f = –60 cm, u = –75 cm.

$1/v + 1/u = 1/f \rightarrow 1/v = 1/f - 1/u = -1/60 + 1/75 = (-5 + 4)/300 = -1/300 \rightarrow v =$ **–300 cm** (3.0 m in front of the dish).

$m = -v/u = -(-300)/(-75) =$ **–4**.

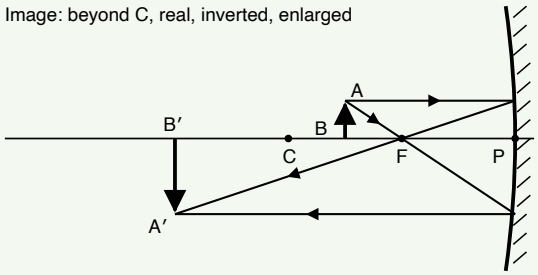
The image is **real, inverted and enlarged** (four times the size of the flame), formed beyond C on the same side as the object.

OR

(D) See the figure: a ray from the top of the flame parallel to the principal axis passes through F after reflection; a ray through F becomes parallel to the principal axis after reflection. The reflected rays meet beyond C.

The image is formed **beyond C**; it is **real, inverted and enlarged**.

Image: beyond C, real, inverted, enlarged



Marking: (A) 0.6 m (at F) – ½ mark; parallel rays from the Sun converge at F – ½ mark · (B) No – ½ mark; convex mirror diverges the reflected rays, so no heat is concentrated – ½ mark · (C) v = –300 cm – 1 mark; m = –4 – ½ mark; real, inverted, enlarged – ½ mark · OR (D) Correct ray diagram with arrows – 1 mark; beyond C – ½ mark; real, inverted, enlarged – ½ mark

Examiner tip: Use f = R/2 and keep the signs: for a concave mirror both f and the object distance are negative.

Q.39 Long answer question. Attempt either option (A) or (B). (5 marks) **[5]**

(A) A company in Shimla is designing an electric room heater that should consume 1210 W when connected to the 220 V supply.

I. Calculate the resistance of the heating element and the current it draws. (1)

II. The element is to be made of nichrome wire of cross-sectional area 0.25 mm^2. The resistivity of nichrome is 1.0×10^{-6} Ω m. Calculate the length of wire needed. (2)

III. For a larger room, the company wants a 2420 W heater for the same 220 V supply, made from the same nichrome wire of cross-sectional area 0.25 mm^2. What length of wire will be needed? (1)

IV. On winter evenings the supply voltage sometimes falls to 200 V. Assuming the resistance of the element does not change, find the power of the heater at this voltage. (1)

Answer (5 marks)

I. $P = V^2/R \rightarrow R = V^2/P = (220 \times 220)/1210 = 48400/1210 =$ **40 Ω**.

$I = P/V = 1210/220 =$ **5.5 A**. (Check: $V/R = 220/40 = 5.5$ A.)

II. $R = \rho l/A \rightarrow l = RA/\rho$

$A = 0.25\ mm^2 = 0.25 \times 10^{-6}\ m^2$

$l = (40 \times 0.25 \times 10^{-6})/(1.0 \times 10^{-6}) =$ **10 m**.

III. $R' = V^2/P' = 48400/2420 =$ **20 Ω**

$l' = R'A/\rho = (20 \times 0.25 \times 10^{-6})/(1.0 \times 10^{-6}) =$ **5 m**. (A heater of higher power on the same supply

needs a smaller resistance, so a shorter wire.)

IV. $P' = V'^2/R = (200 \times 200)/40 =$ **1000 W**.

Marking: I: R = 40 Ω – ½ mark; I = 5.5 A – ½ mark · II: l = RA/ρ – ½ mark; area converted to m^2 – ½ mark; l = 10 m – 1 mark · III: R′ = 20 Ω – ½ mark; l′ = 5 m – ½ mark · IV: 1000 W – 1 mark

Examiner tip: Convert mm^2 to m^2 ($1\ mm^2 = 10^{-6}\ m^2$) before substituting; this is the most common error.

OR

(B) I. A thick copper wire is passed vertically through the centre of a horizontal sheet of cardboard, and a steady current is passed **upward** through the wire. Iron filings sprinkled on the cardboard arrange themselves in a pattern when the cardboard is gently tapped. Describe the pattern, and state the direction of the magnetic field lines as seen from above. Name the rule you used. (1)

II. Two small compasses are placed on the cardboard: one 3 cm due **east** of the wire and the other 3 cm due **north** of the wire. Assuming that the Earth's magnetic field is negligible compared with the field of the wire, in which direction will the north pole of each compass needle point? Explain. (2)

III. The same wire, still carrying the current vertically upward, is now placed between the poles of a strong horseshoe magnet so that the magnetic field is horizontal and directed from **west to east**. In which direction will the wire be pushed? Name the rule you used and show how you applied it. (2)

Answer (5 marks)

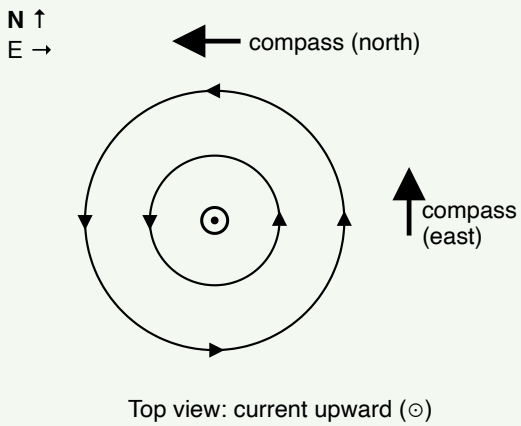
I. The iron filings arrange themselves in **concentric circles** centred on the wire. By the **right-hand thumb rule** (hold the wire in the right hand with the thumb pointing upward along the current; the fingers curl in the direction of the field), the field lines are **anticlockwise** as seen from above.

II. A compass needle sets along the tangent to the field line through its position, with its north pole pointing in the direction of the field. Going anticlockwise as seen from above (see the figure):

Compass due east of the wire – north pole points towards the **north**.

Compass due north of the wire – north pole points towards the **west**.

III. By **Fleming's left-hand rule**: stretch the thumb, forefinger and middle finger of the left hand mutually perpendicular. Point the forefinger along the field (towards the east) and the middle finger along the current (vertically upward); the thumb then points towards the **north**. So the wire is pushed towards the **north**.



Top view: current upward (⊙)

Marking: I: Concentric circles – ½ mark; anticlockwise seen from above (right-hand thumb rule) – ½ mark · II: East compass points north – 1 mark; north compass points west – 1 mark · III: Fleming's left-hand rule correctly applied – 1 mark; towards the north – 1 mark

Examiner tip: Draw a quick top view with N, E, S and W marked and the field circle drawn anticlockwise; a compass needle always lies along the tangent to the field line. In Fleming's rule use the LEFT hand: Forefinger – Field, middle finger – current, thuMb – Motion.

All the best for your exam!