SCIENCE (Subject Code 086)

Class X (2026-27) · ANSWER KEY & MARKING SCHEME — SET 1

Time Allowed: 3 Hours **Maximum Marks:** 80

General Instructions:

- This key gives a full worked solution for every question, including both options of each internal choice.
- Any other correct method or equivalent wording should be given full credit.
- Marks shown in italics against a question indicate the intended step-wise distribution.
- For numerical questions, award marks for the correct formula, correct substitution and correct unit even if the final arithmetic slips.

SECTION A — BIOLOGY

(Unit II: World of Living, and Unit V: Natural Resources) — 30 marks

1. A student collects four samples of digestive fluid from four different parts of the human digestive system. The sample that will turn blue litmus paper red most strongly was collected from the: **[1]**

(A) mouth (oral cavity)
(B) stomach
(C) duodenum
(D) ileum

Answer

(B) stomach

Gastric juice secreted by the gastric glands contains hydrochloric acid, which makes the contents of the stomach strongly acidic (about pH 1.5–2). Saliva in the mouth is nearly neutral, and the contents of the duodenum and ileum are made alkaline by bile and pancreatic juice.

2. A sprinter's leg muscles begin to ache after running a 400 m race at full speed. The substance that has built up in those muscle cells is: **[1]**

(A) ethanol and carbon dioxide
(B) lactic acid
(C) pyruvate and oxygen
(D) glucose

Answer

(B) lactic acid

During a hard sprint the muscles use oxygen faster than the blood can supply it. In this shortage of oxygen the pyruvate formed from glucose is broken down anaerobically in the muscle cells into lactic acid, and it is the build-up of lactic acid that causes cramps and the aching feeling. Ethanol and carbon dioxide are produced by yeast, not by human muscle.

3. Which one of the following blood vessels carries oxygen-rich blood? **[1]**

(A) pulmonary artery
(B) pulmonary vein
(C) superior vena cava
(D) renal vein

Answer

(B) pulmonary vein

The pulmonary vein is the one vein that carries oxygenated blood — it brings blood from the lungs back to the left atrium. The pulmonary artery is the one artery that carries de-oxygenated blood (heart to lungs). Both the superior vena cava and the renal vein return oxygen-poor blood to the heart.

4. In a nephron, blood is filtered under pressure in the: **[1]**

(A) loop of Henle
(B) glomerulus
(C) collecting duct
(D) urinary bladder

Answer

(B) glomerulus

The glomerulus is the cluster of capillaries sitting inside Bowman's capsule. Blood enters it at high pressure and water, glucose, salts, urea and amino acids are filtered out into the capsule. The loop of Henle and the collecting duct are concerned with selective re-absorption, and the bladder only stores the urine that has already been formed.

5. **Assertion (A):** A person pulls the hand away from a hot pan before actually feeling the pain. **[1]**

Reason (R): In a reflex action the impulse travels from the sensory neuron to a relay neuron in the spinal cord and then to the motor neuron, without waiting for a decision from the brain.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but 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

(a) Both A and R are true and R is the correct explanation of A.

The reflex arc is completed in the spinal cord, so the motor command to the arm muscles is issued while the sensory information is still travelling up to the brain. The hand therefore moves first and the feeling of pain is registered a moment later. This short-cut is exactly why reflex arcs evolved — they save time when a delay would cause injury.

6. A potted plant kept in a room bends towards an open window. This happens because auxin: **[1]**

(A) collects on the lit side and makes those cells longer
(B) collects on the shaded side and makes those cells longer
(C) collects on the lit side and makes those cells shorter
(D) is completely destroyed on the shaded side

Answer

(B) collects on the shaded side and makes those cells longer

Auxin is made at the shoot tip and diffuses away from light. It therefore becomes more concentrated on the shaded side of the stem, where it makes the cells elongate more than the cells on the lit side. Because one side of the stem grows longer than the other, the shoot curves towards the light — this is positive phototropism.

7. Which of the following contraceptive methods works purely as a mechanical barrier? **[1]**

(A) oral pills
(B) Copper-T
(C) condom
(D) vasectomy

Answer

(C) condom

A condom simply prevents the sperm from reaching the egg — a physical barrier and nothing more. Oral pills act by changing hormone levels, the Copper-T is an intra-uterine device, and vasectomy is a surgical method in which the vas deferens is blocked.

8. In the food chain grass → grasshopper → frog → snake, 10 000 J of energy is available at the level of the grass. Using the ten per cent law, the energy available to the snake is: **[1]**

(A) 1000 J
(B) 100 J
(C) 10 J
(D) 1 J

Answer

(C) 10 J

By the ten per cent law only about 10% of the energy at one trophic level passes to the next.

Grass 10 000 J → grasshopper 1000 J → frog 100 J → **snake 10 J**.

This steep loss at every step is also the reason food chains rarely have more than four or five links.

9. Assertion (A): Polythene carry bags remain in the soil almost unchanged for decades. **[1]**

Reason (R): Polythene is a non-biodegradable substance, so it is not broken down by the enzymes of decomposer micro-organisms.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but 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

(a) Both A and R are true and R is the correct explanation of A.

Decomposer bacteria and fungi carry enzymes that act on natural materials such as paper, cotton and food waste. Polythene is a man-made polymer for which they have no matching enzyme, so it is not decomposed and simply accumulates in the soil and in water bodies year after year.

10. Aquatic animals such as fish breathe much faster than land animals of a similar size. Give two reasons. **[2]**

Answer

(i) The amount of oxygen dissolved in water is far smaller than the amount of oxygen present in the same volume of air, so a fish gets very little oxygen from each mouthful of water.

(ii) Water is much denser and moves more slowly than air, and diffusion through it is slow, so a large volume of water has to be pushed continuously over the gills to absorb enough oxygen.

Both reasons force the fish to raise its rate of breathing.

Marking: 1 mark for each correct reason.

11. State two differences between the nervous system and the hormonal (endocrine) system in the way each carries information in the human body. **[2]**

OR

Name the plant hormone that promotes cell elongation and the one that inhibits growth, and state one function of each.

Answer

(i) The nervous system carries information as an **electrical impulse along nerve fibres**; the endocrine system carries it as a **chemical (a hormone) dissolved in the blood**.

(ii) A nerve impulse is **extremely fast and its effect is short-lived and limited** to the organ supplied by that nerve; a hormone travels **slowly but its effect lasts much longer** and can reach every part of the body through the blood.

Marking: 1 mark for each valid difference.

Answer — OR option

Promotes cell elongation — auxin. Auxin is made at the shoot tip and makes the cells just behind the tip grow longer, which is what produces the bending of a shoot towards light.

Inhibits growth — abscisic acid. Abscisic acid slows growth, closes the stomata when the plant is short of water, and causes wilting and the shedding of leaves.

Marking: 1 mark for each hormone with its function. Gibberellin, which also promotes stem elongation, is acceptable for the first part.

12. Two farmers grow the same crop. Farmer A sows, year after year, tubers saved from his own previous harvest. Farmer B sows seed obtained by crossing two different varieties. A new fungal disease then spreads through the district. In whose field are some plants more likely to survive? Give a reason. **[2]**

Answer

Some plants in **Farmer B's** field are more likely to survive.

Farmer B's seed is the product of **sexual reproduction** between two different varieties, so his plants differ from one another — the population carries a good deal of variation. Among so many slightly different plants, some are likely to carry a feature that lets them resist the new fungus, and those plants survive and set seed.

Farmer A's tubers are produced by **asexual reproduction**, so his plants are practically identical copies of the parent. If the fungus can attack one of them it can attack all of them, and the whole field may be lost.

Marking: 1 mark for identifying Farmer B, 1 mark for the reason based on variation from sexual reproduction.

13. (a) Name the process by which plants lose water as vapour through the stomata. **[3]**

(b) Explain how this process helps water to move upwards in a tall tree.

(c) State one condition in which the rate of this process falls.

OR

(a) Name the pigment that captures light energy in a leaf.

(b) Write the balanced chemical equation for photosynthesis.

(c) State what happens to the glucose that the plant does not use immediately.

Answer

(a) Transpiration.

(b) As water evaporates from the mesophyll cells and escapes through the stomata, those cells draw water from the xylem next to them. This creates a suction called the **transpiration pull**. Since the column of water in the xylem is continuous from root to leaf, the pull is passed all the way down and lifts water up even to the top of a tall tree.

(c) The rate falls when the surrounding air is **very humid** (also acceptable: at night when the stomata close, in still air, or at a low temperature).

Marking: 1 mark for each part.

Answer — OR option

(a) Chlorophyll.

(b) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ (in the presence of sunlight and chlorophyll).

(c) The glucose that is not used at once is converted into **starch** and stored in the leaves, and later in other parts such as roots, stems and seeds.

Marking: 1 mark for each part; the equation must be balanced.

14. (a) What is meant by biological magnification? **[3]**

(b) Why are organisms at the highest trophic level worst affected by it?

(c) Suggest one practical step a school can take to reduce non-biodegradable waste.

Answer

(a) Biological magnification is the progressive increase in the concentration of a harmful, non-biodegradable substance (for example a pesticide) in the bodies of organisms at each successive higher level of a food chain.

(b) Such a substance is neither broken down nor excreted, so whatever an organism takes in stays in its body. Each consumer eats many organisms from the level below it and therefore receives the whole of the chemical they had stored. The amount keeps adding up at every step, so the concentration is highest in the organisms at the top of the chain — which is often ourselves.

(c) Any one workable step, for example: keep separate bins for biodegradable and non-biodegradable waste and send the second lot for recycling; replace single-use plastic water bottles with steel bottles and a refill station; ask the canteen to use paper or cloth bags instead of polythene.

Marking: 1 mark for each part.

15. Read the following and answer the questions that follow. **[4]**

*Meera set up two identical potted plants, P and Q. She covered the soil of both pots with a plastic sheet so that no water could evaporate from the soil. She then smeared petroleum jelly on the **lower** surface of every leaf of plant P and on the **upper** surface of every leaf of plant Q. Both plants were enclosed in transparent plastic bags and kept side by side in the same well-lit place for four hours. At the end, far more water droplets had collected inside the bag of plant Q than inside the bag of plant P.*

(a) Name the process responsible for the droplets. **(1)**

(b) Explain why more droplets appeared in the bag of plant Q. **(1)**

(c) Why was the soil covered with a plastic sheet? **(1)**

(d) A third plant R had jelly smeared on both surfaces of its leaves and was treated in the same way. State what would be observed, with a reason. **(1)**

Answer

(a) Transpiration.

(b) In an ordinary broad leaf the stomata are far more numerous on the **lower** surface. In plant Q the jelly sealed only the upper surface, so nearly all its stomata stayed open and transpiration went on almost normally. In plant P the jelly sealed the lower surface, blocking most of the stomata, so very little water vapour escaped.

(c) So that the water vapour collected in the bag could have come **only from the leaves** and not from evaporation of water from the soil. This keeps the comparison a fair test.

(d) Hardly any droplets — or none at all. With jelly on both surfaces the stomata of both surfaces are blocked, so transpiration is almost completely stopped.

Marking: 1 mark for each part.

16. **A.** (i) List three features of the alveoli that make them well suited for the exchange of gases. **(3)** **[5]**

(ii) Explain why the wall of the left ventricle of the human heart is thicker than that of the right ventricle. **(2)**

OR

B. (i) Describe how food is moved along and acted upon in the human alimentary canal from the mouth to the small intestine, naming the secretions involved. **(3)**

(ii) State the role of bile in the digestion of fats. **(2)**

Answer

A (i) Any three of the following:

• The alveoli are millions of tiny balloon-like sacs, which together give an enormous surface area for the exchange of gases.

• Their walls are extremely thin — only one cell thick — so gases diffuse across very quickly.

• Their walls carry a dense network of blood capillaries, so the exchanged gases are carried away at once and a steep diffusion gradient is maintained.

• The inner surface is moist, so the gases dissolve before diffusing.

A (ii) The left ventricle has to pump oxygenated blood into the aorta and drive it all the way round the body, against considerable resistance. Doing this needs a high pressure, which needs a thick, powerful muscular wall. The right ventricle only has to send blood the short distance to the lungs, and the delicate lung capillaries would be damaged by a high pressure, so a much thinner wall is enough.

Marking: 1 mark for each feature in (i); 2 marks for a correct explanation in (ii).

Answer — OR option

B (i) Mouth: the teeth chew the food and the salivary glands pour in saliva, whose enzyme **salivary amylase** starts breaking starch into sugar; mucus makes the food slippery and the tongue rolls it into a bolus.

Oesophagus: rhythmic waves of muscular contraction called **peristalsis** push the bolus down into the stomach.

Stomach: the muscular wall churns the food while the gastric glands pour in **gastric juice** — hydrochloric acid (which makes the medium acidic and kills germs), the enzyme **pepsin** (which digests proteins) and mucus (which protects the stomach lining). The food is released in small amounts into the small intestine through a sphincter.

Small intestine: bile from the liver and **pancreatic juice** from the pancreas (containing amylase, trypsin and lipase) act on the food, and finally the **intestinal juice** completes the digestion of carbohydrates, proteins and fats into glucose, amino acids, fatty acids and glycerol.

B (ii) Bile has two roles in the digestion of fats. First, it is alkaline and neutralises the acid coming from the stomach, giving the alkaline medium that the fat-digesting enzyme lipase needs. Second, the bile salts **emulsify** the large fat globules — they break them into very many tiny droplets, which greatly increases the surface area on which lipase can act, so fat is digested much faster. Bile itself contains no enzyme.

Marking: 3 marks for the account in (i) — 1 mark each for mouth, stomach and small intestine with the correct secretions; 2 marks for (ii).

SECTION B — CHEMISTRY

(Unit I: Chemical Substances — Nature and Behaviour) — 25 marks

17. On strong heating, lead nitrate gives lead oxide, nitrogen dioxide and oxygen: **[1]**

$2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

This reaction is best classified as:

(A) combination

(B) displacement

(C) thermal decomposition

(D) double displacement

Answer

(C) thermal decomposition

A single compound is broken down by heat into three simpler products. Because the energy needed is supplied as heat, it is a thermal decomposition (and, being a reaction that absorbs heat, it is endothermic).

18. When the equation ___Al + ___H_2SO_4 → $Al_2(SO_4)_3$ + ___H_2 is balanced using the smallest whole numbers, the coefficients of Al, H_2SO_4 and H_2 respectively are: **[1]**

(A) 2, 3, 3
(B) 2, 3, 2
(C) 1, 3, 3
(D) 3, 2, 3

Answer

(A) 2, 3, 3

The balanced equation is **$2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$**.

Check: Al 2 = 2; S 3 = 3; O 12 = 12; H 6 = 6. Option (B) fails because it leaves 6 hydrogen atoms on the left and only 4 on the right.

19. Four solutions have pH values 2, 6, 8 and 12. Adding a pinch of sodium carbonate will produce the most vigorous fizzing in the solution of pH: **[1]**

(A) 2
(B) 6
(C) 8
(D) 12

Answer

(A) 2

The lower the pH, the higher the concentration of hydrogen ions and the stronger the acid. A carbonate reacts with an acid to give carbon dioxide, so the most acidic solution (pH 2) gives the briskest effervescence. The solutions of pH 8 and 12 are basic and would give no fizzing at all.

20. A white crystalline solid X is used in baking. On heating, X gives a solid residue Y, water vapour, and a gas that turns lime water milky. X is: **[1]**

(A) washing soda
(B) baking soda
(C) bleaching powder
(D) plaster of Paris

Answer

(B) baking soda

Baking soda is sodium hydrogencarbonate. On heating:

$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

The residue Y is sodium carbonate (washing soda), and the gas that turns lime water milky is carbon dioxide. This is exactly the reaction that makes a cake rise.

21. Assertion (A): A clean piece of copper placed in zinc sulphate solution shows no visible change. **[1]**

Reason (R): Copper lies below zinc in the reactivity series and cannot displace zinc from its salt solution.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but 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

(a) Both A and R are true and R is the correct explanation of A.

A displacement reaction happens only when the metal added is *more* reactive than the metal already in the salt. Copper is less reactive than zinc, so it cannot push zinc out of zinc sulphate, and nothing is seen to happen. (The reverse experiment does work — zinc added to copper sulphate turns the blue solution colourless and deposits red-brown copper.)

22. Ionic compounds such as sodium chloride: **[1]**

(A) conduct electricity in the solid state
(B) have very low melting points
(C) conduct electricity when molten or dissolved in water
(D) dissolve readily in petrol

Answer

(C) conduct electricity when molten or dissolved in water

In the solid state the ions are locked in position in the crystal lattice and cannot move, so no current flows. On melting or on dissolving in water the lattice breaks up, the ions become free to move towards the electrodes, and the substance conducts. Ionic compounds also have *high* melting points and dissolve in water rather than in petrol or kerosene.

23. Two successive members of a homologous series differ by: **[1]**

(A) a $-CH_3$ group and 14 u
(B) a $-CH_2-$ group and 14 u
(C) a $-CH_2-$ group and 12 u
(D) a $-C_2H_4-$ group and 28 u

Answer

(B) a $-CH_2-$ group and 14 u

Successive members of a homologous series differ by one $-CH_2-$ unit. Its mass is $12 + (2 \times 1) =$ **14 u**, which is why the molecular masses in a homologous series go up in steps of 14.

24. Soap is not effective for washing clothes in hard water because: **[1]**

(A) soap does not dissolve in hard water at all
(B) calcium and magnesium ions in hard water form an insoluble scum with soap
(C) hard water has a very low pH
(D) soap breaks down into fatty acid and glycerol in hard water

Answer

(B) calcium and magnesium ions in hard water form an insoluble scum with soap

Hard water contains dissolved calcium and magnesium salts. These react with the soap to form an insoluble, sticky curd called scum, which sticks to the cloth. The soap is used up making scum instead of lather, so cleaning is poor. Detergents work in hard water because their calcium and magnesium salts stay soluble.

25. Write a balanced chemical equation with state symbols for the reaction of dilute sulphuric acid with zinc granules, and name the gas evolved. **[2]**

Answer

$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

Check: Zn 1 = 1, H 2 = 2, S 1 = 1, O 4 = 4 — the equation is balanced.

The gas evolved is **hydrogen**. It is collected and tested by bringing a burning splint near the mouth of the tube — the gas burns with a squeaky pop sound.

Marking: 1 mark for the correct balanced equation with state symbols, 1 mark for naming the gas.

26. (a) Name the process used to convert a sulphide ore into its oxide before reduction. **[3]**

(b) Write the balanced equation for the reduction of zinc oxide by carbon.

(c) Why is the metal obtained by such reduction usually refined afterwards?

OR

(a) What is corrosion?

(b) Name the metal that develops a green coating on long exposure to moist air, and name the coating.

(c) State one method of preventing the rusting of an iron gate.

Answer

(a) Roasting — the sulphide ore is heated strongly in the presence of excess air, which converts it into the oxide.

(b) $ZnO + C \rightarrow Zn + CO$

Check: Zn 1 = 1, O 1 = 1, C 1 = 1. Carbon is the reducing agent here.

(c) The metal obtained straight from reduction is impure — it still contains unreacted ore, bits of slag, carbon and traces of other metals. These impurities spoil the properties of the metal, so it is purified, most often by **electrolytic refining**.

Marking: 1 mark for each part.

Answer — OR option

(a) Corrosion is the slow eating away of the surface of a metal by the air, moisture and chemicals around it, which converts the surface into oxides, carbonates or sulphides.

(b) The metal is **copper**, and the green coating is **basic copper carbonate**.

(c) Any one method: painting the gate; oiling or greasing it; galvanising it (coating it with a layer of zinc); or electroplating it. Each works by keeping air and moisture away from the iron surface.

Marking: 1 mark for each part.

27. (a) Name the compound formed when chlorine is passed over dry slaked lime. **[3]**

(b) Write the balanced chemical equation for this reaction.

(c) State one use of the product.

Answer

(a) Bleaching powder, calcium oxychloride, $CaOCl_2$.

(b) $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$

Check: Ca 1 = 1, O 2 = 2, H 2 = 2, Cl 2 = 2 — balanced.

(c) Any one use: for disinfecting drinking water; for bleaching cotton and linen in the textile industry or wood pulp in paper factories; as an oxidising agent in chemical industries.

Marking: 1 mark for each part.

28. Read the following and answer the questions that follow. **[4]**

Ravi tested five household liquids with a universal indicator and recorded the pH of each:

Lemon juice 2 | Milk 6 | Distilled water 7 | Baking-soda solution 9 | Oven cleaner 13

(a) Which liquid has the highest concentration of hydrogen ions? **(1)**

(b) Tooth enamel begins to corrode below pH 5.5. Using the table, explain why rinsing the mouth with the baking-soda solution after a lemon drink helps. **(1)**

(c) A farmer finds that his field soil has pH 5. Name a substance he could add, and state why. **(1)**

(d) Arrange milk, distilled water and oven cleaner in increasing order of hydroxide ion concentration. **(1)**

Answer

(a) Lemon juice. It has the lowest pH (2), and the lower the pH the higher the concentration of hydrogen ions.

(b) A lemon drink leaves the mouth strongly acidic, well below pH 5.5, so the enamel starts to corrode. The baking-soda solution is basic (pH 9), so rinsing with it neutralises the extra acid and raises the pH of the mouth back above 5.5, and the enamel is no longer attacked.

(c) He could add quicklime, slaked lime or chalk — any basic substance. Soil of pH 5 is acidic; a base neutralises the excess acid and brings the pH back towards neutral, which suits the crop.

(d) Milk (6) < distilled water (7) < oven cleaner (13). The higher the pH, the more basic the liquid and the greater its hydroxide ion concentration.

Marking: 1 mark for each part.

29. A. (i) Write the IUPAC name of the second member of the alkane series and describe its electron dot structure. **(2)** **[5]**

(ii) Give two reasons why carbon forms a very large number of compounds. **(2)**

(iii) Write the balanced equation for the complete combustion of ethanol in air. **(1)**

OR

B. (i) Write the balanced equation for the reaction of ethanoic acid with sodium hydrogencarbonate and name the gas released. **(2)**

(ii) What is esterification? Write the equation for the formation of ethyl ethanoate. **(2)**

(iii) State one test that distinguishes ethanol from ethanoic acid. **(1)**

Answer

A (i) The second member of the alkane series is **ethane**, C_2H_6.

Electron dot structure: each carbon atom has four valence electrons and each hydrogen one. The two carbon atoms share **one** pair of electrons with each other, forming the C–C single bond, and each carbon shares one pair with each of **three** hydrogen atoms. In this way every carbon completes its octet and every hydrogen its duplet, giving $H_3C–CH_3$ with each bond drawn as a shared pair of dots.

A (ii) Catenation — carbon atoms join to one another by strong covalent bonds to form long chains, branched chains and rings, with single, double or triple bonds. **Tetravalency** — carbon has a valency of four, so one carbon atom can bond with four other atoms of carbon, hydrogen, oxygen, nitrogen, sulphur or a halogen. Together these give an enormous number of possible structures. (The small size of the carbon atom, which makes its bonds unusually strong and its compounds stable, is also acceptable.)

A (iii) $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ (+ heat and light)

Check: C 2 = 2, H 6 = 6, O 7 = 7 — balanced.

Marking: (i) 1 mark for the name, 1 for the structure; (ii) 1 mark for each reason; (iii) 1 mark for the balanced equation.

Answer — OR option

B (i) $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$

Check: C 3 = 3, H 5 = 5, Na 1 = 1, O 5 = 5 — balanced. The gas released is **carbon dioxide**, seen as brisk effervescence; it turns lime water milky.

B (ii) Esterification is the reaction of a carboxylic acid with an alcohol, in the presence of a little concentrated sulphuric acid, to give a sweet-smelling **ester** and water.

$CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$ (conc. H_2SO_4)

Check: C 4 = 4, H 10 = 10, O 3 = 3 — balanced. The product is ethyl ethanoate.

B (iii) Add a pinch of sodium hydrogencarbonate to each liquid. **Ethanoic acid** gives brisk effervescence of carbon dioxide, which turns lime water milky; **ethanol** gives no effervescence at all. (Alternatively, ethanoic acid turns blue litmus red while ethanol has no effect on litmus.)

Marking: (i) 1 mark for the equation, 1 for the gas; (ii) 1 mark for the definition, 1 for the equation; (iii) 1 mark for the test with the observation.

SECTION C — PHYSICS

(Unit III: Natural Phenomena, and Unit IV: Effects of Current) — 25 marks

30. An object is placed between the pole and the principal focus of a concave mirror. The image formed is: **[1]**

(A) real, inverted and diminished
(B) real, inverted and magnified
(C) virtual, erect and magnified
(D) virtual, erect and diminished

Answer

(C) virtual, erect and magnified

This is the single position for which a concave mirror gives a virtual image. The reflected rays diverge and appear to come from a point behind the mirror, so the image is virtual, erect and larger than the object. It is why a concave mirror is used as a shaving mirror and by dentists.

31. Assertion (A): The sky appears blue to an observer standing on the surface of the Earth. **[1]**

Reason (R): The molecules of air scatter light of shorter wavelengths much more strongly than light of longer wavelengths.

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true but 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

(a) Both A and R are true and R is the correct explanation of A.

The molecules of the atmosphere are very small compared with the wavelength of visible light, and such small particles scatter the shorter (blue) wavelengths far more strongly than the longer (red) ones. Scattered blue light reaches our eyes from every direction in the sky, so the sky looks blue. An astronaut, who has almost no atmosphere above, sees a black sky instead.

32. A uniform metal wire has resistance R. It is cut into three equal pieces and the three pieces are joined in parallel. The resistance of the combination is: **[1]**

(A) R/3

(B) R/9

(C) 3R

(D) 9R

Answer

(B) R/9

Resistance is proportional to length, so each of the three equal pieces has resistance R/3.

Three equal resistances in parallel give one-third of the value of one of them:

$R_p = (R/3) \div 3 =$ **R/9**.

33. A 6 Ω and a 3 Ω resistor are joined in parallel, and this combination is joined in series with a 4 Ω resistor across a 12 V battery of negligible internal resistance. Calculate (a) the total resistance of the circuit and (b) the current drawn from the battery. **[2]**

Answer

(a) For the parallel pair:

$R_p = (6 \times 3) / (6 + 3) = 18/9 =$ **2 Ω**

This 2 Ω is in series with 4 Ω, so the total resistance is

$R = 2 + 4 =$ **6 Ω**

(b) $I = V/R = 12/6 =$ **2 A**

Marking: 1 mark for the total resistance, 1 mark for the current.

34. An electric iron rated 1500 W, 230 V is used for 45 minutes each day. Calculate the electrical energy it consumes in 30 days, in kWh. **[2]**

Answer

Power P = 1500 W = **1.5 kW**. Time per day t = 45 min = 45/60 = **0.75 h**.

Energy used in one day = P × t = 1.5 × 0.75 = **1.125 kWh**

Energy used in 30 days = 1.125 × 30 = **33.75 kWh** (33.75 units)

The voltage rating is not needed for this calculation.

Marking: 1 mark for the energy per day, 1 mark for the 30-day total with the correct unit.

35. An object 4 cm high is placed 15 cm in front of a concave mirror of focal length 10 cm. Find the position, nature and size of the image. **[3]**

OR

An object is placed 30 cm from a convex mirror of focal length 20 cm. Find the position and nature of the image and the magnification.

Answer

Using the sign convention: u = –15 cm, f = –10 cm, h = +4 cm.

Mirror formula: 1/v + 1/u = 1/f

$1/v = 1/f - 1/u = (-1/10) - (-1/15) = -1/10 + 1/15 = (-3 + 2)/30 = -1/30$

v = –30 cm — the image is formed 30 cm in front of the mirror, on the same side as the object, so it is **real**.

Magnification $m = -v/u = -(-30)/(-15) =$ **–2**

The negative sign shows the image is **inverted**, and its size is twice the object's.

Height of image $h' = m \times h = -2 \times 4 =$ **–8 cm**, i.e. 8 cm tall and inverted.

Answer: real, inverted and magnified; 30 cm in front of the mirror; 8 cm tall.

Marking: 1 mark for v, 1 for m, 1 for the size and nature.

Answer — OR option

For a convex mirror: u = –30 cm, f = +20 cm.

$1/v = 1/f - 1/u = 1/20 - (-1/30) = 1/20 + 1/30 = (3 + 2)/60 = 5/60 = 1/12$

v = +12 cm — the image is 12 cm **behind** the mirror, so it is **virtual and erect**.

$m = -v/u = -12/(-30) =$ **+0.4**

The magnification is positive (erect) and less than 1, so the image is **diminished** — it is 0.4 times the size of the object.

Marking: 1 mark for v, 1 for the nature, 1 for the magnification.

36. (a) Name the defect of vision in which a person sees distant objects clearly but cannot see nearby objects clearly. **[3]**

(b) State the type of lens used to correct it and explain why.

(c) A person needs a corrective lens of power +2.5 D. Find its focal length in cm.

Answer

(a) Hypermetropia, also called long-sightedness or far-sightedness.

(b) A **convex (converging) lens** is used. In this defect the eyeball is too short, or the converging power of the eye lens is too low, so rays coming from a nearby object would be brought to a focus *behind* the retina. A convex lens converges the rays a little before they enter the eye, so the image is brought forward exactly onto the retina and near objects are seen clearly.

(c) Power P = 1/f, with f in metres.

f = 1/P = 1/2.5 = 0.4 m = **+40 cm**

Marking: 1 mark for each part.

37. A 4 Ω and a 12 Ω resistor are connected in parallel across a 24 V supply. Calculate (a) the current through each resistor, (b) the total current drawn and (c) the total power dissipated. **[3]**

OR

Three resistors of 2 Ω, 3 Ω and 6 Ω are connected in parallel across a 6 V battery. Find (a) the equivalent resistance, (b) the total current and (c) the current through the 3 Ω resistor.

Answer

In a parallel arrangement each resistor gets the full supply voltage of 24 V.

(a) $I_1 = V/R_1 = 24/4 =$ **6 A**; $I_2 = V/R_2 = 24/12 =$ **2 A**

(b) Total current I = 6 + 2 = **8 A**

Check: $R_p = (4 \times 12)/(4 + 12) = 48/16 = 3\ \Omega$, and I = 24/3 = 8 A. ✓

(c) $P = VI = 24 \times 8 =$ **192 W**

Check: $P = V^2/R_p = 576/3 = 192$ W. ✓

Marking: 1 mark for the two branch currents, 1 for the total current, 1 for the power.

Answer — OR option

(a) $1/R_p = 1/2 + 1/3 + 1/6 = (3 + 2 + 1)/6 = 6/6 = 1$

R_p = 1 Ω

(b) $I = V/R_p = 6/1 =$ **6 A**

(c) Each resistor has the full 6 V across it, so the current in the 3 Ω resistor is

$I_3 = 6/3 =$ **2 A**

Check: 6/2 + 6/3 + 6/6 = 3 + 2 + 1 = 6 A, which matches the total. ✓

Marking: 1 mark for each part.

38. Read the following and answer the questions that follow. **[4]**

Tanvi mounts a convex lens of focal length 20 cm on an optical bench. She places a 5 cm tall candle on the principal axis, 30 cm from the optical centre, and moves a white screen on the other side of the lens until a sharp image appears on it. She then repeats the experiment with the candle placed 15 cm from the lens.

(a) Using the lens formula, find where the screen must be placed in the first case. **(1)**

(b) Find the height and the nature of the image in the first case. **(1)**

(c) In the second case no image can be caught on the screen. Explain why. **(1)**

(d) Where is the image in the second case, and what are its nature and size? **(1)**

Answer

(a) Lens formula: 1/v – 1/u = 1/f, with f = +20 cm and u = –30 cm.

1/v = 1/f + 1/u = 1/20 + (–1/30) = (3 – 2)/60 = 1/60

v = +60 cm — the screen must be placed 60 cm from the lens, on the side away from the candle.

(b) m = v/u = 60/(–30) = **–2**, so h′ = –2 × 5 = **–10 cm**.

The image is **10 cm tall, real, inverted and magnified two times**.

(c) With the candle 15 cm away it lies **between the optical centre and the focus** (15 cm < 20 cm). The rays leaving the lens then **diverge** and never actually meet; they only appear to come from a point on the candle's own side. The image is therefore **virtual**, and a virtual image cannot be caught on a screen.

(d) 1/v = 1/20 + (–1/15) = (3 – 4)/60 = –1/60, so **v = –60 cm** — the image is 60 cm from the lens on the **same side as the candle**.

m = v/u = (–60)/(–15) = **+4**, so h′ = +4 × 5 = **+20 cm**.

The image is **virtual, erect and magnified four times — 20 cm tall**.

Marking: 1 mark for each part.

39. A. A room circuit is connected to a 220 V supply and protected by a 5 A fuse. An electric kettle of resistance 40 Ω and a bulb of resistance 440 Ω are connected in parallel across the supply. **[5]**

(i) Calculate the current drawn by each appliance. **(2)**

(ii) Calculate the total current drawn from the supply. **(1)**

(iii) State, with a calculation, whether the 5 A fuse will blow. **(1)**

(iv) Give one reason why household appliances are connected in parallel and not in series. **(1)**

OR

B. (i) State Joule's law of heating. **(1)**

(ii) Two resistors of 5 Ω and 10 Ω are connected in series across a 30 V battery for 2 minutes. Calculate the heat produced in each resistor. **(3)**

(iii) In which resistor is more heat produced, and why? **(1)**

Answer

A (i) In a parallel circuit each appliance receives the full 220 V.

Kettle: I_1 = V/R = 220/40 = **5.5 A**

Bulb: I_2 = V/R = 220/440 = **0.5 A**

A (ii) Total current I = 5.5 + 0.5 = **6.0 A**

Check: R_p = (40 × 440)/(40 + 440) = 17600/480 = 36.67 Ω, and 220/36.67 = 6.0 A. ✓

A (iii) The current actually drawn, 6.0 A, is greater than the fuse rating of 5 A. **The fuse will blow** — its thin wire melts and breaks the circuit, protecting the wiring and the appliances.

A (iv) Any one reason: in parallel every appliance gets the full 220 V and so works at its rated power; each appliance can be switched on and off on its own; and if one appliance fails the others keep working. In a series circuit the voltage would be shared, every appliance would under-perform, and a single break would stop everything.

Marking: (i) 1 mark for each current; (ii) 1 mark; (iii) 1 mark; (iv) 1 mark.

Answer — OR option

B (i) Joule's law of heating: the heat produced in a resistor is directly proportional to the square of the current flowing through it, to the resistance of the resistor, and to the time for which the current flows — that is, **$H = I^2Rt$**.

B (ii) In series the resistances add: R = 5 + 10 = **15 Ω**.

Current I = V/R = 30/15 = **2 A** — the same current flows through both resistors.

Time t = 2 minutes = **120 s**.

Heat in the 5 Ω resistor: $H_1 = I^2R_1t = (2)^2 \times 5 \times 120 =$ **2400 J**

Heat in the 10 Ω resistor: $H_2 = I^2R_2t = (2)^2 \times 10 \times 120 =$ **4800 J**

Check: 2400 + 4800 = 7200 J, and VIt = 30 × 2 × 120 = 7200 J. ✓

B (iii) More heat is produced in the **10 Ω** resistor. In a series circuit the current and the time are the same for both resistors, so by $H = I^2Rt$ the heat is directly proportional to the resistance — the larger resistance produces more heat.

Marking: (i) 1 mark; (ii) 1 mark for the current, 1 for each heat value; (iii) 1 mark.

— End of paper —

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