

Science 2025, Set 31/2/1

Q.P. Code 31/2/1 · Series GHF2E · 80 marks · 3 hours · March 2025. Questions are from the official CBSE paper. Step-by-step solutions are written by CogniGuru and checked against CBSE's published answer key. Where the key itself disagrees with the arithmetic, the solution says so.

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Section A: Multiple choice

20 questions, 1 mark each. MCQs (Q1 to Q16) and assertion-reason (Q17 to Q20).

Q1 · CHEMICAL REACTIONS AND EQUATIONS · 1 MARK

The correct balanced chemical equation showing exothermic reaction in which natural gas burns in air is:

- (A) $\text{CH}_4 + \text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ (B) $\text{CH}_4 + 2\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O} + \text{Energy}$
(C) $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ (D) $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + \text{Energy}$

SOLUTION

Natural gas is methane. Count atoms: carbon 1 each side; hydrogen 4 each side with $2\text{H}_2\text{O}$; oxygen $2 + 2 = 4$ on the right, so 2O_2 on the left.

The reaction is exothermic, so the energy released is shown on the product side. Only option D is both balanced and shows the energy.

Answer: (D) $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + \text{Energy}$

Q2 · ACIDS, BASES AND SALTS · 1 MARK

The warning sign shown in the given figure must invariably be displayed/pasted on the containers which contain hydroxide of:



- (A) Aluminium (B) Calcium
(C) Sodium (D) Magnesium

SOLUTION

The sign shows a liquid burning a hand: it warns of a corrosive substance.

Sodium hydroxide is a strong, corrosive base. Calcium, magnesium and aluminium hydroxides are weak or sparingly soluble, so they are not marked in this way.

Answer: (C) Sodium

Q3 · ACIDS, BASES AND SALTS · 1 MARK

The body of human beings works within the pH range of:

- (A) 6.1 to 6.8 (B) 6.5 to 7.3
(C) 7.0 to 7.8 (D) 7.5 to 8.1

SOLUTION

Our body works in a narrow, slightly basic range of pH 7.0 to 7.8 (blood is about 7.4). Living organisms are sensitive to pH changes.

Answer: (C) 7.0 to 7.8

Q4 · METALS AND NON-METALS · 1 MARK

Aluminium powder is used in thermit welding because:

- (A) Its reaction with iron is highly exothermic. (B) When it is heated with iron (III) oxide, molten iron is obtained.
(C) When it is heated with iron (III) oxide, molten aluminium oxide is obtained to join railway tracks. (D) Its melting point is low as compared to iron and a molten alloy of iron and aluminium is formed on heating which is used to join railway tracks.

SOLUTION



Aluminium is more reactive than iron, and the reaction gives out so much heat that the iron is produced in the molten state. This molten iron is poured on the gap between railway tracks to weld them.

Answer: (B) When it is heated with iron (III) oxide, molten iron is obtained.

Common mistake: Choosing A. The reaction of aluminium is with iron(III) oxide, not with iron, and the point of the process is the molten iron it makes.

Q5 · METALS AND NON-METALS · 1 MARK

Two metals zinc and tin are dissolved separately in definite proportions in molten copper (the primary metal) to obtain two different alloys respectively known as:

- (A) Bronze and Brass (B) Brass and Solder
(C) Brass and Bronze (D) Solder and Bronze

SOLUTION

Copper + zinc = brass. Copper + tin = bronze. (Solder is lead + tin.)

In the order zinc, tin the alloys are brass and bronze.

Answer: (C) Brass and Bronze

Q6 · LIFE PROCESSES · 1 MARK

The opening and closing of stomata is regulated by:

- (A) CO₂ concentration in stomata
- (B) Temperature in guard cells
- (C) O₂ concentration in stomata
- (D) Amount of water in guard cells

SOLUTION

The guard cells on both sides of a stomatal pore take in water and swell, which opens the pore. When they lose water they shrink and the pore closes.

Answer: (D) Amount of water in guard cells

Q7 · LIFE PROCESSES · 1 MARK

One-cell thick blood vessels are known as:

- (A) Alveoli
- (B) Capillaries
- (C) Arteries
- (D) Veins

SOLUTION

Capillaries have walls one cell thick, so materials can pass between the blood and the tissues. Arteries and veins have thick walls, and alveoli are air sacs in the lungs, not blood vessels.

Answer: (B) Capillaries

Q8 · CONTROL AND COORDINATION · 1 MARK

Observe the given figures A and B. When chhui-mui (sensitive) plant is touched, its leaves fold. This is due to:



Figure A



Figure B

- (A) Hormonal effect
- (B) Thermal effect
- (C) Change in amount of water in cells
- (D) Electromagnetic effect

SOLUTION

The touch signal travels from cell to cell. The cells at the base of the leaf then lose water and shrink, so the leaf folds and droops. The plant has no muscles.

Answer: (C) Change in amount of water in cells

Q9 · HOW DO ORGANISMS REPRODUCE? · 1 MARK

Bryophyllum produces new plant through:

- (A) Apical buds formed on the tip of the plant
(B) Vegetative buds produced in the notches of the leaf
(C) Flowers produced in the notches of the branches
(D) Fruits formed on the branches of the plant

SOLUTION

Bryophyllum reproduces vegetatively: small buds form in the notches along the margin of a leaf, fall to the soil and grow into new plants.

Answer: (B) Vegetative buds produced in the notches of the leaf

Q10 · HOW DO ORGANISMS REPRODUCE? · 1 MARK

The number of chromosomes in a cell division is halved. This kind of cell division is observed in:

- (A) Only testis
(B) Only ovary
(C) Ovary and testis both
(D) All cells of the body

SOLUTION

Halving the chromosome number is meiosis, which forms the gametes. Sperms form in the testis and eggs form in the ovary, so it happens in both. Other body cells divide by mitosis and keep the number.

Answer: (C) Ovary and testis both

Q11 · LIGHT: REFLECTION AND REFRACTION · 1 MARK

If the absolute refractive indices of two media X and Y are $\frac{6}{5}$ and $\frac{4}{3}$ respectively, then the refractive index of Y with respect to X will be:

- (A) $\frac{10}{9}$
(B) $\frac{9}{10}$
(C) $\frac{9}{8}$
(D) $\frac{8}{9}$

SOLUTION

$$n_{XY} = \frac{n_Y}{n_X} = \frac{4/3}{6/5} = \frac{4}{3} \times \frac{5}{6} = \frac{20}{18} = \frac{10}{9}.$$

Answer: (A) $\frac{10}{9}$

Common mistake: Inverting the ratio. "Y with respect to X" means n_Y divided by n_X .

Q12 · LIGHT: REFLECTION AND REFRACTION · 1 MARK

An object is placed at a distance of 30 cm from the pole of a concave mirror. If its real and inverted image is formed at 60 cm in front of the mirror, the focal length of the mirror is:

- (A) -15 cm
(B) -20 cm
(C) +20 cm
(D) +15 cm

SOLUTION

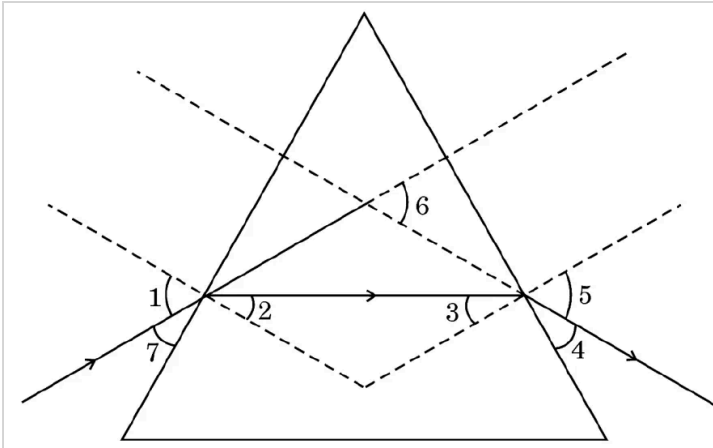
$u = -30$ cm and $v = -60$ cm (real image, in front of the mirror).

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} = -\frac{1}{60} - \frac{1}{30} = -\frac{3}{60} = -\frac{1}{20}, \text{ so } f = -20 \text{ cm.}$$

Answer: (B) –20 cm

Q13 · LIGHT: REFLECTION AND REFRACTION · 1 MARK

In the given figure the angle of incidence and the angle of deviation respectively are:



(A) 1 and 5

(B) 7 and 6

(C) 7 and 4

(D) 1 and 6

SOLUTION

The angle of incidence is measured between the incident ray and the normal at the first face: angle 1 (angle 7 is the angle with the surface itself).

The angle of deviation is between the direction of the original (extended) incident ray and the emergent ray: angle 6.

Answer: (D) 1 and 6

Common mistake: Measuring the angle from the surface instead of from the normal.

Q14 · ELECTRICITY · 1 MARK

An electric bulb is connected to a power supply of 220 V. If the current drawn by the bulb from the supply is 500 mA, the power of the bulb is:

(A) 11 W

(B) 110 W

(C) 220 W

(D) 1100 W

SOLUTION

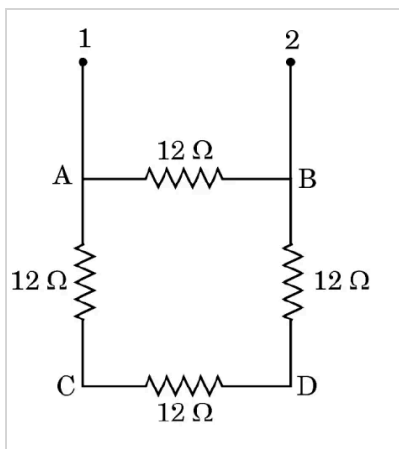
$$I = 500 \text{ mA} = 0.5 \text{ A. } P = VI = 220 \times 0.5 = 110 \text{ W.}$$

Answer: (B) 110 W

Common mistake: Using 500 as the current and getting 110 000 W. Convert milliamperes to amperes first.

Q15 · ELECTRICITY · 1 MARK

Four identical resistors of $12\ \Omega$ each are connected in series to form a square ABCD as shown in the figure. The resistance of the network between the two points 1 and 2 is:

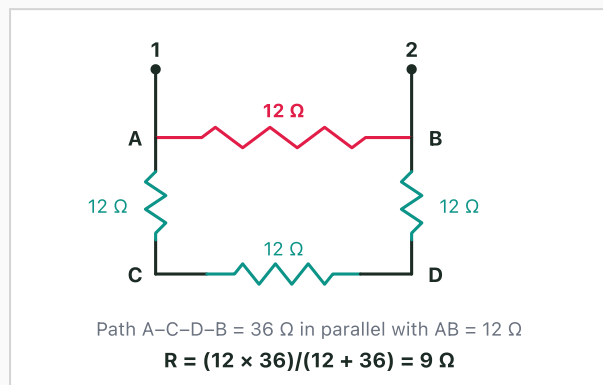


(A) $48\ \Omega$

(B) $36\ \Omega$

(C) $9\ \Omega$

(D) $6\ \Omega$

SOLUTION

Between points A and B there are two paths: the top resistor directly ($12\ \Omega$), and the other three resistors in series, $A \rightarrow C \rightarrow D \rightarrow B$ ($12 + 12 + 12 = 36\ \Omega$).

These two paths are in parallel: $\frac{1}{R} = \frac{1}{12} + \frac{1}{36} = \frac{3+1}{36} = \frac{1}{9}$, so $R = 9\ \Omega$.

Answer: (C) $9\ \Omega$

Q16 · OUR ENVIRONMENT · 1 MARK

Identify from the following a group containing all non-biodegradable substances.

(A) Leather, Glass, Plastic

(B) Cotton, Wood, Nylon

(C) DDT, Polyester, Glass

(D) Leather, Silk, Wool

SOLUTION

Leather, cotton, wood, silk and wool come from living things and are broken down by decomposers, so they are biodegradable. Glass, plastic, nylon, polyester and DDT are not broken down by microbes.

Only DDT, polyester and glass are all non-biodegradable.

Answer: (C) DDT, Polyester, Glass

Q17 · METALS AND NON-METALS · 1 MARK

Assertion (A): The metals high up in the reactivity series cannot be obtained from their compounds by heating with carbon.

Reason (R): Displacement reactions can also be used to obtain metal.

- (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

SOLUTION

Assertion: true. Highly reactive metals hold on to oxygen more strongly than carbon does.

Reason: true, a more reactive metal can displace a less reactive one from its compound. But this does not explain why carbon fails for the metals at the top.

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

Q18 · HEREDITY · 1 MARK

Assertion (A): A mango seed will germinate to form a mango tree.

Reason (R): Heredity determines the process by which traits and characteristics are reliably inherited from parents to offspring.

- (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

SOLUTION

A mango seed always gives a mango tree because the traits of the parent are passed on reliably through the DNA. That is exactly what heredity means, so R explains A.

Answer: (A) Both A and R are true and R is the correct explanation of A

Q19 · ELECTRICITY · 1 MARK

Assertion (A): Nichrome is an alloy which is commonly used in electrical heating devices such as electric irons, toasters, etc.

Reason (R): The resistivity of nichrome is high and its resistance decreases with increase in temperature.

- (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

SOLUTION

Assertion: true, nichrome has a high resistivity and does not burn at high temperatures.

Reason: the resistivity is high, but the resistance of an alloy like nichrome changes very little with temperature (it does not decrease). So the reason is false.

Answer: (C) A is true, but R is false

Q20 · LIFE PROCESSES · 1 MARK

Assertion (A): Animals will not get energy if they eat (consume) coal as food.

Reason (R): Specific enzymes are needed for the breakdown of a particular food.

(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

SOLUTION

Animals have no enzyme that can break down coal, so they cannot digest it or get energy from it. This is because each food needs its own specific enzyme, so R explains A.

Answer: (A) Both A and R are true and R is the correct explanation of A

Section B: Very short answer

6 questions, 2 marks each (30 to 50 words).

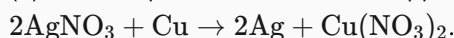
Q21 · METALS AND NON-METALS · 2 MARKS

(a) In common practice silver is recovered from silver nitrate solution by the use of copper metal. Name the type of reaction that takes place in this process and give the chemical equation of the reaction involved.

(b) Name the method used for refining silver.

SOLUTION

(a) It is a displacement reaction: copper is more reactive than silver, so it displaces silver from its salt solution.



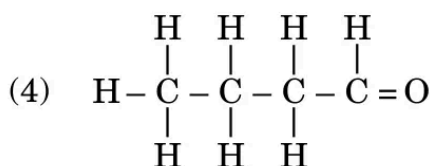
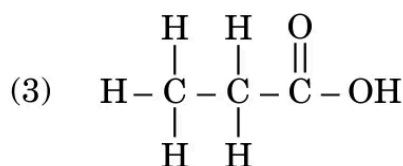
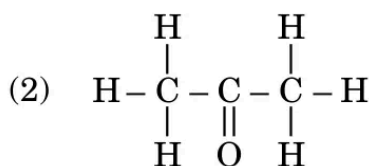
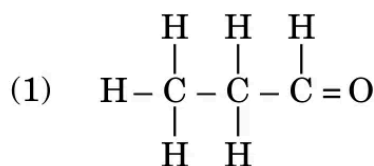
(b) Silver is refined by electrolytic refining (pure silver on the cathode, impure silver as the anode, and silver nitrate solution as the electrolyte).

Answer: (a) displacement reaction (b) electrolytic refining

Q22 · CARBON AND ITS COMPOUNDS · 2 MARKS

(a) Select from the following the members of same homologous series: (1) a three-carbon aldehyde, $\text{CH}_3\text{CH}_2\text{CHO}$; (2) a three-carbon ketone, CH_3COCH_3 ; (3) a three-carbon acid, $\text{CH}_3\text{CH}_2\text{COOH}$; (4) a four-carbon aldehyde, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$.

(b) What happens to (i) the melting point, and (ii) the solubility of compounds as the molecular mass of the compounds in a homologous series increases?

**SOLUTION**

(a) A homologous series has the same functional group, and each member differs from the next by a CH_2 unit. (1) and (4) both end in the aldehyde group $-\text{CHO}$ and differ by one CH_2 : propanal and butanal. (2) is a ketone and (3) is a carboxylic acid.

(b)(i) The melting point increases as the molecular mass increases. (ii) The solubility (in water) shows a regular gradation: it decreases as the molecular mass increases.

Answer: (a) (1) and (4) (b) melting point rises; solubility falls

Q23 · CONTROL AND COORDINATION · 2 MARKS

Name the parts of hind-brain of the human brain. Which part of the hind-brain controls involuntary actions such as blood pressure and salivation?

SOLUTION

The hind-brain has three parts: the pons, the medulla and the cerebellum.

The medulla controls involuntary actions such as blood pressure, salivation and vomiting. (The cerebellum controls posture and balance.)

Answer: Pons, medulla and cerebellum; the medulla

Q24 · HOW DO ORGANISMS REPRODUCE? · 2 MARKS

(a) Write one function each of the following, in a seed: (i) Seed coat (ii) Cotyledon (iii) Radicle (iv) Plumule

OR

(b) Write the main steps to culture yeast in the laboratory.

SOLUTION

(a)(i) Seed coat: protects the seed. (ii) Cotyledon: stores food for the growing embryo. (iii) Radicle: grows into the root on germination. (iv) Plumule: grows into the shoot.

(b) Take a test tube with about 10 g of sugar in 100 mL of water, add a pinch of yeast granules and keep it in a warm place for 1 to 2 hours. The yeast cells bud and multiply, and you can see them under a microscope.

Answer: (a) protects; stores food; root; shoot (b) sugar solution + yeast, kept warm for 1–2 hours

Q25 · LIGHT: REFLECTION AND REFRACTION · 2 MARKS

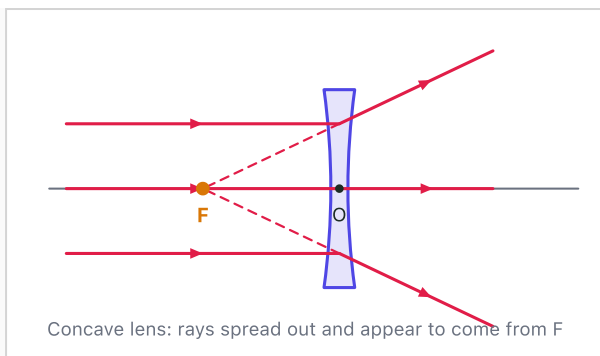
(a) Out of the two lenses, one concave and the other convex, state which one will diverge a parallel beam of light falling on it. Draw a ray diagram to show the principal focus of the lens.

OR

(b) A ray of light after refraction from a convex lens emerges parallel to its principal axis. (i) Draw a labelled ray diagram to show it. (ii) In this case, the incident ray before refraction from the lens passes through a point on its principal axis.

Name the point.

SOLUTION



(a) The concave lens diverges a parallel beam. Its principal focus is the point on the axis from which the diverged rays appear to come (shown by the dashed lines).

(b)(i) The incident ray passes through the principal focus of the convex lens on the side of the object, bends at the lens and emerges parallel to the principal axis. (ii) The point is the principal focus F .

Answer: (a) concave lens, see diagram (b) the principal focus F

Q26 · ELECTRICITY · 2 MARKS

An electric kettle is rated 750 W; 220 V. Can this kettle be used in a circuit which has a fuse of current rating 3 A? Give reason for your answer.

SOLUTION

$$I = \frac{P}{V} = \frac{750}{220} = 3.41 \text{ A.}$$

The kettle draws 3.41 A, which is more than the 3 A rating of the fuse. The fuse wire would melt and break the circuit, so the kettle cannot be used with this fuse.

Answer: No: the kettle draws ≈ 3.4 A, more than 3 A, so the fuse will melt

Section C: Short answer

7 questions, 3 marks each (50 to 80 words).

Q27 · CHEMICAL REACTIONS AND EQUATIONS · 3 MARKS

(a) (i) Define the term decomposition reaction. Write one chemical equation each for decomposition reaction where energy is supplied in the form of heat, light or electricity.

(ii) Decomposition of vegetable matter into compost is considered an exothermic reaction. Why?

OR

(b) Why are decomposition reactions called the opposite of combination reactions? Write one chemical equation each for these two types of reactions mentioning the name of the reactant(s) and the product(s) involved in the reactions.

SOLUTION

(a)(i) In a decomposition reaction a single reactant breaks down to give two or more products.

Heat: $\text{CaCO}_3 \xrightarrow{\text{heat}} \text{CaO} + \text{CO}_2$. Light: $2\text{AgCl} \xrightarrow{\text{sunlight}} 2\text{Ag} + \text{Cl}_2$. Electricity: $2\text{H}_2\text{O} \xrightarrow{\text{electric current}} 2\text{H}_2 + \text{O}_2$.

(ii) Because heat is given out when vegetable matter is broken down by microbes, the reaction is exothermic.

(b) A combination reaction joins two or more reactants into a single product, while a decomposition reaction splits a single reactant into two or more products, so the two are opposite.

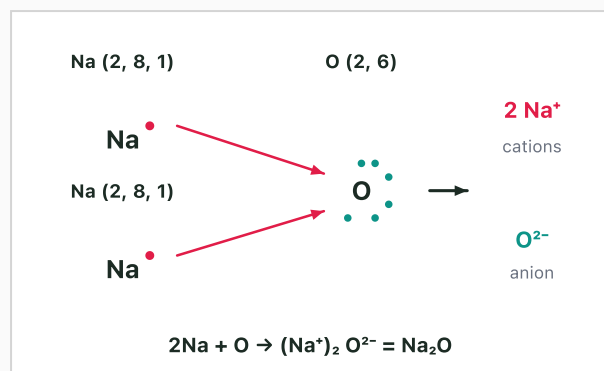
Combination: carbon + oxygen $\rightarrow$ carbon dioxide, $\text{C} + \text{O}_2 \rightarrow \text{CO}_2 + \text{heat}$. Decomposition: calcium carbonate $\rightarrow$ calcium oxide + carbon dioxide, $\text{CaCO}_3 \xrightarrow{\text{heat}} \text{CaO} + \text{CO}_2$.

Answer: (a) one reactant breaks into two or more products; heat is released in composting (b) opposite processes, examples above

Q28 · METALS AND NON-METALS · 3 MARKS

Write the electron-dot structures of (i) sodium, and (ii) oxygen. Using these structures, show the formation of sodium oxide. Mark the anion and cation present in this compound. (At. No. – Sodium = 11 and Oxygen = 8)

SOLUTION



Sodium (atomic number 11) has the electron arrangement 2, 8, 1: one dot (electron) in its outer shell. Oxygen (atomic number 8) has 2, 6: six dots in its outer shell, and it needs two more to complete an octet.

Each sodium atom gives its single outer electron to oxygen. Two sodium atoms give two electrons to one oxygen atom:
 $2\text{Na} \rightarrow 2\text{Na}^+ + 2\text{e}^-$ and $\text{O} + 2\text{e}^- \rightarrow \text{O}^{2-}$.

The oppositely charged ions attract: $(\text{Na}^+)_2 \text{O}^{2-}$, that is Na_2O . The cation is Na^+ and the anion is O^{2-} .

Answer: Na_2O : cation Na^+ , anion O^{2-}

Q29 · CONTROL AND COORDINATION · 3 MARKS

(a) Define hormone.

(b) "Hormones should be secreted in precise quantities. We have a feedback mechanism through which this is done." With the help of an example justify the statement.

SOLUTION

(a) Hormones are chemical messengers made in one part of the body that travel in the blood to a target organ or tissue and regulate a body function.

(b) Example: when the blood sugar level rises, the cells of the pancreas detect it and make more insulin, which lowers the blood sugar. When the level falls, the pancreas cells sense this and reduce insulin secretion. So the amount of the hormone is adjusted by the effect it has: this is feedback regulation.

Answer: Hormones are chemical messengers; blood sugar and insulin form a feedback loop

Q30 · HEREDITY · 3 MARKS

The lowest part of the ear called earlobe, is closely attached to the side of the head in some of us (Figure 'X'), and not in others, called free earlobe (Figure 'Y'). Attached and free earlobes are two variants found in human populations. The gene for free earlobe is dominant over attached earlobes.

- (a) A man with attached earlobes marries a woman having free earlobes. 50% of their children have free earlobes and 50% have attached earlobes. Explain the inheritance of this trait and write the trait combinations of the progeny.
- (b) Write the gene combinations of the father and the mother in the above case.

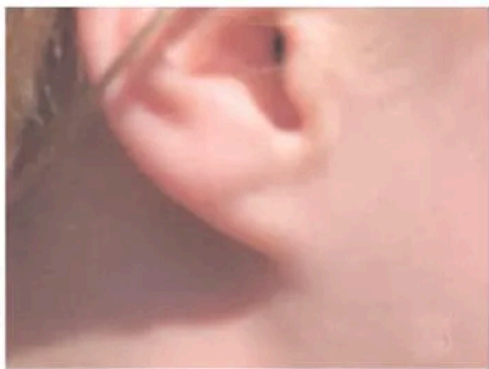


Figure 'X'

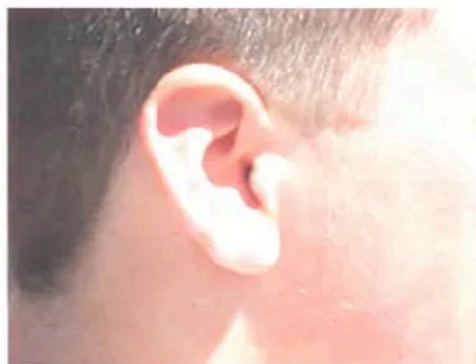


Figure 'Y'

SOLUTION

Let F be the dominant gene for free earlobes and f the recessive gene for attached earlobes. Attached earlobes can only be ff .

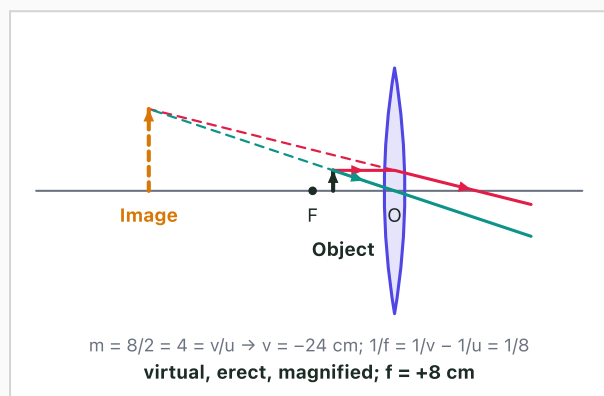
(b) The father has attached earlobes: ff . Half the children have attached earlobes (ff), so each of them gets an f from the mother as well as from the father. Half have free earlobes, so the mother must carry both F and f : she is Ff .

(a) Cross $ff \times Ff$. The father gives only f . The mother gives F or f in equal numbers. The children are Ff (free earlobes) and ff (attached earlobes) in the ratio 1 : 1, that is 50% each.

Answer: (a) $Ff : ff = 1 : 1$ (free : attached) (b) father ff , mother Ff

Q31 · LIGHT: REFLECTION AND REFRACTION · 3 MARKS

A convex lens forms an 8.0 cm long image of a 2.0 cm long object which is kept at a distance of 6.0 cm from the optical centre of the lens. If the object and the image are on the same side of the lens, find (i) the nature of the image, (ii) the position of the image, and (iii) the focal length of the lens.

SOLUTION

The object and image are on the same side of a convex lens, so the image is virtual (and erect, since the object is within the focal length).

- (i) The image is virtual and erect.

(ii) $h = +2.0$ cm, $h' = +8.0$ cm, $u = -6.0$ cm. $m = \frac{h'}{h} = \frac{v}{u}$: $\frac{8.0}{2.0} = \frac{v}{-6.0}$, so $v = -24$ cm. The image is 24 cm from the lens on the same side as the object.

(iii) $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = -\frac{1}{24} + \frac{1}{6} = \frac{-1+4}{24} = \frac{1}{8}$, so $f = +8$ cm.

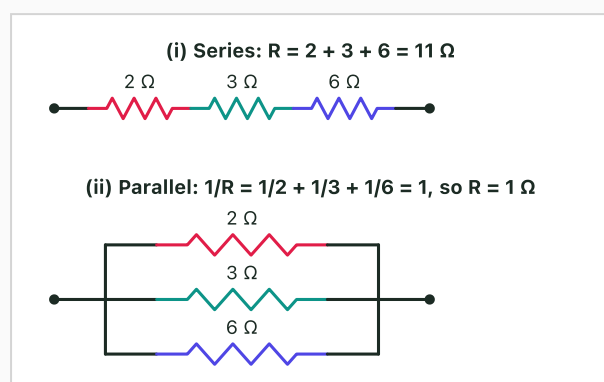
Answer: (i) virtual and erect (ii) $v = -24$ cm (iii) $f = +8$ cm

Common mistake: Reading 8.0 cm and 6.0 cm as 80 cm and 60 cm: the decimal point is easy to miss in the printed paper.

Q32 · ELECTRICITY · 3 MARKS

Three resistors of $2\ \Omega$, $3\ \Omega$ and $6\ \Omega$ are connected in (i) series, and (ii) parallel. Draw the arrangements of the resistors and find the equivalent resistance of each arrangement.

SOLUTION



(i) In series the resistances add: $R_s = 2 + 3 + 6 = 11\ \Omega$.

(ii) In parallel: $\frac{1}{R_p} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} = \frac{3+2+1}{6} = 1$, so $R_p = 1\ \Omega$.

Answer: (i) $11\ \Omega$ (ii) $1\ \Omega$

Q33 · OUR ENVIRONMENT · 3 MARKS

Write the essential function performed by ozone at the higher levels of the atmosphere. How is it formed in the upper atmosphere? Write the name of the group of chemicals mainly responsible for the depletion of ozone layer.

SOLUTION

Function: the ozone layer shields the surface of the Earth from the harmful ultraviolet (UV) radiation of the Sun, which can cause skin cancer.

Formation: UV radiation splits some molecular oxygen into free oxygen atoms, $O_2 \rightarrow O + O$. These atoms combine with molecular oxygen to form ozone, $O + O_2 \rightarrow O_3$.

The chemicals mainly responsible for ozone depletion are the chlorofluorocarbons (CFCs).

Answer: Absorbs UV; $O + O_2 \rightarrow O_3$; CFCs

Section D: Long answer

3 questions, 5 marks each (80 to 120 words).

Q34 · CARBON AND ITS COMPOUNDS · 5 MARKS

- (a) (i) A compound 'X' having two carbon atoms in its molecule turns blue litmus red and 5 – 8% solution of 'X' in water is widely used as a preservative. Identify the compound 'X' and write its structure. [1½]
- (ii) Compare its pH nature with a mineral acid. [½]
- (iii) 'X' on reacting with alcohols produces sweet smelling compounds, used in making perfumes. Name the reaction and write its chemical equation. [1½]
- (iv) When sodium carbonate is added to 'X', a colourless gas is produced which turns lime water milky. Write the chemical equation for the reaction giving the name of the salt produced. [1½]

OR

- (b) (i) Differentiate between saturated and unsaturated hydrocarbons by giving one example each, with a structural formula.
- (ii) Write the method of converting an unsaturated hydrocarbon into a saturated hydrocarbon. Name the industry where this reaction is commonly used.
- (iii) Write the name and structure of a hydrocarbon having double bond and four carbon atoms in its one molecule.

SOLUTION

- (a)(i) X is ethanoic acid (acetic acid), CH_3COOH . Its 5–8% solution is vinegar. Structure:
 $\text{H}-\text{C}(\text{H})(\text{H})-\text{C}(=\text{O})-\text{O}-\text{H}$ (a methyl group joined to the carboxyl group).
- (ii) It is a weak acid, so the pH of its solution is higher than that of a mineral acid of the same concentration.
- (iii) Esterification: $\text{CH}_3\text{COOH} + \text{CH}_3\text{CH}_2\text{OH} \xrightarrow{\text{conc. H}_2\text{SO}_4} \text{CH}_3\text{COOCH}_2\text{CH}_3 + \text{H}_2\text{O}$ (ethyl ethanoate).
- (iv) $2\text{CH}_3\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{CH}_3\text{COONa} + \text{CO}_2 + \text{H}_2\text{O}$. The salt is sodium ethanoate (sodium acetate) and the gas is carbon dioxide.
- (b)(i) Saturated hydrocarbons have only single bonds between the carbon atoms (general formula $\text{C}_n\text{H}_{2n+2}$), for example propane, $\text{CH}_3\text{CH}_2\text{CH}_3$. Unsaturated hydrocarbons have at least one double or triple bond (general formulas C_nH_{2n} and $\text{C}_n\text{H}_{2n-2}$), for example propene, $\text{CH}_2=\text{CH}-\text{CH}_3$.
- (ii) Add hydrogen in the presence of a nickel or palladium catalyst (hydrogenation). This is commonly used in the vegetable oil industry to turn oils into ghee.
- (iii) Butene, $\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_3$ (but-1-ene), which has four carbon atoms and a double bond.

Answer: (a) ethanoic acid; higher pH than a mineral acid; esterification; sodium ethanoate (b) see steps; hydrogenation with Ni/Pd; butene

Q35 · LIFE PROCESSES · 5 MARKS

- (a) (i) "The length of the small intestine in various animals depends on the food they eat." Justify the statement.
- (ii) Discuss the role of the pancreas and bile juice in the digestion of food in human beings.
- (iii) How is the small intestine designed to absorb digested food?

OR

- (b) (i) State the role of rings of cartilage present in the throat.
- (ii) Discuss the role of the ribs and diaphragm when air is taken in during the breathing cycle.
- (iii) Why do we get muscle cramps during heavy exercise? Explain.

SOLUTION

- (a)(i) Herbivores such as cows eat grass, which is hard to digest because of cellulose, so they need a longer small intestine. Meat is easier to digest, so carnivores such as tigers have a shorter small intestine.

(ii) The pancreas secretes pancreatic juice that contains trypsin to digest proteins and lipase to break down emulsified fats. Bile juice (from the liver) emulsifies fats, breaking large globules into smaller ones, and makes the medium alkaline so that the pancreatic enzymes can act.

(iii) The inner wall of the small intestine has millions of finger-like projections called villi. They increase the surface area for absorption, and they are rich in blood vessels that carry the absorbed food to every cell of the body.

(b)(i) The rings of cartilage keep the air passage from collapsing when there is no air in it.

(ii) During inhalation the ribs are lifted up and outward and the diaphragm flattens (moves down). The chest cavity becomes larger, so air is sucked into the lungs (alveoli).

(iii) During heavy exercise the muscle cells do not get enough oxygen, so they respire anaerobically: pyruvate is turned into lactic acid. The build-up of lactic acid in the muscles causes cramps.

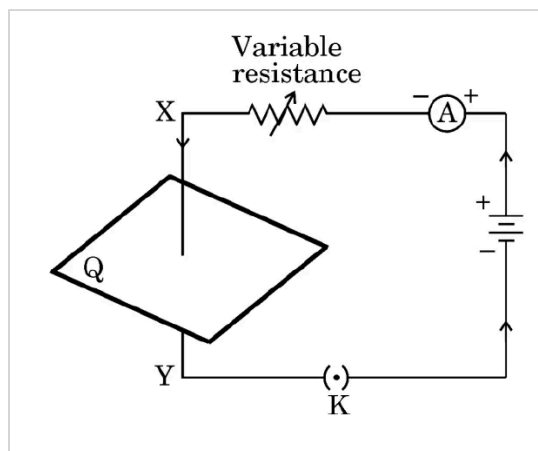
Answer: (a) longer for cellulose; trypsin, lipase, bile; villi (b) keep trachea open; ribs up, diaphragm flat; lactic acid

Q36 • MAGNETIC EFFECTS OF ELECTRIC CURRENT • 5 MARKS

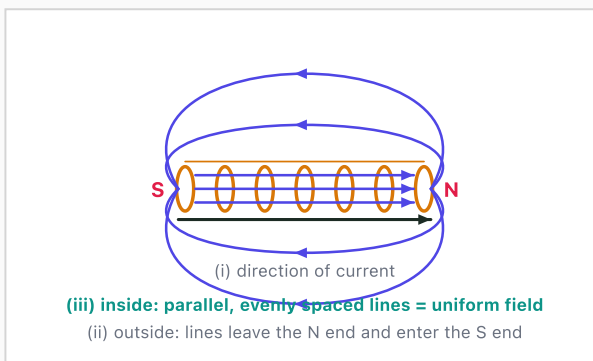
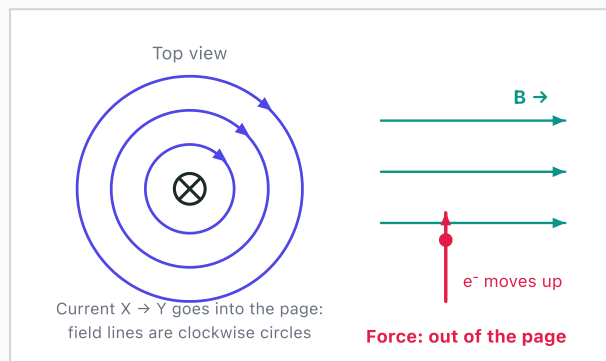
(a) The given figure shows the current passing through the straight conductor XY. (i) Copy the diagram and draw the magnetic field lines when current flows from conductor X to Y. (ii) Name and state the rule used in determining the direction of the magnetic field lines in the situation given above. (iii) State Fleming's left hand rule. Using this rule, determine the direction of force applied on an electron entering a uniform magnetic field as shown in the figure.

OR

(b) (i) Define the term solenoid. Draw the pattern of the magnetic field lines in and around a current carrying straight solenoid. Mark on the pattern the (i) direction of current, (ii) direction of field lines near the ends of the solenoid, and (iii) region where the magnetic field is uniform. (ii) How would you make an electromagnet using a current carrying solenoid?



SOLUTION



(a)(i) The field lines are concentric circles on the cardboard, with the conductor at the centre. For current from X to Y (downward) they run clockwise when seen from above (from the X end).

- (ii) The right-hand thumb rule: imagine holding the current-carrying straight conductor in your right hand with the thumb pointing in the direction of the current. The fingers then wrap around the conductor in the direction of the magnetic field lines.
- (iii) Fleming's left-hand rule: stretch the thumb, forefinger and middle finger of the left hand mutually perpendicular. If the forefinger points in the direction of the magnetic field and the middle finger in the direction of the current, then the thumb points in the direction of the force on the conductor.

For the electron, the current is opposite to its motion. It moves up in a field pointing to the right, so the conventional current points down. The force is out of the plane of the paper (upwards towards the viewer).

(b)(i) A solenoid is a coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder. Its field pattern is like that of a bar magnet: inside, the lines are parallel and evenly spaced, so the field is uniform; outside, they leave the north end and enter the south end (diagram above).

(ii) Place a piece of soft iron inside the current-carrying solenoid. The iron is magnetised by the field and forms an electromagnet.

Answer: (a) circles; right-hand thumb rule; Fleming's left-hand rule, force out of the plane (b) solenoid pattern; soft iron core

Section E: Case studies

3 case studies, 4 marks each.

Q37 · ACIDS, BASES AND SALTS · 4 MARKS

Case study 1. Acid-base indicators can be used to distinguish between an acid and a base. Universal indicator, a mixture of several indicators, shows different colours at different concentrations of acids and bases, thereby indicating their pH on the pH scale of 0 – 14. The pH of a solution is measured by pH paper, which is a paper impregnated with a universal indicator.

- (a) Solution P is a strong acid while solution Q is a strong base. On the pH scale, where would you place the solutions P and Q? [1]
- (b) A solution has a pH of 7. Name a compound you would use to (i) increase its pH, and (ii) decrease its pH. [1]
- (c) (i) When the pH of a solution is decreased from 4 to 2, what effect does it produce on its hydronium ion concentration? State the colour change shown by the pH paper. [2]

OR

- (c) (ii) A person is feeling pain and irritation in the stomach due to indigestion. What could be the pH of the fluid in the stomach? Write the common name of the medicines people use for remedy. Give the chemical name of "milk of magnesia" often used for this purpose. [2]

SOLUTION

- (a) P (strong acid) lies at the low end, about pH 0 to 4. Q (strong base) lies at the high end, about pH 12 to 14.
- (b) (i) To increase the pH add a base such as sodium hydroxide, NaOH. (ii) To decrease the pH add an acid such as hydrochloric acid, HCl.
- (c)(i) The hydronium ion concentration increases (a fall of 2 pH units makes it 100 times larger). The pH paper changes from yellow/orange to red/pink.
- (c)(ii) Indigestion is caused by excess acid, so the pH of the stomach fluid is low, about 1 to 3. People take antacids (for example milk of magnesia). The chemical name of milk of magnesia is magnesium hydroxide, $\text{Mg}(\text{OH})_2$.

Answer: (a) P: pH 0–4; Q: pH 12–14 (b) NaOH, HCl (c) $[\text{H}_3\text{O}^+]$ increases, yellow/orange to red (OR) pH 1–3, antacid, $\text{Mg}(\text{OH})_2$

Q38 · HOW DO ORGANISMS REPRODUCE? · 4 MARKS

Case study 2. When a girl is born, the ovaries already contain thousands of immature eggs. On reaching puberty, some of these start maturing. One matured egg is released every month by one of the ovaries. The two oviducts unite into an elastic bag-like structure known as uterus.

- (a) Write the site of fertilization in human female. [1]
(b) How does the uterus prepare itself to receive and nurture the growing embryo? Explain. [1]
(c) (i) What happens when the egg is not fertilized? [2]

OR

- (c) (ii) How does the developing embryo get nutrition from the mother's blood? Explain. [2]

SOLUTION

- (a) Fertilisation takes place in the oviduct (fallopian tube).
(b) The lining of the uterus becomes thick and spongy and is richly supplied with blood, so that it can nourish the growing embryo.
(c)(i) The thick uterine lining is not needed, so it slowly breaks down and comes out through the vagina as blood and mucus along with the unfertilised egg. This is menstruation.
(c)(ii) Through the placenta, a special disc-like tissue embedded in the uterine wall. It has villi on the embryo's side and blood spaces on the mother's side, so oxygen and nutrients pass from the mother's blood to the embryo (and waste passes back to the mother).

Answer: (a) oviduct (b) lining thickens with blood (c) menstruation (OR) the placenta

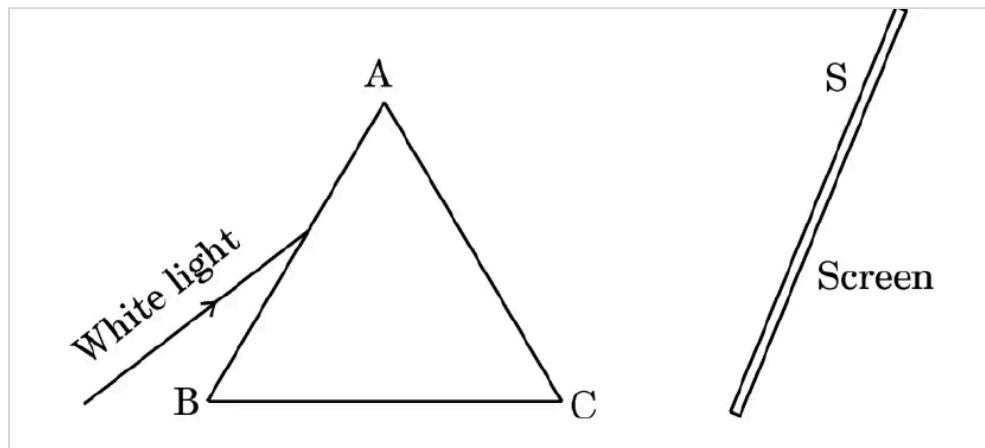
Q39 · HUMAN EYE AND THE COLOURFUL WORLD · 4 MARKS

Case study 3. A person allowed a narrow beam of white light from the sun to enter a dark room through a small aperture and placed a glass prism in its path in such a manner that the beam falls on the face AB of the prism as shown in the figure. A screen S is placed on the other side of the prism, facing AC. On turning the prism slowly, a beautiful band of colours is obtained on the screen. It is the spectrum of sunlight.

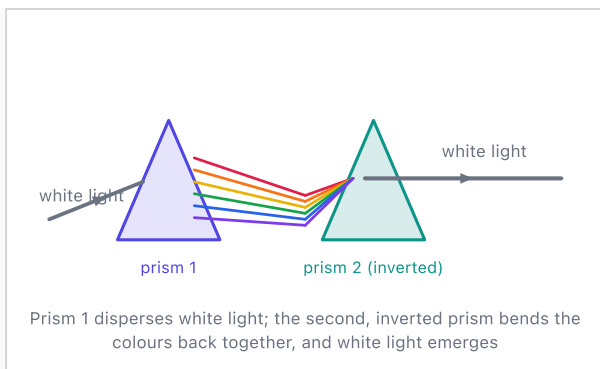
- (a) Name the phenomenon due to which a prism splits the incident white light into a band of colours. [1]
(b) State the reason of getting a band of seven colours in the above case. [1]
(c) (i) Explain with the help of a labelled ray diagram, an experimental arrangement to show the recombination of the spectrum of white light. [2]

OR

- (c) (ii) Draw a labelled ray diagram to show the formation of a rainbow. [2]



SOLUTION



(a) Dispersion of light.

(b) Different colours of light bend through different angles with respect to the incident ray as they pass through the prism: violet bends the most and red the least. So the white light spreads out into seven colours.

(c)(i) Place a second identical prism upside down next to the first one. The spectrum from the first prism falls on the second prism, which bends the colours back in the opposite way, and a beam of white light emerges from the other side of the second prism (diagram above).

(c)(ii) A rainbow is formed by the dispersion of sunlight by small water droplets in the air. The light is refracted and dispersed on entering a droplet, reflected internally at the back of the droplet, and refracted again as it leaves, so a band of colours reaches the eye. The observer must stand with the Sun behind them. In the diagram, draw the Sun's rays, the droplet, the red and violet rays and the observer's eye with arrows.

Answer: (a) dispersion (b) different colours bend by different angles (c) inverted second prism recombines (OR) droplet: refraction, internal reflection, refraction

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