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Section A: Multiple choice

Q1 · CHEMICAL REACTIONS AND EQUATIONS · 1 MARK

(A) 8 : 1 (B) 2 : 1
(C) 1 : 2 (D) 1 : 8

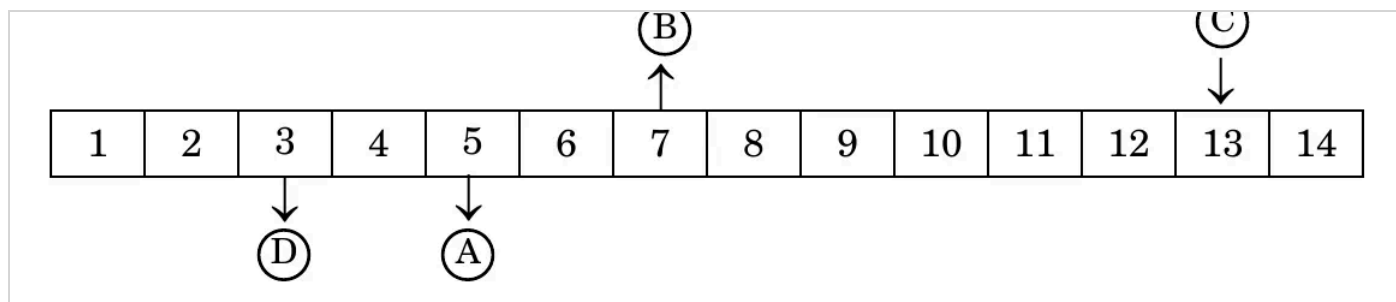
Common mistake: Giving 2 : 1. That is the ratio of volumes, not masses; oxygen atoms are 16 times heavier than hydrogen atoms.

(A) Al_3O_4 and MgO_2 (B) Al_2O_3 and MgO
(C) Al_3O_4 and MgO (D) Al_2O_3 and MgO_2

Answer: (B) Al_2O_3 and MgO

Q3 · ACIDS, BASES AND SALTS · 1 MARK

The following table shows the pH values of four solutions A, B, C and D on a pH scale. The solutions A, B, C and D respectively are of a:

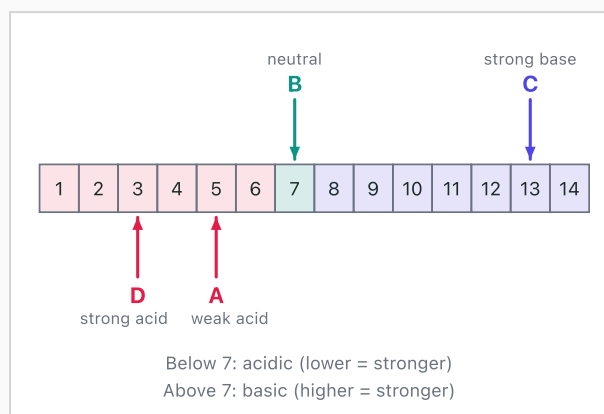


(A) Strong acid, weak acid, neutral, strong base

(B) Weak acid, neutral, weak base, strong base

(C) Weak acid, neutral, strong base, weak base

(D) Weak acid, neutral, strong base, strong acid

SOLUTION

Read the pH values: $A = 5$, $B = 7$, $C = 13$, $D = 3$.

$\text{pH} < 7$ is acidic, the lower the stronger: A (5) is a weak acid and D (3) is a strong acid. $\text{pH} = 7$ is neutral (B).

$\text{pH} > 7$ is basic: C (13) is a strong base.

Answer: (D) Weak acid, neutral, strong base, strong acid

Common mistake: Reading the solutions in the order of the scale (1 to 14) instead of in the order of the letters A, B, C, D.

Q4 · ACIDS, BASES AND SALTS · 1 MARK

Consider the following reactions:

(i) Dilute hydrochloric acid reacts with sodium hydroxide.

(ii) Magnesium oxide reacts with dilute hydrochloric acid.

(iii) Carbon dioxide reacts with sodium hydroxide.

It is found that in each case:

(A) Salt and water is formed.

(B) Neutral salts are formed.

(C) Hydrogen gas is formed.

(D) Acidic salts are formed.

SOLUTION

(i) $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$ (neutralisation).

(ii) $\text{MgO} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2\text{O}$ (a metal oxide is basic, so it neutralises the acid).

(iii) $\text{CO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$ (a non-metal oxide is acidic, so it reacts with the base).

In all three, a salt and water are formed. No hydrogen gas appears, and the salt in (iii) is a basic salt, not neutral or acidic.

Answer: (A) Salt and water is formed.

Q5 · METALS AND NON-METALS · 1 MARK

Reaction between two elements A and B, forms a compound C. A loses electrons and B gains electrons. Which one of the following properties will not be shown by compound C?

- (A) It has high melting point.
- (B) It is highly soluble in water.
- (C) It has weak electrostatic forces of attraction between its oppositely charged ions.
- (D) It conducts electricity in its molten state or aqueous solution.

SOLUTION

When A gives electrons to B, an ionic compound forms.

Ionic compounds have strong electrostatic forces between the oppositely charged ions. That is why they have high melting points, dissolve in water and conduct electricity when molten or dissolved.

So the one property it does not show is "weak" forces of attraction.

Answer: (C) It has weak electrostatic forces of attraction between its oppositely charged ions.

Q6 · METALS AND NON-METALS · 1 MARK

The metals obtained from their molten chlorides by the process of electrolytic reduction are:

- (A) Gold and silver
- (B) Calcium and magnesium
- (C) Aluminium and silver
- (D) Sodium and iron

SOLUTION

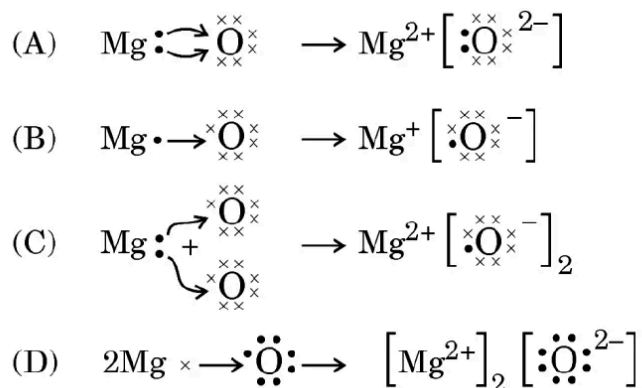
Metals high in the reactivity series (sodium, calcium, magnesium and so on) hold on to their oxygen or chlorine too strongly for carbon to reduce them. They are extracted by electrolysis of their molten chlorides.

Gold and silver are very unreactive and occur native or are easily obtained, and iron is extracted by reduction of its oxide with carbon. So the pair is calcium and magnesium.

Answer: (B) Calcium and magnesium

Q7 • METALS AND NON-METALS • 1 MARK

The formation of magnesium oxide is correctly shown in option:



(A) (A) One Mg atom gives 2 electrons to one O atom: Mg^{2+} and O^{2-}

(B) (B) One Mg atom gives 1 electron: Mg^+ and O^-

(C) (C) One Mg atom gives electrons to two O atoms: Mg^{2+} and two O^- ions

(D) (D) Two Mg atoms give electrons to one O atom: $(\text{Mg}^{2+})_2$ and O^{2-}

SOLUTION

Magnesium has 2 outer electrons (2, 8, 2) and oxygen has 6 (2, 6) and needs 2 more to complete its octet.

So one Mg atom transfers both its outer electrons to one O atom, giving Mg^{2+} and O^{2-} in the ratio 1 : 1: MgO.

Option A shows exactly this. The other options show a wrong number of electrons moved or a wrong ratio of ions.

Answer: (A)

Q8 • LIFE PROCESSES • 1 MARK

Secretion of less saliva in mouth will effect the conversion of:

(A) proteins into amino acids

(B) fats into fatty acids and glycerol

(C) starch into simple sugars

(D) sugars into alcohol

SOLUTION

Saliva contains the enzyme salivary amylase, which starts breaking down starch in the mouth into simple sugars (maltose).

With less saliva, this conversion is affected. Protein and fat digestion happen later, in the stomach and small intestine.

Answer: (C) starch into simple sugars

Q9 • CONTROL AND COORDINATION • 1 MARK

The plant hormone whose concentration stimulates the cells to grow longer on the side of the shoot which is away from light is:

(A) Cytokinins

(B) Gibberellins

(C) Adrenaline

(D) Auxins

SOLUTION

Auxin collects on the shaded side of the shoot and makes the cells there grow longer. The shoot then bends towards the light.

Adrenaline is an animal hormone, and cytokinins and gibberellins do not cause this bending.

Answer: (D) Auxins

Q10 · HOW DO ORGANISMS REPRODUCE? · 1 MARK

The correct/true statement(s) for a bisexual flower is/are:

- (i) They possess both stamen and pistil.
- (ii) They possess either stamen or pistil.
- (iii) They exhibit either self-pollination or cross-pollination.
- (iv) They cannot produce fruits on their own.

(A) (i) only

(B) (iv) only

(C) (i) and (iii)

(D) (i) and (iv)

SOLUTION

A bisexual flower has both male (stamen) and female (pistil) parts, so (i) is true and (ii) is false.

Because it has both parts, it can be self-pollinated or cross-pollinated, so (iii) is true. It can form fruits on its own after pollination and fertilisation, so (iv) is false.

Answer: (C) (i) and (iii)

Q11 · HEREDITY · 1 MARK

If pea plants with round and green seeds ($RRyy$) are crossed with pea plants having wrinkled and yellow seeds ($rrYY$), the seeds developed by the plants of F_1 generation will be:

(A) 50% round and green

(B) 75% wrinkled and green

(C) 100% round and yellow

(D) 75% wrinkled and yellow

SOLUTION

The parents give only one kind of gamete each: Ry from $RRyy$ and rY from $rrYY$.

Every F_1 plant is $RrYy$. Round (R) is dominant over wrinkled and yellow (Y) is dominant over green, so all the seeds are round and yellow.

Answer: (C) 100% round and yellow

Common mistake: Writing the 9 : 3 : 3 : 1 ratio. That is for the F_2 generation, not F_1 .

Q12 · LIFE PROCESSES · 1 MARK

The breakdown of glucose has taken the following pathway: Glucose $\rightarrow$ (a) $\rightarrow$ Pyruvate + Energy $\rightarrow$ (b) $\rightarrow$ Lactic acid + Energy. The sites 'a' and 'b' respectively are:

(A) Mitochondria and Oxygen deficient muscle cells

(B) Cytoplasm and Oxygen rich muscle cells

(C) Cytoplasm and Yeast cells

(D) Cytoplasm and Oxygen deficient muscle cells

SOLUTION

The first step, glucose to pyruvate, happens in the cytoplasm of every cell.

Lactic acid forms when pyruvate is broken down without oxygen in our muscle cells (yeast makes ethanol instead). So 'b' is oxygen-deficient muscle cells.

Answer: (D) Cytoplasm and Oxygen deficient muscle cells

Q13 · LIGHT: REFLECTION AND REFRACTION · 1 MARK

Mirror 'X' is used to concentrate sunlight in solar furnace and Mirror 'Y' is fitted on the side of the vehicle to see the traffic behind the driver. Which of the following statements are true for the two mirrors?

- (i) The image formed by mirror 'X' is real, diminished and at its focus.
 - (ii) The image formed by mirror 'Y' is virtual, diminished and erect.
 - (iii) The image formed by mirror 'X' is virtual, diminished and erect.
 - (iv) The image formed by mirror 'Y' is real, diminished and at its focus.
- (A) (i) and (ii) (B) (ii) and (iii)
(C) (iii) and (iv) (D) (i) and (iv)

SOLUTION

Mirror X concentrates sunlight, so it is a concave mirror. Sunlight comes from far away (infinity), and a concave mirror focuses it to a real, highly diminished point image at its focus. So (i) is true and (iii) is false.

Mirror Y is a rear-view mirror, which is a convex mirror. A convex mirror always forms a virtual, erect and diminished image. So (ii) is true and (iv) is false.

Answer: (A) (i) and (ii)

Q14 · HUMAN EYE AND THE COLOURFUL WORLD · 1 MARK

An old person is suffering from an eye defect caused by weakening of ciliary muscles and diminishing flexibility of the eye lens. If the defect of vision is 'a' which can be corrected by lens 'b', then 'a' and 'b' respectively are:

- (A) hypermetropia and convex lens (B) presbyopia and bifocal lens
(C) myopia and concave lens (D) myopia and bifocal lens

SOLUTION

Weak ciliary muscles and a stiffer lens with age cause presbyopia: the person cannot focus on both near and far objects.

It is corrected with a bifocal lens (concave on the top for distance, convex at the bottom for reading).

Answer: (B) presbyopia and bifocal lens

Common mistake: Choosing hypermetropia. Presbyopia is the age-related defect; hypermetropia is caused by a short eyeball or a weak lens at any age.

Q15 · OUR ENVIRONMENT · 1 MARK

Which of the following groups do not constitute a food chain?

- (i) Wolf, rabbit, grass, lion
 - (ii) Plankton, man, grasshopper, fish
 - (iii) Hawk, grass, snake, grasshopper, frog
 - (iv) Grass, snake, wolf, tiger
- (A) (i) and (iv) (B) (i) and (iii)
(C) (ii) and (iii) (D) (ii) and (iv)

SOLUTION

A food chain starts with a producer and each organism is eaten by the next one. (i) grass → rabbit → wolf → lion and (iii) grass → grasshopper → frog → snake → hawk can both be put in a proper order, so they are chains.

In (ii), man does not eat plankton in a chain with a grasshopper and fish, and in (iv) a snake does not eat grass, so neither can be arranged into a chain. These two do not constitute a food chain.

Answer: (D) (ii) and (iv)

Q16 · OUR ENVIRONMENT · 1 MARK

The percentage of solar energy which is not converted into food energy by the leaves of green plants in a terrestrial ecosystem is about:

- (A) 1% (B) 10%
(C) 90% (D) 99%

SOLUTION

Green plants in a terrestrial ecosystem capture only about 1% of the solar energy falling on their leaves and convert it into food energy.

So about $100\% - 1\% = 99\%$ is not converted.

Answer: (D) 99%

Common mistake: Answering 1%. That is the energy that is converted; the question asks for the part that is not.

Q17 · CHEMICAL REACTIONS AND EQUATIONS · 1 MARK

Assertion (A): Decomposition reactions are generally endothermic reactions.

Reason (R): Decomposition of organic matter into compost is an exothermic process.

- (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: most decomposition reactions need heat, light or electricity to break bonds, so they absorb energy. True.

Reason: composting releases heat, so it is exothermic. True.

But the reason is an exception to the rule in the assertion, so it does not explain it.

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

Q18 · HEREDITY · 1 MARK

Assertion (A): A human child bears all the basic features of human beings.

Reason (R): It looks exactly like its parents, showing very little variations.

- (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: reproduction copies the basic body design, so a child has all the basic human features. True.

Reason: a child does not look exactly like its parents; DNA copying is not perfect and sexual reproduction mixes the genes of two parents, so there are variations. False.

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

Q19 · MAGNETIC EFFECTS OF ELECTRIC CURRENT · 1 MARK

Assertion (A): No two magnetic field lines are found to cross each other.

Reason (R): The compass needle cannot point towards two directions at the point of intersection of two magnetic field lines.

(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

The direction of the field at a point is the direction a compass needle points there. A needle can point only one way, so a point cannot have two field directions.

So two field lines can never cross. The reason is true and it is exactly why the assertion is true.

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

Q20 · OUR ENVIRONMENT · 1 MARK

Assertion (A): The amount of ozone in the atmosphere began to drop sharply in the 1980s.

Reason (R): The oxygen atoms combine with molecular oxygen to form ozone.

(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

The ozone layer thinned sharply in the 1980s, mainly because of chlorofluorocarbons (CFCs). Assertion: true.

Ozone forms when an oxygen atom joins an oxygen molecule ($O + O_2 \rightarrow O_3$). Reason: true. But this is how ozone is made, not why it dropped, so it does not explain the assertion.

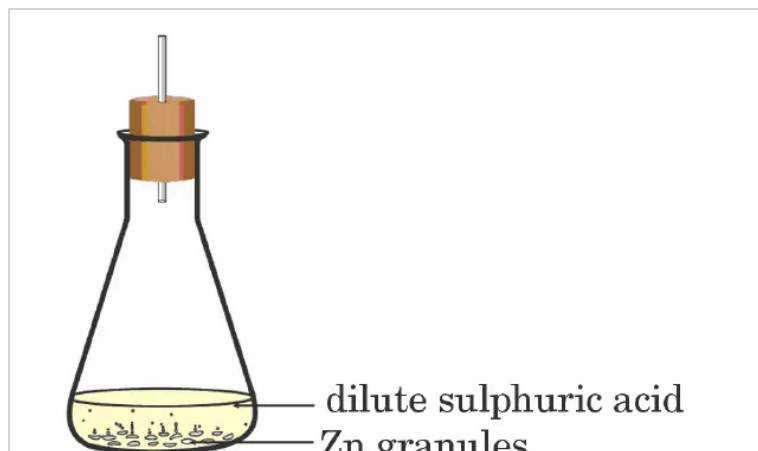
Answer: (B) Both A and R are true, but R is not the correct explanation of A

Section B: Very short answer

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

Q21 · CHEMICAL REACTIONS AND EQUATIONS · 2 MARKS

A student performs the following experiment in his school laboratory: a conical flask with a cork holds dilute sulphuric acid and granules of zinc. List two observations to justify that in this experiment a chemical change has taken place.



SOLUTION

The reaction is $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$.

Observation 1: bubbles of a gas (hydrogen) are given off from the surface of the zinc granules, so a new substance forms.

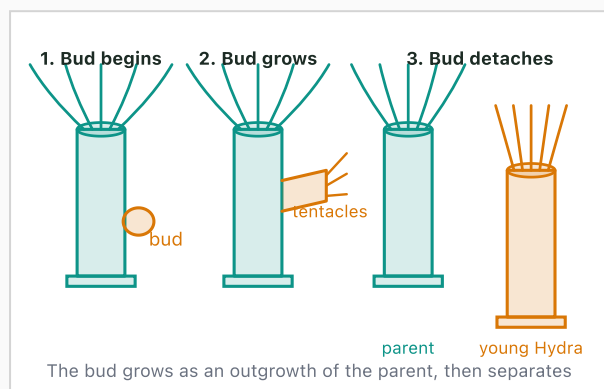
Observation 2: the flask becomes warm, because the reaction gives out heat (a rise in temperature). The zinc granules also slowly get smaller and disappear.

Answer: Evolution of gas (hydrogen) and a rise in temperature

Q22 · HOW DO ORGANISMS REPRODUCE? · 2 MARKS

Draw labelled diagrams to show different stages of budding in Hydra.

SOLUTION



Budding in Hydra goes in stages:

1. A regenerative (dividing) cell group on the side of the parent divides and forms a small outgrowth, the bud.
2. The bud grows, develops a mouth and tentacles, and stays attached to the parent for a while.
3. The fully formed bud detaches from the parent and lives as a new, independent Hydra.

Answer: Bud forms, bud grows with tentacles, bud detaches (diagram above)

Q23 · LIFE PROCESSES · 2 MARKS

(a) Besides minimising the loss of blood, why is it essential to plug any leak in a blood vessel? Name the component of blood which helps in this process and state how this component performs this function.

OR

(b) (i) The transport system in plants is relatively slower than in animals. Give reasons.

(ii) State the role of phloem in the transport of materials in plants.

SOLUTION

(a) A leak would lower the blood pressure and so reduce the efficiency of the pumping system (the heart), and the body would get less oxygen. The component that helps is the platelets, which gather at the injured spot and help the blood to clot, sealing the leak.

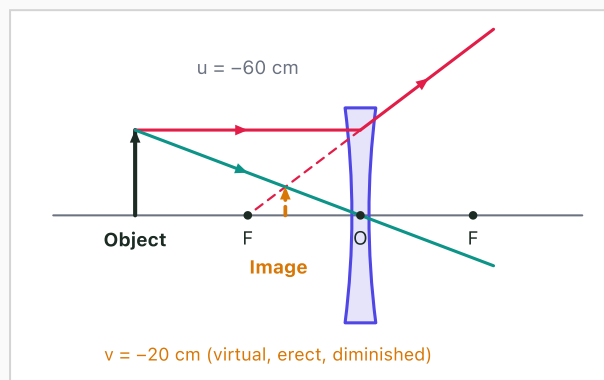
(b)(i) Plants have low energy needs: they do not move and have a large proportion of dead cells in many tissues, so a slow transport system is enough.

(ii) Phloem carries (translocates) the soluble products of photosynthesis, such as sucrose, from the leaves to the other parts of the plant, including storage organs of roots, fruits, seeds and growing organs. It also carries amino acids.

Answer: (a) To keep the blood pressure up; platelets clot the blood (b) low energy needs; phloem translocates food from leaves

Q24 · LIGHT: REFLECTION AND REFRACTION · 2 MARKS

An object is placed at a distance of 60 cm from a concave lens of focal length 30 cm. Use lens formula to find the position of the image formed in this case.

SOLUTION

With the new Cartesian sign convention, the object is on the left: $u = -60$ cm. A concave lens has a negative focal length: $f = -30$ cm.

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$, so $\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = -\frac{1}{30} - \frac{1}{60} = -\frac{3}{60} = -\frac{1}{20}$.

$v = -20$ cm. The image is 20 cm from the lens on the same side as the object (it is virtual, erect and diminished:

$$m = \frac{v}{u} = \frac{1}{3}).$$

Answer: $v = -20$ cm: the image is 20 cm in front of the lens, on the object's side

Common mistake: Dropping the sign of f or u . Both are negative here, and a sign slip gives a wrong (positive, real) image position.

Q25 · ELECTRICITY · 2 MARKS

(a) A wire of resistance R is cut into three equal parts. If these three parts are then joined in parallel, calculate the total resistance of the combination so formed.

OR

(b) Define electric power. When do we say that the power consumed in an electric circuit is 1 watt?

SOLUTION

(a) Each part has one third of the length, so its resistance is $\frac{R}{3}$.

In parallel: $\frac{1}{R_p} = \frac{3}{R} + \frac{3}{R} + \frac{3}{R} = \frac{9}{R}$, so $R_p = \frac{R}{9}$.

(b) Electric power is the rate at which electrical energy is consumed (or dissipated) in a circuit: $P = \frac{W}{t} = VI$.

The power is 1 watt when 1 joule of energy is used in 1 second, that is when a current of 1 A flows at a potential difference of 1 V ($1 \text{ W} = 1 \text{ V} \times 1 \text{ A}$).

Answer: (a) $\frac{R}{9}$ (b) rate of consuming electrical energy; $1 \text{ W} = 1 \text{ J per second}$

Q26 · OUR ENVIRONMENT · 2 MARKS

"Excessive use of chemicals and pesticides in agriculture adversely effect the environment." Justify this statement.

SOLUTION

Chemicals and pesticides used by farmers get washed from the fields into the soil and into water bodies, and they affect the living (biotic) and non-living (abiotic) parts of the ecosystem.

Most of these chemicals are not biodegradable, so they are taken in by plants and small organisms and pass up the food chain. They get concentrated at each trophic level (biological magnification), so the top consumers, including humans, carry the most.

Thus the health of organisms at all trophic levels is affected, and soil fertility and water quality fall.

Answer: Non-biodegradable chemicals wash into soil and water and build up along the food chain

Section C: Short answer

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

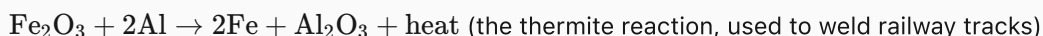
Q27 · METALS AND NON-METALS · 3 MARKS

(a) "Displacement reactions also play a key role in extracting metals in the middle of the reactivity series." Justify this statement with two examples.

(b) Why can metals high up in the reactivity series not be obtained by reduction of their oxides by carbon?

SOLUTION

(a) A more reactive metal such as aluminium can displace a less reactive metal from its oxide, and the reaction gives out so much heat that the metal is obtained in the molten state. Examples:



(b) Metals high in the reactivity series (K, Na, Ca, Mg, Al) have more affinity for oxygen than carbon has. So carbon cannot take the oxygen away from their oxides. They are obtained by electrolysis of their molten compounds.

Answer: Thermite reactions of aluminium; high metals bind oxygen more strongly than carbon does

Q28 · METALS AND NON-METALS · 3 MARKS

(a) With the help of an activity, explain the conditions under which iron articles get rusted.

OR

(b) (i) Name two metals which react violently with cold water. List any three observations which a student notes when these metals are dropped in a beaker containing water.

(ii) Write a test to identify the gas evolved (if any) during the reaction of these metals with water.

SOLUTION

(a) Take three test tubes A, B and C and put clean iron nails in each.

A: pour ordinary water and cork it (air and water both present). B: pour boiled distilled water, add about 1 mL of oil on top and cork it (oil stops air from dissolving, so water but no air). C: put anhydrous calcium chloride and cork it (it absorbs moisture, so air but no water).

After a few days the nails rust in test tube A only. So iron rusts only when it is exposed to both air (oxygen) and water.

(b)(i) Sodium and potassium (lithium also reacts, less violently). Observations: a violent reaction takes place; a large amount of heat is given out; the metal moves on the water and the gas evolved may catch fire.

(ii) The gas is hydrogen ($2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$). Bring a burning matchstick or splinter near it: it burns with a pop sound.

Answer: (a) Iron rusts in the presence of both air and water (b) Na, K; the gas is hydrogen and burns with a pop

Q29 · CONTROL AND COORDINATION · 3 MARKS

Plants have neither a nervous system nor muscles, even then they respond to stimuli. For example, the leaves of chhui-mui (touch-me-not) plant when touched begin to fold up and droop.

(a) How is the information communicated in "touch-me-not" plants?

(b) What enables the plant cells to bring out the observable response?

(c) Differentiate the movement mentioned above from the movement of tendrils in a pea plant.

SOLUTION

(a) Plant cells use electrical and chemical means to pass the information that a touch has occurred from cell to cell.

(b) The cells change their shape by changing the amount of water in them: some cells lose water and shrink, so the leaf folds and droops.

(c) Touch-me-not (a nastic movement) is growth independent and does not take place in the direction of the stimulus. The tendril of a pea plant (a tropic movement, thigmotropism) is growth dependent: the cells on the side away from the support grow faster, and it moves in the direction of the stimulus.

Answer: Electro-chemical signals; cells change shape as water moves out; nastic (growth independent) vs tropic (growth dependent)

Q30 · HEREDITY · 3 MARKS

(a) What are chromosomes?

(b) Explain in brief how stability of DNA content of a species is ensured in sexually reproducing organisms?

SOLUTION

(a) Chromosomes are thread-like structures in the nucleus. They carry the genes that control the traits of an organism, and they contain the information for inheritance of features from the parents to the next generation, in the form of DNA (deoxyribonucleic acid) molecules.

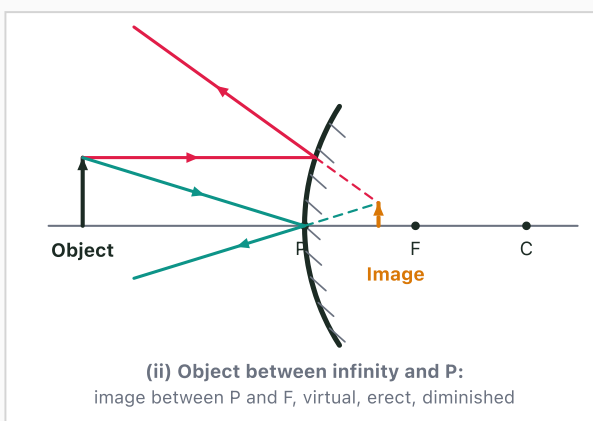
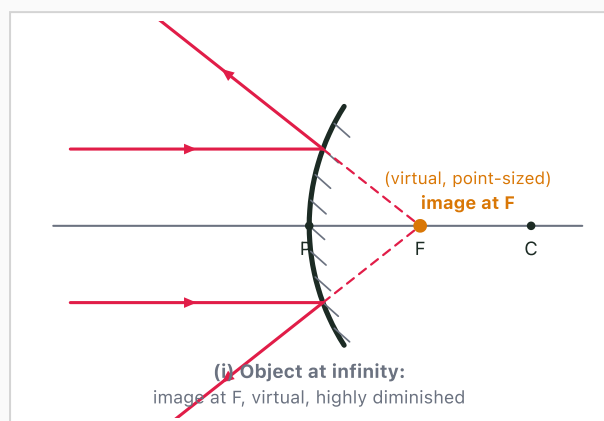
(b) Each body cell has two copies of every chromosome, one from the male parent and one from the female parent. During the formation of germ cells (gametes) the number is halved. When the male and female gametes fuse in fertilisation, the zygote gets back the normal number of chromosomes and the same amount of DNA. So the DNA content stays the same from one generation to the next.

Answer: Chromosomes carry genes (DNA); gametes have half the number and fertilisation restores it

Q31 · LIGHT: REFLECTION AND REFRACTION · 3 MARKS

Draw ray diagrams to show the nature, position and relative size of the image formed by a convex mirror when the object is placed (i) at infinity and (ii) between infinity and pole P of the mirror.

SOLUTION



(i) Object at infinity: rays arrive parallel to the principal axis. After reflection they diverge and look as if they come from the focus F behind the mirror. The image is formed at F, virtual and erect, and highly diminished (point-sized).

(ii) Object between infinity and the pole: the image is formed behind the mirror, between P and F. It is virtual, erect and diminished.

Mark arrows on the rays and show the reflected rays going back as dashed lines to the image.

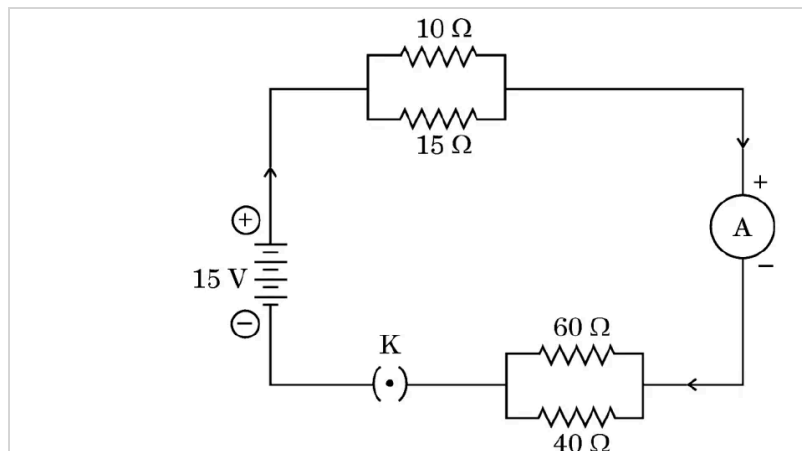
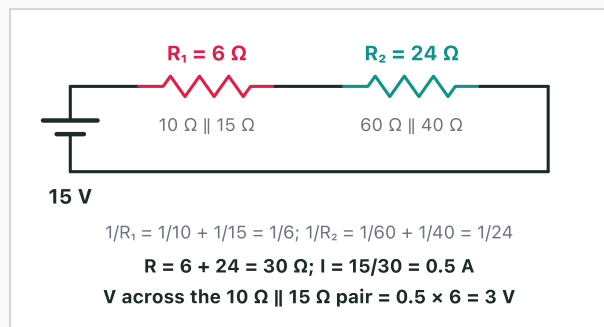
Answer: (i) at F, virtual, point-sized (ii) between P and F, virtual, erect, diminished

Q32 · ELECTRICITY · 3 MARKS

Consider the following electric circuit: a 15 V battery, a key K, an ammeter A, the resistors 10 Ω and 15 Ω joined in parallel in one part, and the resistors 60 Ω and 40 Ω joined in parallel in the other part, the two parts being in series.

Calculate the values of the following:

- The total resistance of the circuit
- The total current drawn from the source
- Potential difference across the parallel combination of 10 Ω and 15 Ω resistors

**SOLUTION**

(a) The 10 Ω and 15 Ω pair in parallel: $\frac{1}{R_1} = \frac{1}{10} + \frac{1}{15} = \frac{3+2}{30} = \frac{1}{6}$, so $R_1 = 6 \Omega$.

The 60 Ω and 40 Ω pair in parallel: $\frac{1}{R_2} = \frac{1}{60} + \frac{1}{40} = \frac{2+3}{120} = \frac{1}{24}$, so $R_2 = 24 \Omega$.

The two parts are in series: $R = R_1 + R_2 = 6 + 24 = 30 \Omega$.

(b) $I = \frac{V}{R} = \frac{15}{30} = 0.5 \text{ A}$.

(c) The same 0.5 A passes through the first parallel pair, so the potential difference across it is $V_1 = IR_1 = 0.5 \times 6 = 3 \text{ V}$.

Answer: (a) 30 Ω (b) 0.5 A (c) 3 V

Common mistake: Adding $10 + 15 + 60 + 40$ as if all four were in series, or forgetting that the parallel pair is reduced first.

Q33 · ELECTRICITY · 3 MARKS

(a) Write the relationship between resistivity and resistance of a cylindrical conductor of length l and area of cross-section A . Hence derive the SI unit of resistivity.

(b) Why are alloys used in electrical heating devices?

SOLUTION

$$(a) R = \rho \frac{l}{A}, \text{ so } \rho = \frac{RA}{l}.$$

$$\text{Unit of } \rho = \frac{\Omega \times \text{m}^2}{\text{m}} = \Omega \text{ m (ohm metre)}.$$

(b) Alloys have a higher resistivity than pure metals, so more heat is produced for the same current. They also do not oxidise (burn) readily at high temperatures, so they last long.

Answer: (a) $R = \rho l/A$; unit $\Omega \text{ m}$ (b) higher resistivity and they do not burn readily

Section D: Long answer

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

Q34 · CARBON AND ITS COMPOUNDS · 5 MARKS

(a) (i) Draw two isomeric structures of Butene (C_4H_8).

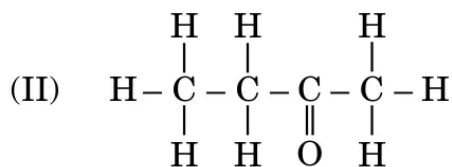
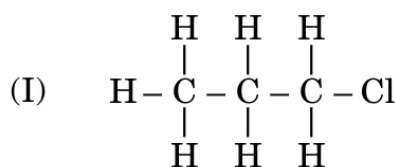
(ii) Name the following compounds: (I) $H_3C-CH_2-CH_2-Cl$ drawn in full, with three carbon atoms in a chain and the chlorine on the last one; (II) a four-carbon chain with a $C=O$ group on the third carbon.

(iii) Write the chemical equations for the following reactions. Mention one essential condition each for these reactions to take place. (I) Ethanol undergoes complete oxidation (II) Propene undergoes hydrogenation (III) Ethanoic acid reacts with ethanol

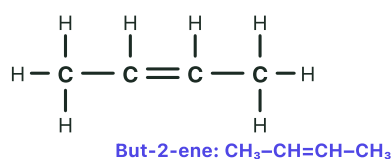
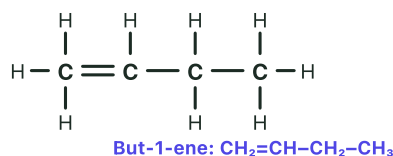
OR

(b) (i) A carbon compound X is a good solvent. On reaction with sodium, X forms two products Y and Z. Z is used to convert vegetable oil into vegetable ghee. Identify and name X, Y and Z. Also write the equation of reaction of X with sodium to justify your answer.

(ii) Write chemical equation to show what happens when ethanol: (I) burns in oxygen/air. (II) is heated at 443 K in excess conc. H_2SO_4 . (III) reacts with acidified potassium dichromate.



SOLUTION



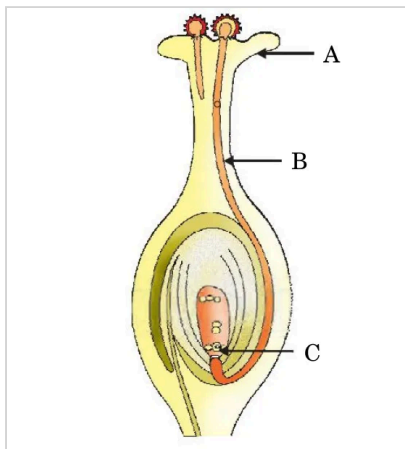
- (a)(i) The two isomers of butene are but-1-ene, $\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_3$, and but-2-ene, $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$ (drawn above). (2-methylpropene is a third isomer.)
- (ii) (I) $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ is chloropropane (1-chloropropane). (II) The four-carbon chain with a $\text{C}=\text{O}$ on the third carbon (a ketone) is butanone (butan-2-one), $\text{CH}_3\text{COCH}_2\text{CH}_3$.
- (iii) (I) $\text{CH}_3\text{CH}_2\text{OH} + 2[\text{O}] \xrightarrow{\text{alk. KMnO}_4 \text{ or acidified K}_2\text{Cr}_2\text{O}_7, \text{ heat}} \text{CH}_3\text{COOH} + \text{H}_2\text{O}$.
- (II) $\text{CH}_3\text{CH}=\text{CH}_2 + \text{H}_2 \xrightarrow{\text{Ni / Pd catalyst}} \text{CH}_3\text{CH}_2\text{CH}_3$.
- (III) $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} \xrightarrow{\text{conc. H}_2\text{SO}_4} \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$ (ethyl ethanoate, an ester).
- (b)(i) X is ethanol ($\text{C}_2\text{H}_5\text{OH}$), Y is sodium ethoxide ($\text{C}_2\text{H}_5\text{ONa}$) and Z is hydrogen gas (H_2), which turns vegetable oil into ghee.
- $2\text{C}_2\text{H}_5\text{OH} + 2\text{Na} \rightarrow 2\text{C}_2\text{H}_5\text{ONa} + \text{H}_2$.
- (ii) (I) $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O} + \text{heat} + \text{light}$. (II) $\text{CH}_3\text{CH}_2\text{OH} \xrightarrow{\text{conc. H}_2\text{SO}_4, 443 \text{ K}} \text{CH}_2=\text{CH}_2 + \text{H}_2\text{O}$ (dehydration gives ethene). (III) $\text{CH}_3\text{CH}_2\text{OH} \xrightarrow{\text{acidified K}_2\text{Cr}_2\text{O}_7} \text{CH}_3\text{COOH}$.

Answer: (a) but-1-ene and but-2-ene; chloropropane; butanone; equations above (b) X ethanol, Y sodium ethoxide, Z hydrogen

Common mistake: Writing the conditions as "catalyst" without naming it. Say nickel or palladium for hydrogenation, and concentrated sulphuric acid for esterification.

Q35 · HOW DO ORGANISMS REPRODUCE? · 5 MARKS

- (a) (i) Write the functions of the following parts of human female reproductive system: (I) Ovary (II) Fallopian tube (III) Uterus
- (ii) State briefly two contraceptive methods used by human males.
- OR
- (b) (i) Differentiate between self-pollination and cross-pollination.
- (ii) Identify A, B and C in the diagram given below and write one function of each.



SOLUTION

- (a)(i) (I) Ovary: produces the female gametes (eggs) and the female hormones (oestrogen and progesterone). (II) Fallopian tube (oviduct): the site of fertilisation, where the egg and sperm meet. (III) Uterus: the site of implantation of the embryo and its development into a baby.
- (ii) Methods used by males: a mechanical barrier, the condom, which stops the sperms from reaching the egg; and a surgical method, vasectomy, in which the vas deferens is blocked or cut so sperms are not released.
- (b)(i) Self-pollination: pollen grains move from the anther of a flower to the stigma of the same flower. Cross-pollination: pollen grains move from the anther of one flower to the stigma of another flower of the same species.

(ii) A is the stigma: it receives the pollen and provides a suitable surface for it to germinate. B is the pollen tube: it carries the male germ cells (gametes) down to the female gamete in the ovary. C is the egg cell (female germ cell): it fuses with the male gamete to form the zygote.

**Answer: (a) ovary: eggs and hormones; fallopian tube: fertilisation; uterus: implantation; condoms, vasectomy
(b) A stigma, B pollen tube, C egg cell**

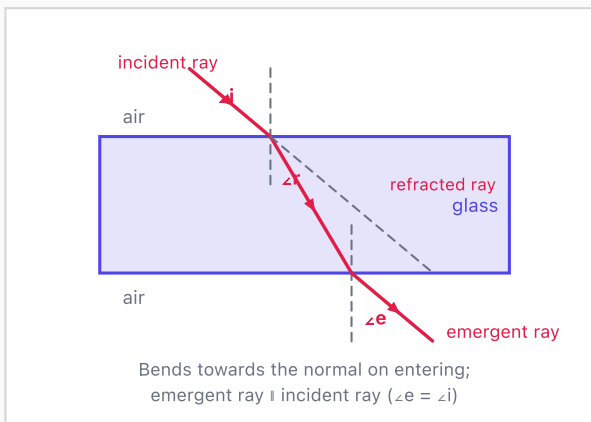
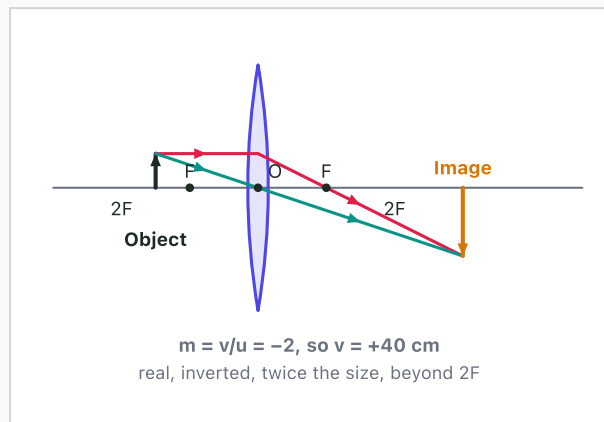
Q36 · LIGHT: REFLECTION AND REFRACTION · 5 MARKS

- (a) (i) The power of a lens 'X' is -2.5 D . Name the lens and determine its focal length in cm. For which eye defect of vision will an optician prescribe this type of lens as a corrective lens?
- (ii) "The value of magnification 'm' for a lens is -2 ." Using new Cartesian Sign Convention and considering that an object is placed at a distance of 20 cm from the optical centre of this lens, state: (I) the nature of the image formed; (II) size of the image compared to the size of the object; (III) position of the image, and (IV) sign of the height of the image.
- (iii) The numerical values of the focal lengths of two lenses A and B are 10 cm and 20 cm respectively. Which one of the two will show higher degree of convergence/divergence? Give reason to justify your answer.

OR

- (b) (i) Draw a ray diagram to show the refraction of a ray of light through a rectangular glass slab when it falls obliquely from air into glass.
- (ii) State Snell's law of refraction of light.
- (iii) Differentiate between the virtual images formed by a convex lens and a concave lens on the basis of: (I) object distance, and (II) magnification.

SOLUTION



(a)(i) A negative power means a concave (diverging) lens. $f = \frac{1}{P} = \frac{1}{-2.5\text{ D}} = -0.4\text{ m} = -40\text{ cm}$. A concave lens is prescribed for myopia (short-sightedness).

(ii) For a lens $m = \frac{v}{u}$. With $m = -2$ and $u = -20\text{ cm}$: $v = mu = (-2)(-20) = +40\text{ cm}$. (This lens is a convex lens, since a concave lens never forms a magnified, inverted image.)

(I) The image is real and inverted. (II) It is magnified: twice the size of the object. (III) It is on the other side of the lens, 40 cm from it, beyond $2F$. (IV) The height of the image is negative.

(iii) Power $P = \frac{1}{f}$, so the lens with the smaller focal length has the larger power. Lens A (10 cm) shows the higher degree of convergence/divergence, because a shorter focal length means light is bent more.

(b)(i) A ray bends towards the normal on entering the glass, and away from the normal on leaving, so the emergent ray is parallel to the incident ray but shifted sideways (diagram above).

(ii) Snell's law: for light of a given colour and a given pair of media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant: $\frac{\sin i}{\sin r} = \text{constant}$.

(iii) Convex lens: the virtual image forms only when the object is between O and F , and the image is magnified.
Concave lens: the virtual image forms for an object anywhere in front of the lens, and the image is diminished.

Answer: (a) concave lens, $f = -40$ cm, myopia; real, inverted, magnified, $v = +40$ cm, negative; lens A (b) see diagram; Snell's law; table

Common mistake: Taking $v = -40$ cm in (ii). For a lens the magnification is $\frac{v}{u}$ with signs, so a negative m with a negative u gives a positive v .

Section E: Case studies

3 case studies, 4 marks each.

Q37 · ACIDS, BASES AND SALTS · 4 MARKS

Case study 1. Seawater contains many salts dissolved in it. Common salt is separated from these salts. Deposits of solid salt are also found in several parts of the world. These large crystals are often brown due to impurities. This is called rock salt and is mined like coal. The common salt is an important raw material for chemicals of daily use.

- (a) Write balanced chemical equations to show the products formed during electrolysis of brine. [1]
(b) List two uses of any one product obtained during electrolysis of brine. [1]
(c) (i) A mild non-corrosive basic salt 'A', used for faster cooking, is strongly heated to produce a compound 'B', that is used for removing permanent hardness of water. Identify A and B and also write the equation for the reaction that occurs when A is heated. [2]

OR

- (c) (ii) Define water of crystallisation. Give two examples of salts that have water of crystallisation. [2]

SOLUTION

(a) $2\text{NaCl}(\text{aq}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}(\text{aq}) + \text{Cl}_2(\text{g}) + \text{H}_2(\text{g})$. Chlorine forms at the anode and hydrogen at the cathode; sodium hydroxide stays in the solution.

(b) Uses of sodium hydroxide: making soaps and detergents, paper making (also degreasing metals, artificial fibres). (Or hydrogen: fuel, and making margarine and ammonia; or chlorine: water treatment, PVC, bleach.) Any two uses of one product.

(c)(i) A is sodium hydrogencarbonate (baking soda), NaHCO_3 ; B is sodium carbonate (washing soda is its hydrated form), Na_2CO_3 . $2\text{NaHCO}_3 \xrightarrow{\text{heat}} \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$.

(c)(ii) Water of crystallisation is the fixed number of water molecules present in one formula unit of a salt. Examples: $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (blue vitriol) and $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ (gypsum); also $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$.

Answer: (a) $2\text{NaCl} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{Cl}_2 + \text{H}_2$ (c) A = NaHCO_3 , B = Na_2CO_3 (OR) fixed water molecules per formula unit

Q38 · LIFE PROCESSES · 4 MARKS

Case study 2. The maintenance functions of all living organisms must go on even when they are not doing anything particular. Even when we are just sitting in a class or even asleep, this maintenance job has to go on. These maintenance processes require energy to prevent damage and break-down of cells and tissues, which is obtained by the individual organism from the food prepared by the autotrophs, called producers.

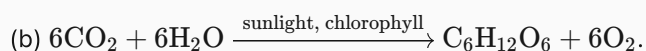
- (a) Name and define the process by which green plants prepare food. [1]
(b) Write chemical equation involved in the above process. [1]
(c) (i) State in proper sequence the events that occur in synthesis of food by desert plants. [2]

OR

- (c) (ii) Explain giving reasons what happens to the rate at which the green plants will prepare food (I) during cloudy weather, and (II) when stomata get blocked due to dust. [2]

SOLUTION

(a) Photosynthesis. It is the process by which green plants capture sunlight and convert it into chemical energy (food), with the help of chlorophyll, by turning carbon dioxide and water into carbohydrates.



(c)(i) Desert plants: (1) they open their stomata at night and take in carbon dioxide, which they store as an intermediate acid; (2) in the day, chlorophyll absorbs light energy; (3) light energy is converted to chemical energy; (4) the stored intermediate is acted on by this energy and carbon dioxide is reduced to carbohydrate.

(c)(ii) (I) In cloudy weather the rate of photosynthesis decreases, because less sunlight (light energy) reaches the leaves. (II) When the stomata are blocked by dust, the rate decreases, because carbon dioxide cannot enter and gas exchange is reduced.

Answer: (a) photosynthesis (b) $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ (c) see steps

Q39 · MAGNETIC EFFECTS OF ELECTRIC CURRENT · 4 MARKS

Case study 3. In our homes, we receive the supply of electric power through a main supply also called mains, either supported through overhead electric poles or by underground cables. In our country the potential difference between the two wires (live wire and neutral wire) of this supply is 220 V.

- (a) Write the colours of the insulation covers of the line wires through which supply comes to our homes. [1]
(b) What should be the current rating of the electric circuit (220 V) so that an electric iron of 1 kW power rating can be operated? [1]
(c) (i) What is the function of the earth wire? State the advantage of the earth wire in domestic electric appliances such as electric iron. [2]

OR

- (c) (ii) List two precautions to be taken to avoid electrical accidents. State how these precautions prevent possible damage to the circuit/appliance. [2]

SOLUTION

(a) The live wire has red insulation and the neutral wire has black insulation (the earth wire is green).

(b) $P = 1 \text{ kW} = 1000 \text{ W}$ and $V = 220 \text{ V}$. From $P = VI$: $I = \frac{1000}{220} = 4.54 \text{ A}$. The nearest standard rating above this is a 5 A circuit.

(c)(i) The earth wire gives a low-resistance path to the ground for any leakage current. If the metal body of the iron becomes live, the current flows to the earth and the body stays at the potential of the earth, so the user does not get an electric shock.

(c)(ii) Two precautions: use a fuse wire in the circuit (it melts and breaks the circuit when the current is too high, preventing damage from overloading), and connect the metallic body of appliances to the earth wire (it prevents electric shock from leakage of current).

Answer: (a) red (live) and black (neutral) (b) 4.54 A, so a 5 A rating (c) low-resistance path to earth, so no shock (OR) fuse and earth wire

Common mistake: Writing 4 A. The current is 4.54 A, which is more than 4, so the rating has to be the next standard value, 5 A.

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