CBSE 2024 Science — Set 3 — Answer Key

English Medium

Time Allowed: 3 Hours | Maximum Marks: 80

General Instructions:

1. This question paper contains 39 questions. All questions are compulsory.
2. Section A has 20 MCQs carrying 1 mark each.
3. Section B has 6 questions carrying 2 marks each.
4. Section C has 7 questions carrying 3 marks each.
5. Section D has 3 questions carrying 5 marks each.
6. Section E has 3 case-study based questions carrying 4 marks each.
7. Draw neat diagrams wherever required.

Section A

Multiple Choice Questions (1 mark each)

Q.1 [1 mark]

Identify the product 'X' obtained in the following chemical reaction:

$CaCO_3 \rightarrow (\Delta)$ 'X' + CO_2

(a) Quick lime <<

(b) Gypsum

(c) Lime Stone

(d) Plaster of Paris

Explanation:

When calcium carbonate ($CaCO_3$) is heated, it decomposes into calcium oxide (CaO), commonly known as quick lime, and carbon dioxide (CO_2).

$CaCO_3 \rightarrow (\Delta)$ CaO + CO_2.

This is a thermal decomposition reaction.

Q.2 [1 mark]

Select a pair of natural indicator from the following:

(a) Litmus and methyl orange

(b) Turmeric and Litmus <<

(c) Phenolphthalein and methyl orange

(d) Methyl orange and Turmeric

Explanation:

Litmus is obtained from lichens and turmeric is obtained from turmeric plant — both are natural indicators.

Methyl orange and phenolphthalein are synthetic (artificial) indicators.

Q.3 [1 mark]

A chemical compound used in glass, soap and paper industries is:

(a) Washing Soda <<

(b) Baking Soda

(c) Bleaching Powder

(d) Common Salt

Explanation:

Washing soda (sodium carbonate, Na_2CO_3) is used in glass, soap and paper industries.

Baking soda is used in cooking, bleaching powder in water treatment, and common salt in food.

Q.4 [1 mark]

The structural formula of Cyclohexane is:

(a) Six-membered ring with alternating double bonds and one H on each carbon (structure A, benzene type)

(b) Six-membered ring with all single C–C bonds and two H on each carbon (structure B) <<

(c) Ring with two C≡C triple bonds and two CH_2 groups (structure C)

(d) Six-membered ring with alternating double bonds and one H on each carbon (structure D, benzene type)

Explanation:

Cyclohexane (C_6H_{12}) has a six-membered carbon ring with all single bonds.

Each carbon atom is bonded to two hydrogen atoms.

Option (B) shows the correct structure with all single C–C bonds and two H atoms on each carbon in a ring arrangement.

Q.5 [1 mark]

Consider the following Chemical equation:

a Al_2O_3 + b HCl → c $AlCl_3$ + d H_2O

In order to balance this chemical equation, the values of a, b, c and d must be:

(a) 1, 6, 2 and 3 <<

(b) 1, 6, 3 and 2

(c) 2, 6, 2 and 3

(d) 2, 6, 3 and 2

Explanation:

Balancing: $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$.

Check: Al: 2=2, O: 3=3, H: 6=6, Cl: 6=6.

So a=1, b=6, c=2, d=3.

Q.6 [1 mark]

Which one of the following hydrocarbons is different from the others?

(a) C_4H_{10}

(b) C_7H_{14} <<

(c) C_5H_{12}

(d) C_2H_6

Explanation:

C_4H_{10} (butane), C_5H_{12} (pentane), and C_2H_6 (ethane) all follow the alkane general formula C_nH_{2}_n+2.

C_7H_{14} follows C_nH_2_n, which is the general formula of cycloalkanes or alkenes, making it different from the other three saturated hydrocarbons.

Q.7 [1 mark]

Which one of the following reactions is different from the remaining three?

(a) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

(b) $CaO + H_2O \rightarrow Ca(OH)_2$ <<

(c) $KNO_3 + H_2SO_4 \rightarrow KHSO_4 + HNO_3$

(d) $ZnCl_2 + H_2S \rightarrow ZnS + 2HCl$

Explanation:

Reactions (A), (C), and (D) are all double displacement reactions where two compounds exchange ions.

Reaction (B) $CaO + H_2O \rightarrow$

$Ca(OH)_2$ is a combination reaction (two reactants combine to form a single product), making it different from the others.

Q.8 [1 mark]

Select from the following a plant hormone which promotes cell division.

(a) Gibberellins
(b) Auxins
(c) Abscissic Acid
(d) Cytokinins <<

Explanation:

Cytokinins are plant hormones that promote cell division (cytokinesis).
Auxins promote cell elongation, gibberellins promote stem elongation and seed germination, and abscisic acid inhibits growth and promotes dormancy.

Q.9 [1 mark]

Part(s) of a flower which attracts insects for pollination is (are):

(a) petals and Sepals
(b) anther and Stigma
(c) petals only <<
(d) sepals only

Explanation:

Petals are the brightly coloured parts of a flower that attract insects and other pollinators for pollination.
Sepals protect the flower bud but do not typically attract pollinators.
Anther and stigma are reproductive parts.

Q.10 [1 mark]

In an experiment to study independent inheritance of two separate traits: shape and colour of seeds, the ratio of the different combinations in F_2 progeny would be:

(a) 1 : 3
(b) 1 : 2 : 1
(c) 9 : 3 : 3 : 1 <<
(d) 9 : 1 : 1 : 3

Explanation:

When two traits are studied independently (dihybrid cross), the F_2 generation shows a phenotypic ratio of 9:3:3:1.

This is Mendel's law of independent assortment.

9 show both dominant traits, 3 show first dominant + second recessive, 3 show first recessive + second dominant, 1 shows both recessive traits.

Q.11 [1 mark]

Which of the following statement(s) is (are) true about human heart?

(a) Right atrium receives oxygenated blood from lungs through pulmonary artery.

(b) Left atrium transfers oxygenated blood to left ventricle which sends it to various parts of the body.

(c) Right atrium receives deoxygenated blood from different parts of the body through vena cava.

(d) Left atrium transfers oxygenated blood to aorta which sends it to different parts of the body.

(a) (b) only

(b) (a) and (d)

(c) (b) and (c) <<

(d) (b) and (d)

Explanation:

Statement (b) is correct: Left atrium receives oxygenated blood from lungs via pulmonary veins and transfers it to the left ventricle.

Statement (c) is correct: Right atrium receives deoxygenated blood from the body through the vena cava (superior and inferior).

Statement (a) is wrong because the right atrium receives deoxygenated blood, not oxygenated.

Statement (d) is wrong because left atrium transfers blood to the left ventricle (not directly to the aorta).

Q.12 [1 mark]

A cross between two tall pea plants resulted in offsprings having a few dwarf plants. The gene-combination of the parental plants must be:

(a) Tt and Tt <<
(b) Tt and tt
(c) TT and tt
(d) TT and Tt

Explanation:

For dwarf plants (tt) to appear in the offspring, both parents must carry the recessive allele 't'.

If both parents are tall and produce some dwarf offspring, they must both be heterozygous (Tt).

The cross Tt × Tt gives TT:Tt:tt in ratio 1:2:1, so 3 tall : 1 dwarf.

Q.13 [1 mark]

The Phenomena of light involved in the formation of a rainbow in the sky are:

(a) Refraction, dispersion and reflection
(b) Refraction, dispersion and total internal reflection
(c) Dispersion, scattering and reflection
(d) Dispersion, refraction and internal reflection <<

Explanation:

Sunlight is refracted and dispersed on entering a raindrop, internally reflected inside it, and refracted again on leaving.

So the correct option is (D).

Q.14 [1 mark]

In case of four wires of same material, the resistance will be minimum if the diameter and length of the wire respectively are:

(a) D/2 and L/4
(b) D/4 and 4L
(c) 2D and L

(d) 4D and 2L <<

Explanation:

$R = \rho L/A$ and $A = \pi D^2/4$, so $R = 4\rho L/(\pi D^2)$, i.e. $R \propto L/D^2$.

(A) D/2, L/4: $(L/4)/(D/2)^2 = L/D^2 \rightarrow 1$

(B) D/4, 4L: $4L/(D/4)^2 = 64\ L/D^2$

(C) 2D, L: $L/(2D)^2 = 0.25\ L/D^2$

(D) 4D, 2L: $2L/(4D)^2 = 0.125\ L/D^2$

The smallest value is for (D), so the wire with diameter 4D and length 2L has the minimum resistance.

Q.15 [1 mark]

A food chain will be more advantageous in terms of energy if it has:

(a) 2 trophic levels <<

(b) 3 trophic levels

(c) 4 trophic levels

(d) 5 trophic levels

Explanation:

At each trophic level, only about 10% of the energy is transferred to the next level. Therefore, a food chain with fewer trophic levels (2 trophic levels) will be more energy efficient and advantageous, as less energy is lost in transfer.

Q.16 [1 mark]

Consider the following statements about ozone:

(a) Ozone is poisonous gas.

(b) Ozone shields the earth's surface from the infrared radiation from the sun.

(c) Ozone is a product of UV radiations acting on oxygen molecule.

(d) At the lower level of the earth's atmosphere, ozone performs most essential function.

The correct statements are:

(a) (a) and (b)

(b) (a) and (c) <<

(c) (b) and (c)

(d) (b) and (d)

Explanation:

(a) is correct — ozone (O_3) is a poisonous gas.

(c) is correct — ozone is formed when UV radiation acts on oxygen molecules: $3O_2 \rightarrow (UV)\ 2O_3$.

(b) is incorrect — ozone shields from UV radiation, not infrared.

(d) is incorrect — ozone performs its essential UV-shielding function in the upper atmosphere (stratosphere), not at lower levels.

Q.17 [1 mark]

Assertion (A): A piece of Zinc metal gets reddish brown coating when kept in copper sulphate solution for some time.

Reason (R): Copper is more reactive metal than Zinc.

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

(b) Both (A) and (R) are true and (R) is not correct explanation of (A).

(c) (A) is true, but (R) is false. <<

(d) (A) is false, but (R) is true.

Explanation:

Assertion (A) is true: Zinc displaces copper from copper sulphate solution ($Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$), and the deposited copper gives a reddish brown coating.

Reason (R) is false: Zinc is more reactive than copper (not the other way around). That is exactly why zinc can displace copper.

Q.18 [1 mark]

Assertion (A): Offsprings produced by asexual reproduction are genetically similar to the parents.

Reason (R): Asexual reproduction involves a single parent.

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

(b) Both (A) and (R) are true and (R) is not correct explanation of (A).
(c) (A) is true, but (R) is false.
(d) (A) is false, but (R) is true.

Explanation:
Both statements are true.
Asexual reproduction involves only a single parent, and since there is no fusion of gametes from two parents, the offspring are genetically identical (clones) to the parent.
The reason correctly explains the assertion — because only one parent is involved, there is no genetic variation.

Q.19 [1 mark]

Assertion (A): Red light signals are used to stop the vehicles on the road.
Reason (R): Red coloured light is scattered the most so as to be visible from a large distance.

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true and (R) is not correct explanation of (A).
(c) (A) is true, but (R) is false. <<
(d) (A) is false, but (R) is true.

Explanation:
Assertion (A) is true: Red light signals are indeed used to stop vehicles.
Reason (R) is false: Red light is scattered the least (not the most) because it has the longest wavelength.
It is precisely because red light is scattered the least that it can travel the farthest and remain visible from a large distance, making it suitable for danger/stop signals.

Q.20 [1 mark]

Assertion (A): The waste we generate daily may be biodegradable or non-biodegradable.
Reason (R): The waste generated, if not disposed off properly may cause serious environmental problems.

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

(b) Both (A) and (R) are true and (R) is not correct explanation of (A). <<

(c) (A) is true, but (R) is false.

(d) (A) is false, but (R) is true.

Explanation:

Both statements are true.

Daily waste can be biodegradable (food waste, paper) or non-biodegradable (plastics, metals).

Improper disposal can cause environmental problems.

However, (R) does not explain (A) — the reason talks about disposal issues, not about why waste is classified as biodegradable or non-biodegradable.

Section B

Very Short Answer Questions (2 marks each)

Q.21 [2 marks]

When magnesium ribbon is burnt in air, an ash of white colour is produced. Write chemical equation for the reaction giving the chemical name of the ash produced. State the type of chemical reaction giving justification for your answer.

Answer: Chemical equation: $2Mg + O_2 \rightarrow 2MgO$

The white ash produced is Magnesium Oxide (MgO).

Type of reaction: Combination reaction (also an oxidation reaction).

Justification: Two reactants (magnesium and oxygen) combine to form a single product (magnesium oxide). It is also an exothermic reaction as heat and light are produced during burning.

Explanation:

When magnesium ribbon burns in air, it combines with oxygen to form magnesium oxide (MgO), which is a white ash.

$2Mg + O_2 \rightarrow 2MgO$.

This is a combination reaction because two substances combine to form one product.

It is also an oxidation reaction as magnesium gains oxygen.

Q.22 [2 marks]

Where are auxins synthesized? How do they promote phototropism?

Answer: Auxins are synthesized at the tip (apex) of the stem/shoot. When light falls on one side of the plant, auxins move to the shaded side. Higher concentration of auxin on the shaded side causes cells on that side to elongate more. This causes the plant to bend towards the light source, a phenomenon called phototropism.

Explanation:

Auxins are plant hormones synthesized at the shoot tip.

In phototropism, when light comes from one direction, auxins migrate to the shaded side of the stem.

The higher auxin concentration on the dark side stimulates greater cell elongation there, causing the stem to curve towards the light.

Q.23 [2 marks]

(a) List any two pairs of visible contrasting characters of garden pea plants used by Mendel for his experiments stating the dominant and recessive characters in each pair.

OR

(b) In human beings, the probability of getting a male or a female child is 50%. Explain with the help of a flow diagram only.

Answer: (a) Two pairs of contrasting characters:

1. Stem height: Tall (dominant) vs Dwarf (recessive)

2. Seed shape: Round (dominant) vs Wrinkled (recessive)

Other valid pairs: Seed colour (Yellow-dominant vs Green-recessive), Flower colour (Purple-dominant vs White-recessive), Pod shape (Inflated-dominant vs Constricted-recessive), Pod colour (Green-dominant vs Yellow-recessive), Flower position (Axial-dominant vs Terminal-recessive).

OR

(b) Father: XY, Mother: XX

Father produces two types of sperms: X and Y

Mother produces one type of eggs: X

Cross: X (from mother) + X (from father) = XX (Female child)

X (from mother) + Y (from father) = XY (Male child)

Since there is equal probability of X or Y sperm fertilizing the egg, the probability of male or female child is 50% each.

Explanation:

(a) Mendel used 7 pairs of contrasting characters.

Any two valid pairs with correct dominant/recessive identification are acceptable.

(b) Sex determination in humans depends on the father's sperm.

XX = female, XY = male.

Since father produces X and Y sperms in equal proportion, probability is 50% for each sex.

OR

Q.23 [2 marks]

In human beings, the probability of getting a male or a female child is 50%. Explain with the help of a flow diagram only.

Answer: Father: XY, Mother: XX

Father produces two types of sperms: X and Y (in equal proportion)

Mother produces one type of eggs: X

Flow diagram:

Father (XY) → Sperm X or Sperm Y

Mother (XX) → Egg X

Sperm X + Egg X = XX (Female child) — 50% probability

Sperm Y + Egg X = XY (Male child) — 50% probability

Thus, the probability of getting a male or female child is equal (50% each).

Explanation:

Sex determination in humans: Males have XY chromosomes and produce X and Y type sperms in equal numbers.

Females have XX chromosomes and produce only X type eggs.

When X sperm fertilizes egg → XX (girl).

When Y sperm fertilizes egg → XY (boy).

Probability is 50% for each.

Q.24 [2 marks]

When do we say that a particular person is suffering from hypermetropia? List two causes of this defect. Name the type of lens used to correct this defect.

Answer: Hypermetropia (long-sightedness/far-sightedness) is a defect of vision in which a person can see distant objects clearly but cannot see nearby objects clearly. The image of a nearby object is formed behind the retina.

Two causes:

1. The focal length of the eye lens becomes too long (eye lens becomes too thin/flat).
2. The eyeball becomes too short (shortening of the eyeball).

Correction: A convex lens (converging lens) of appropriate power is used to correct this defect.

Explanation:

In hypermetropia, the near point of the eye shifts farther away from the normal 25 cm.

Nearby objects appear blurred because the image forms behind the retina.

Causes include the eye lens being too thin or the eyeball being too short.

A convex lens converges the light rays before they enter the eye, bringing the image back onto the retina.

Q.25 [2 marks]

(a) Draw a labelled diagram to show the pattern of magnetic field lines produced due to a current carrying straight conductor. Mark on it the direction of current in the conductor and the direction of magnetic field lines.

OR

(b) Name the device used to magnetise a piece of magnetic material. Draw a labelled diagram to show the arrangement used for the magnetisation of a cylinder made of soft iron.

Answer: (a) The magnetic field lines around a current-carrying straight conductor are concentric circles centred on the wire. The direction of field lines can be determined by the right-hand thumb rule: if the thumb points in the direction of current, the curled fingers give the direction of magnetic field lines. The diagram should show: a straight conductor (wire) with current direction marked, concentric circular field lines around it with arrows showing their direction.

OR

(b) The device used is a solenoid (electromagnet). A solenoid carrying current acts as a magnet. To magnetise a soft iron cylinder, it is placed inside a solenoid (coil of insulated wire). When current flows through the solenoid, the soft iron cylinder gets magnetised. The labelled diagram should show: a solenoid (coil), battery, switch, soft iron cylinder inside the coil.

Explanation:

(a) Magnetic field lines around a straight current-carrying conductor are concentric circles.

Direction follows right-hand thumb rule.

(b) A solenoid connected to a battery is used for magnetisation.
When the soft iron cylinder is placed inside the solenoid carrying current, it becomes a magnet.

OR

Q.25 [2 marks]

Name the device used to magnetise a piece of magnetic material. Draw a labelled diagram to show the arrangement used for the magnetisation of a cylinder made of soft iron.

Answer: The device used is a solenoid (electromagnet). A solenoid is a coil of many turns of insulated copper wire. When current flows through the solenoid, it produces a strong magnetic field inside it. To magnetise a soft iron cylinder, it is placed inside the solenoid. The labelled diagram should show: a solenoid (coil of wire), battery/cell, switch, ammeter, and the soft iron cylinder placed inside the coil.

Explanation:
A solenoid carrying direct current acts as a strong magnet.
When a soft iron bar/cylinder is placed inside, it gets magnetised by the magnetic field of the solenoid.
The magnetisation lasts as long as current flows (temporary magnet for soft iron).

Q.26 [2 marks]

What are decomposers? List two consequences of their absence in an ecosystem.

Answer: Decomposers are micro-organisms (bacteria, fungi) that break down the dead remains and waste products of organisms into simpler substances. They help in the recycling of nutrients.

Two consequences of absence of decomposers:

1. Dead bodies of plants and animals would pile up and not be broken down, leading to accumulation of organic waste.
2. Nutrients would not be recycled back into the soil, making the soil infertile and eventually disrupting the entire food chain/ecosystem.

Explanation:

Decomposers break down complex organic matter from dead organisms into simpler inorganic substances that are returned to the soil.
Without them: (1) dead matter would accumulate, (2) nutrient cycling would stop, soil would lose fertility, and ecosystems would collapse.

Section C

Short Answer Questions (3 marks each)

Q.27 [3 marks]

State reasons for the following:
(a) Zinc oxide is an amphoteric oxide.
(b) Sodium metal is stored in bottle filled with kerosene oil.
(c) In the reactions of nitric acid with metals, generally hydrogen gas is not evolved.

Answer: (a) Zinc oxide (ZnO) is amphoteric because it reacts with both acids and bases to form salt and water:
$ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$ (reacts with acid)
$ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$ (reacts with base)

(b) Sodium is a highly reactive metal that reacts vigorously with oxygen and moisture in air. It catches fire when exposed to air. Kerosene oil prevents contact with air and moisture, keeping sodium safe.

(c) Nitric acid (HNO_3) is a strong oxidising agent. The hydrogen gas (H_2) produced during the reaction is immediately oxidised to water (H_2O) by nitric acid. Hence, H_2 gas is not evolved. Exception: Magnesium and manganese react with very dilute

HNO_3 to evolve H_2 gas.

Explanation:

(a) ZnO shows both acidic and basic properties, reacting with both acids and bases.

(b) Sodium is highly reactive with air and moisture, so it is stored in kerosene to prevent reaction.

(c) HNO_3 is a strong oxidising agent that oxidises H_2 to H_2O.

Q.28 [3 marks]

(a) State giving reason the reduction process to obtain the following metals from their compounds:

(i) Mercury

(ii) Copper

(iii) Sodium

OR

(b) State giving reason for the change in appearance observed when each of the following metal is exposed to atmospheric air for some time:

(i) Silver

(ii) Copper

(iii) Iron

Answer: (a) (i) Mercury: Mercury is a low-reactivity metal (below copper in reactivity series). Its oxide (HgO) can be reduced by simply heating: $2HgO \rightarrow (\Delta) 2Hg + O_2$. Heating alone is sufficient.

(ii) Copper: Copper is low in the reactivity series, so it can be obtained from its ore without a strong reducing agent. Cu_2S is roasted in air to give Cu_2O, and Cu_2O reacts with the remaining Cu_2S to give copper: $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$. (Copper oxide can also be reduced by heating with carbon: $CuO + C \rightarrow Cu + CO$.)

(iii) Sodium: Sodium is a highly reactive metal (top of reactivity series). It cannot be reduced by carbon or heat. Electrolytic reduction is used: NaCl is electrolysed

in molten state to obtain sodium metal.

OR

(b) (i) Silver: Silver reacts with hydrogen sulphide (H_2S) in air and forms a black coating of silver sulphide (Ag_2S). This is called tarnishing.
(ii) Copper: Copper reacts with moist air (containing CO_2) and forms a green coating of basic copper carbonate [$CuCO_3.Cu(OH)_2$]. This is called corrosion of copper.
(iii) Iron: Iron reacts with oxygen and moisture in air to form a reddish-brown coating of hydrated iron oxide ($Fe_2O_3.xH_2O$), commonly known as rust.

Explanation:
(a) The method of reduction depends on the metal's position in the reactivity series: low reactivity metals (Hg) by heating alone, medium reactivity (Cu) by reduction with carbon, high reactivity (Na) by electrolysis.

(b) Metals corrode differently: Silver turns black (Ag_2S), Copper turns green (basic copper carbonate), Iron turns reddish-brown (rust/hydrated iron oxide).

OR

Q.28 [3 marks]

State giving reason for the change in appearance observed when each of the following metal is exposed to atmospheric air for some time:
(i) Silver
(ii) Copper
(iii) Iron

Answer: (i) Silver: Silver reacts with hydrogen sulphide (H_2S) present in air and forms a black coating of silver sulphide (Ag_2S). This is called tarnishing of silver.
(ii) Copper: Copper reacts with moist air containing CO_2 and forms a green coating of basic copper carbonate [$CuCO_3.Cu(OH)_2$].
(iii) Iron: Iron reacts with oxygen and moisture in air to form a reddish-brown flaky

coating of hydrated iron oxide ($Fe_2O_3.xH_2O$), commonly known as rust.

Explanation:

All three metals undergo corrosion when exposed to atmospheric air.

Silver tarnishes to black (Ag_2S), copper develops green patina (basic copper carbonate), and iron forms reddish-brown rust (hydrated iron oxide).

Q.29 [3 marks]

We water the soil but it reaches the topmost leaves of the plants. Explain in brief the process involved.

Answer: The process involved is transpiration pull (also called ascent of sap). The steps are:

1. Roots absorb water from the soil by osmosis through root hair cells.
2. Water moves from root hair cells to the xylem vessels in the root through osmosis.
3. A continuous column of water is maintained in the xylem vessels from root to leaves.
4. Transpiration (evaporation of water) occurs from the stomata on the leaf surface.
5. This loss of water from leaves creates a suction force (transpiration pull) that pulls water upward through the xylem.
6. The cohesion of water molecules and adhesion to xylem walls helps maintain the continuous water column.

Thus, the transpiration pull created by evaporation of water from leaves is the main driving force that pulls water from roots to the topmost leaves.

Explanation:

Water transport in plants from roots to leaves is driven by transpiration pull.

Water is absorbed by root hairs via osmosis, transported through xylem vessels, and the suction force created by transpiration (water loss from leaf stomata) pulls the water column upward against gravity.

Q.30 [3 marks]

(a) List two constituents of Central Nervous System (CNS). How are these components protected from injuries?

(b) Write two limitations of the use of electrical impulses.

Answer: (a) Two constituents of CNS: Brain and Spinal cord.

Protection:

- Brain is protected by the cranium (skull/bony box) and cerebrospinal fluid.
- Spinal cord is protected by the vertebral column (backbone) and cerebrospinal fluid.

The fluid (cerebrospinal fluid) acts as a shock absorber.

(b) Two limitations of electrical impulses (nervous control):

1. Electrical impulses reach only those cells that are connected by nerve cells. Not all cells can be reached.
2. Once the electrical impulse is generated and transmitted, the cell takes time to reset its mechanisms before another impulse can be generated. This means the response is short-lived and cannot be sustained for long periods.

Explanation:

(a) CNS = Brain + Spinal cord.

Brain is protected by skull (cranium) and CSF.

Spinal cord is protected by vertebral column and CSF.

(b) Limitations of electrical (nervous) transmission: limited to nerve-connected cells and responses are not sustained/long-lasting.

Q.31 [3 marks]

Name and explain the phenomenon of light due to which the path of a beam of light becomes visible when it enters a smoke filled room through a small hole. Also state the dependence of colour of the light we receive on the size of the particle of the medium through which the beam of light passes.

Answer: The phenomenon is called Tyndall Effect. When a beam of light enters a

smoke-filled room through a small hole, the path of light becomes visible because the smoke particles scatter the light. The smoke particles are large enough to scatter all wavelengths of light, making the beam visible.

Dependence on particle size:

- When the particles are very fine (much smaller than the wavelength of light), shorter wavelengths (blue) are scattered more than longer wavelengths (red). This is Rayleigh scattering.
- When the particles are larger (comparable to or larger than the wavelength of light), all wavelengths are scattered almost equally, and the scattered light appears white.

Explanation:

The Tyndall effect is the scattering of light by colloidal/suspended particles.

Smoke particles scatter the light beam making it visible.

The colour of scattered light depends on particle size: fine particles scatter shorter wavelengths (blue) preferentially, while larger particles scatter all colours equally (white light).

Q.32 [3 marks]

Explain in brief the function of an electric fuse in a domestic circuit. An electric heater of current rating 3 kW; 220 V is to be operated in an electric circuit of rating 5 A. What is likely to happen when the heater is switched 'ON'? Justify your answer with necessary calculation.

Answer: Function of electric fuse: An electric fuse is a safety device that protects electrical circuits and appliances from damage due to overloading or short circuits. It contains a wire made of an alloy of tin and lead with low melting point. When current exceeds the rated value, the fuse wire melts and breaks the circuit.

Calculation:

Power of heater (P) = 3 kW = 3000 W

Voltage (V) = 220 V

Current drawn by heater: I = P/V = 3000/220 = 13.6 A

Since the circuit has a rating of only 5 A, and the heater draws 13.6 A (which is much greater than 5 A), the fuse will blow (melt) when the heater is switched ON. The circuit will break and the heater will not work. This prevents damage to the wiring and potential fire hazard.

Explanation:

The fuse protects against overcurrent.

The heater draws I = P/V = 3000/220 = 13.6 A, which exceeds the 5 A circuit rating.

So the fuse will melt/blow, breaking the circuit and preventing damage.

Q.33 [3 marks]

(a) State Ohm's law. Write formula for the equivalent resistance R_p of the parallel combination of three resistors of values R_1, R_2 and R_3.

(b) Find the resistance of the following network of resistors:

[A circuit diagram showing three resistors, each of resistance R: one in series on top, and two in parallel (one on top, one on bottom) between points X and Y]

Answer: (a) Ohm's Law: At constant temperature, the current flowing through a conductor is directly proportional to the potential difference across its ends. V = IR, where V is potential difference, I is current, and R is resistance.

For parallel combination: $1/R_p = 1/R_1 + 1/R_2 + 1/R_3$

(b) From the circuit diagram: Two resistors R are in parallel between two nodes, and one resistor R is in series with this parallel combination.

Parallel combination of two R resistors: 1/R_parallel = 1/R + 1/R = 2/R, so R_parallel = R/2.

Total resistance = R (series) + R/2 (parallel) = 3R/2.

Explanation:

(a) Ohm's law: V = IR.

Parallel formula: $1/R_p = 1/R_1 + 1/R_2 + 1/R_3$.

(b) Two R resistors in parallel give R/2, which is in series with the third R resistor, giving total = R + R/2 = 3R/2.

Section D

Long Answer Questions (5 marks each)

Q.34 [5 marks]

(a) (i) Five solutions A, B, C, D and E when tested with pH paper showed pH as 4, 1, 13, 7 and 10 respectively. Which solution is:

(1) Strongly acidic (2) Strongly alkaline (3) Weakly acidic (4) Neutral and (5) Weakly alkaline? Arrange the solutions in increasing order of H^+ ion concentration.

(ii) Write the name and formula of (1) an acidic salt and (2) a basic salt, giving the name of the parent acid and parent base used to form the salt in each case.

OR

(b) Name and state in brief the process which is used to prepare sodium hydroxide from sodium chloride. In this process along with the main product two gases 'X' and 'Y' are also given off at the two electrodes. Name 'X' and 'Y' specifying the name of their respective electrode at which each gas is obtained. One of these gases when reacts with dry calcium hydroxide produces a compound 'Z' which is widely used in water treatment plants and textile industries. Name Z and write chemical equation for the reaction involved in its formation.

Answer: (a) (i) pH 1 = B = Strongly acidic

pH 4 = A = Weakly acidic

pH 7 = D = Neutral

pH 10 = E = Weakly alkaline
pH 13 = C = Strongly alkaline

Increasing order of H^+ ion concentration: C < E < D < A < B (lower pH = higher H^+ concentration)

(ii) (1) Acidic salt: Sodium hydrogen sulphate ($NaHSO_4$). Parent acid: Sulphuric acid (H_2SO_4). Parent base: Sodium hydroxide (NaOH).
(2) Basic salt: Sodium carbonate (Na_2CO_3). Parent acid: Carbonic acid (H_2CO_3). Parent base: Sodium hydroxide (NaOH).

OR

(b) The process is Chlor-alkali process (Electrolysis of brine/concentrated NaCl solution).
$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$
X = Chlorine gas (Cl_2) — obtained at the anode (positive electrode)
Y = Hydrogen gas (H_2) — obtained at the cathode (negative electrode)
Z = Bleaching powder (Calcium hypochlorite) — $CaOCl_2$
Reaction: $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$

Explanation:
(a)(i) pH scale: lower pH = more acidic, higher pH = more basic.
H^+ concentration is inversely related to pH.
(a)(ii) Acidic salts have replaceable H^+ ions; basic salts have replaceable OH^- ions.

(b) Chlor-alkali process electrolyses brine to give NaOH, Cl_2 (anode), H_2 (cathode).
$Cl_2 + Ca(OH)_2 \rightarrow CaOCl_2$ (bleaching powder) + H_2O.

OR

Q.34 [5 marks]

Name and state in brief the process which is used to prepare sodium

hydroxide from sodium chloride. In this process along with the main product two gases 'X' and 'Y' are also given off at the two electrodes. Name 'X' and 'Y' specifying the name of their respective electrode at which each gas is obtained. One of these gases when reacts with dry calcium hydroxide produces a compound 'Z' which is widely used in water treatment plants and textile industries. Name Z and write chemical equation for the reaction involved in its formation.

Answer: The process is Chlor-alkali process — Electrolysis of brine (concentrated sodium chloride solution).

$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$

Gas X = Chlorine gas (Cl_2) — produced at the anode (positive electrode)

Gas Y = Hydrogen gas (H_2) — produced at the cathode (negative electrode)

Compound Z = Bleaching powder (Calcium oxychloride / Calcium hypochlorite) — $CaOCl_2$

It is used in water treatment plants (for disinfection) and textile industries (for bleaching).

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

(Dry calcium hydroxide + Chlorine gas → Bleaching powder + Water)

Explanation:

Chlor-alkali process produces NaOH by electrolysing brine.

Cl_2 at anode, H_2 at cathode.

Chlorine reacts with dry slaked lime to form bleaching powder ($CaOCl_2$), used in water purification and textile bleaching.

Q.35 [5 marks]

(a) (i) What are spores? On which structures are they formed? How do they overcome unfavourable conditions? Name the organism which multiplies

with the help of these structures.
(ii) Give two reasons why some plants are grown by the method of vegetative propagation. List two methods used to grow plants vegetatively.

OR

(b) (i) Study the diagram given below and name the parts marked as A, B and C. What happens when B reaches C in the ovary? Mention its significance.
(ii) Write the post fertilisation changes that occur in a flower.

Answer: (a) (i) Spores are small, rounded, thick-walled reproductive structures that are formed on the top of thread-like structures called sporangia (on hyphae). They can survive unfavourable conditions because they are covered by thick protective walls that protect them from extreme temperature and desiccation. When conditions become favourable, they germinate and grow into new organisms. Organism: Rhizopus (bread mould).

(ii) Two reasons for vegetative propagation:
1. Plants that do not produce viable seeds can be grown by this method.
2. Plants grown by vegetative propagation bear flowers and fruits earlier than those grown from seeds.
Other reasons: exact genetic copies (clones) of parent plant, desirable characters are preserved.

Two methods: Cutting (e.g., rose), Layering (e.g., jasmine), Grafting (e.g., mango), Budding.

OR

(b) (i) A = male germ cell (male gamete / sperm nucleus) travelling in the pollen

tube, B = pollen tube, C = female germ cell (egg) inside the ovule.
When the pollen tube (B) reaches the ovule in the ovary, it releases the male germ cell, which fuses with the female germ cell (egg) at C. This is fertilisation and it forms the zygote.
Significance: the zygote develops into the embryo, so the species continues; the fusion of gametes from two parents brings variation.

(ii) Post-fertilisation changes in a flower:
1. Zygote divides repeatedly to form an embryo within the ovule.
2. Ovule develops into a seed (containing the embryo).
3. Ovary enlarges and develops into a fruit; the ovary wall becomes the fruit wall (pericarp).
4. Sepals, petals, stamens, style and stigma wither and fall off.

Explanation:
(a)(i) Spores are reproductive units with thick walls formed in sporangia, used by Rhizopus.
(a)(ii) Vegetative propagation is used for seedless plants and faster fruit bearing; methods include cutting, layering, grafting.
(b)(i) Parts of flower: pollen, pollen tube, ovule.
Fertilisation occurs when pollen tube reaches ovule.
(b)(ii) After fertilisation: ovule becomes seed, ovary becomes fruit.

OR

Q.35 [5 marks]

(i) Study the diagram given below and name the parts marked as A, B and C. What happens when B reaches C in the ovary? Mention its significance.
(ii) Write the post fertilisation changes that occur in a flower.

Answer: (i) A = male germ cell (male gamete / sperm nucleus) travelling in the pollen tube, B = pollen tube, C = female germ cell (egg) inside the ovule.
When the pollen tube (B) reaches the ovule in the ovary, it releases the male germ cell, which fuses with the female germ cell (egg) at C. This is fertilisation and

it forms the zygote.

Significance: the zygote develops into the embryo, so the species continues; the fusion of gametes from two parents brings variation.

(ii) Post-fertilisation changes in a flower:

1. Zygote divides repeatedly to form an embryo within the ovule.
2. Ovule develops into a seed (containing the embryo).
3. Ovary enlarges and develops into a fruit; the ovary wall becomes the fruit wall (pericarp).
4. Sepals, petals, stamens, style and stigma wither and fall off.

Explanation:

After pollination, pollen tube grows from stigma to ovule.

Fertilisation (fusion of male and female gametes) occurs in the ovule.

Post-fertilisation: ovule → seed, ovary → fruit, other floral parts wither.

Q.36 [5 marks]

(a) (i) Draw a ray diagram to show the path of the refracted ray in each of the following cases:

A ray of light incident on a concave lens

(1) parallel to its principal axis, and

(2) is directed towards its principal focus.

(ii) A 4 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 24 cm. The distance of object from the lens is 16 cm. Find the position and size of image formed.

OR

(b) (i) Draw a ray diagram to show the path of the reflected ray in each of the following cases:

A ray of light incident on a convex mirror

(1) parallel to its principal axis, and

(2) is directed towards its principal focus.

(ii) A 1.5 cm tall candle flame is placed perpendicular to the principal axis of a concave mirror of focal length 12 cm. If the distance of the flame from the pole of the mirror is 18 cm, use mirror formula to determine the position and size of the image formed.

Answer: (a) (i) Ray diagram for concave lens:

(1) A ray parallel to the principal axis, after refraction through a concave lens, appears to diverge from the principal focus (F) on the same side as the incident ray.

(2) A ray directed towards the principal focus of a concave lens, after refraction, emerges parallel to the principal axis.

(ii) Given: h = 4 cm, f = +24 cm (convex lens), u = -16 cm

Using lens formula: $1/v - 1/u = 1/f$

$1/v = 1/f + 1/u = 1/24 + 1/(-16) = 1/24 - 1/16 = (2-3)/48 = -1/48$

$v = -48$ cm

The image is formed 48 cm on the same side as the object (virtual image).

Magnification: $m = v/u = -48/(-16) = 3$

Image height: $h' = m \times h = 3 \times 4 = 12$ cm

The image is virtual, erect, and enlarged (12 cm tall), formed 48 cm from the lens on the same side as the object.

OR

(b) (i) Ray diagram for convex mirror:

(1) A ray parallel to the principal axis, after reflection from a convex mirror, appears to diverge from the principal focus (F) behind the mirror.

(2) A ray directed towards the principal focus of a convex mirror, after reflection,

emerges parallel to the principal axis.

(ii) Given: h = 1.5 cm, f = -12 cm (concave mirror), u = -18 cm
Using mirror formula: 1/v + 1/u = 1/f
1/v = 1/f - 1/u = 1/(-12) - 1/(-18) = -1/12 + 1/18 = (-3+2)/36 = -1/36
v = -36 cm
The image is formed 36 cm in front of the mirror (real image).

Magnification: m = -v/u = -(-36)/(-18) = -2
Image height: h' = m × h = -2 × 1.5 = -3 cm
The image is real, inverted, and enlarged (3 cm tall), formed 36 cm in front of the mirror.

Explanation:
(a)(i) Concave lens ray diagrams follow standard rules.
(a)(ii) Lens formula gives v = -48 cm (virtual), m = 3, h' = 12 cm.

(b)(i) Convex mirror ray diagrams.
(b)(ii) Mirror formula gives v = -36 cm (real), m = -2, h' = -3 cm (inverted, real, magnified).

OR

Q.36 [5 marks]

(i) Draw a ray diagram to show the path of the reflected ray in each of the following cases:
A ray of light incident on a convex mirror
(1) parallel to its principal axis, and
(2) is directed towards its principal focus.
(ii) A 1.5 cm tall candle flame is placed perpendicular to the principal axis of a concave mirror of focal length 12 cm. If the distance of the flame from the pole of the mirror is 18 cm, use mirror formula to determine the position and size of the image formed.

Answer: (i) Convex mirror ray diagram:

(1) A ray parallel to the principal axis, after reflection, appears to diverge from the focus (F) behind the mirror. The reflected ray diverges but appears to come from F.

(2) A ray directed towards the focus (F) behind the convex mirror, after reflection, emerges parallel to the principal axis.

(ii) Given: h = 1.5 cm, f = -12 cm, u = -18 cm

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

$1/v = 1/f - 1/u = (-1/12) - (-1/18) = -1/12 + 1/18 = (-3+2)/36 = -1/36$

$v = -36$ cm

The image is formed at 36 cm in front of the mirror (real image, same side as the object).

Magnification: $m = -v/u = -(-36)/(-18) = 36/(-18) = -2$

Image height: $h' = m \times h = -2 \times 1.5 = -3$ cm

The image is real, inverted, magnified, and 3 cm tall, formed 36 cm in front of the concave mirror.

Explanation:

Convex mirror always forms virtual, erect, diminished images for real objects.

For the concave mirror numerical: using $1/v + 1/u = 1/f$ with proper sign convention gives v = -36 cm (real image), magnification = -2, image height = 3 cm (inverted).

Q.37(a) [4 marks]

Case Study: More than three million carbon compounds have been discovered in the field of chemistry. The diversity of these compounds is due to the capacity of carbon atoms for bonding with one another as well as with other atoms. Most of the carbon compounds are poor conductors of

electricity and have low melting and boiling points.

Write the molecular formula of first two members of homologous series having functional group –Br.

Answer: The homologous series with functional group –Br is the haloalkane (bromoalkane) series.

First member: CH_3Br (Bromomethane / Methyl bromide)

Second member: C_2H_5Br (Bromoethane / Ethyl bromide)

Explanation:

Bromoalkanes have the general formula C_nH_{2}_n_{+1}Br.

First member (n=1): CH_3Br, Second member (n=2): C_2H_5Br.

Q.37(b) [4 marks]

Case Study (continued):

Given below are the formulae of some functional groups:

(i) –C(=O)–H

(ii) –C(=O)–

Write the name of these functional groups.

Answer: (i) –CHO (–C(=O)–H) is the Aldehyde functional group.

(ii) –C(=O)– is the Ketone functional group (also called carbonyl group when between two carbon atoms).

Explanation:

(i) The –CHO group is the aldehyde functional group, found in compounds like methanal (formaldehyde) and ethanal (acetaldehyde).

(ii) The –CO– group (C=O between two carbons) is the ketone functional group, found in compounds like propanone (acetone).

Q.37(c) [4 marks]

Case Study (continued):

(i) What would be observed on adding a 5% alkaline potassium

permanganate drop by drop to some warm ethanol taken in a test tube? State the role of $KMnO_4$ in the reaction and write the chemical equation for the reaction involved.

OR

(ii) Write the name of the compound formed when ethanol is heated at 443 K temperature with excess of conc. H_2SO_4. What is the role of conc. H_2SO_4 in the reaction? Write chemical equation for the reaction involved.

Answer: (i) Observation: The purple/pink colour of potassium permanganate ($KMnO_4$) gets decolourised as it is added drop by drop to warm ethanol.

Role of $KMnO_4$: It acts as an oxidising agent. It supplies oxygen for oxidation of ethanol to ethanoic acid (acetic acid).

Chemical equation: $CH_3CH_2OH + 2[O] \rightarrow$(alkaline $KMnO_4$) $CH_3COOH + H_2O$

(Ethanol is oxidised to Ethanoic acid)

OR

(ii) The compound formed is Ethene (C_2H_4).

Role of conc. H_2SO_4: It acts as a dehydrating agent (removes water from ethanol).

Chemical equation: $CH_3CH_2OH \rightarrow$(conc. H_2SO_4, 443 K) $CH_2{=}CH_2 + H_2O$

(Ethanol undergoes dehydration to form Ethene and water)

This is a dehydration reaction (elimination reaction).

Explanation:

(i) $KMnO_4$ oxidises ethanol to ethanoic acid; its purple colour is decolourised.

(ii) Conc. H_2SO_4 dehydrates ethanol at 443 K to form ethene ($CH_2{=}CH_2$).

OR

Q.37(c) [4 marks]

Case Study (continued):

Write the name of the compound formed when ethanol is heated at 443 K temperature with excess of conc. H_2SO_4. What is the role of conc. H_2SO_4 in the reaction? Write chemical equation for the reaction involved.

Answer: The compound formed is Ethene (C_2H_4).

Role of conc. H_2SO_4: It acts as a dehydrating agent — it removes water from ethanol.

Chemical equation:

$CH_3CH_2OH \rightarrow$(conc. H_2SO_4, 443 K) $CH_2=CH_2 + H_2O$

(Ethanol → Ethene + Water)

This is a dehydration reaction (type of elimination reaction).

Explanation:

Heating ethanol with excess concentrated sulphuric acid at 443 K (170°C) causes dehydration of ethanol to form ethene gas and water.

H_2SO_4 acts as a dehydrating agent.

Q.38(a) [4 marks]

Case Study: Human digestive system is a tube running from mouth to anus. Its main function is to breakdown complex molecules present in the food which cannot be absorbed as such into smaller molecules. These molecules are absorbed across the walls of the tube and the absorbed food reaches each and every cell of the body where it is utilised for obtaining energy.

Name the glands present in the buccal cavity and write the components of food on which the secretion of these glands act upon.

Answer: The glands present in the buccal cavity are Salivary glands. There are three pairs of salivary glands.

Their secretion (saliva) contains an enzyme called salivary amylase (ptyalin).

Salivary amylase acts upon starch (a complex carbohydrate) and breaks it down

into maltose (sugar).

Starch →(salivary amylase) Maltose

Explanation:

Salivary glands in the buccal cavity secrete saliva containing salivary amylase enzyme, which digests starch (carbohydrates) into simpler sugars (maltose).

Q.38(b) [4 marks]

Case Study (continued):

Two organs have a sphincter muscle at their exit. Name them.

Answer: The two organs with sphincter muscles at their exit are:

1. Stomach — has the pyloric sphincter at its exit (regulates the release of food into the small intestine).

2. Small intestine (ileum) / Large intestine (rectum) — has the anal sphincter at the exit (anus), which controls the elimination of undigested food.

Alternatively: Stomach (pyloric sphincter) and Rectum/Anus (anal sphincter).

Explanation:

Sphincter muscles are ring-shaped muscles that control the passage of food.

The pyloric sphincter is at the exit of the stomach, and the anal sphincter is at the exit of the rectum/large intestine.

Q.38(c) [4 marks]

Case Study (continued):

What will happen if:

(i) mucus is not secreted by the gastric glands.

(ii) Villi are absent in the small intestine.

OR

"Bile juice does not contain any enzyme, yet it has important roles in

digestion." Justify the statement.

Answer: (i) If mucus is not secreted by gastric glands: The hydrochloric acid (HCl) secreted by the gastric glands would damage/erode the inner lining (mucous membrane) of the stomach. This would lead to ulcers in the stomach wall. Mucus protects the stomach lining from the corrosive action of HCl.

(ii) If villi are absent in the small intestine: The surface area for absorption of digested food would be greatly reduced. This would result in poor/slow absorption of nutrients into the blood. The body would not get adequate nutrition despite eating food.

OR

Bile juice (secreted by liver, stored in gall bladder) does not contain any enzyme but plays important roles:
1. Bile salts break down large fat globules into smaller globules (emulsification of fats), increasing the surface area for enzyme action by lipase.
2. Bile juice makes the medium in the small intestine alkaline, which is necessary for the action of pancreatic enzymes.
Thus, bile juice aids in the digestion of fats even without containing any enzyme.

Explanation:
(i) Without mucus, HCl would corrode the stomach lining, causing ulcers.
(ii) Without villi, absorption surface area decreases drastically, leading to poor nutrient absorption.
OR: Bile emulsifies fats (increases surface area for lipase) and provides alkaline medium for intestinal enzymes.

OR

Q.38(c) [4 marks]

Case Study (continued):
"Bile juice does not contain any enzyme, yet it has important roles in

digestion." Justify the statement.

Answer: Bile juice is secreted by the liver and stored in the gall bladder. Although it does not contain any digestive enzyme, it plays two important roles in digestion:

1. Emulsification of fats: Bile salts present in bile juice break down large fat globules into smaller fat droplets. This process is called emulsification. It increases the surface area of fats, making it easier for the enzyme lipase to act on them.

2. Making the medium alkaline: Bile juice makes the acidic food (coming from the stomach) alkaline. This alkaline medium is necessary for the pancreatic enzymes (trypsin, lipase, amylase) to function properly in the small intestine.

Thus, bile juice facilitates fat digestion and creates optimal conditions for enzymatic action, even though it contains no enzymes itself.

Explanation:

Bile from the liver has no enzymes but emulsifies fats (breaking large globules into small droplets for lipase to act) and makes the intestinal medium alkaline for pancreatic enzyme function.

Q.39(a) [4 marks]

Case Study: In a domestic circuit five LED bulbs are arranged as shown. The source voltage is 220 V and the power rating of each bulb is marked in the circuit diagram. Based on the following circuit diagram, answer the following questions:

[Circuit diagram: a battery (220 V source) with an ammeter. The positive lead goes to a two-contact key with contacts K_1 and K_2. K_1 connects to bulb A (22 W, 220 V), which returns to the negative terminal. K_2 connects to four bulbs B, C, D and E joined in series (each marked 11 W; 55 V), which return to the negative terminal.]

State what happens when: (i) key K_1 is closed. (ii) key K_2 is closed.

Answer: (i) When K_1 is closed: only bulb A glows (it gets the full 220 V, its rated voltage). Bulbs B, C, D and E do not glow because K_2 is open.
(ii) When K_2 is closed: bulbs B, C, D and E (in series) glow, each with 55 V across it (4 × 55 V = 220 V), i.e. at their rated voltage. Bulb A does not glow because K_1 is open.

Explanation:
K_1 completes the circuit through bulb A only;
K_2 completes it through the series chain B–C–D–E (4 × 55 V = 220 V).

Q.39(b) [4 marks]

Case Study (continued):
Find the current drawn by the bulb B when it glows.

Answer: Bulbs B, C, D and E are in series, so the same current flows through each.
For bulb B: P = 11 W, V = 55 V
I = P/V = 11/55 = 0.2 A

Explanation:
Series chain, so one current. I = P/V = 11 W / 55 V = 0.2 A.

Q.39(c) [4 marks]

Case Study (continued):
Calculate:
(i) the resistance of bulb B, and
(ii) total resistance of the combination of four bulbs B, C, D and E.

OR

What would happen to the glow of all the bulbs in the circuit when keys K_1

and K_2 both are closed and the bulb C suddenly get fused? Give reason to justify your answer.

Answer: (i) Resistance of bulb B: $R = V^2/P = (55)^2/11 = 3025/11 = 275\ \Omega$

(ii) B, C, D, E are identical and in series:

$R_{total} = 4 \times 275 = 1100\ \Omega$

(Check: 220 V / 0.2 A = 1100 Ω)

OR

When K_1 and K_2 are both closed, bulb A is in one branch and the chain B–C–D–E is in another, both across the 220 V source. If bulb C fuses, the series chain is broken, so B, C, D and E all stop glowing. Bulb A is unaffected and keeps glowing with the same brightness, because it is in its own branch and still has the full 220 V across it.

Explanation:

(i) $R = V^2/P = 55^2/11 = 275\ \Omega$.

(ii) Four 275 Ω bulbs in series = 1100 Ω.

OR: if C fuses, the series chain B–E goes dark;

A in its own parallel branch is unaffected.

OR

Q.39(c) [4 marks]

Case Study (continued):

What would happen to the glow of all the bulbs in the circuit when keys K_1 and K_2 both are closed and the bulb C suddenly get fused? Give reason to justify your answer.

Answer: When K_1 and K_2 are both closed, bulb A (one branch) and the series chain B–C–D–E (other branch) are in parallel across the 220 V source.

If bulb C fuses, the series chain is broken: no current flows through B, C, D or E, so all four stop glowing.

Bulb A is unaffected and glows with the same brightness, because it is in its own

branch and still has the full 220 V across it. Branches in parallel work independently.

Explanation:

Series chain breaks when C fuses (B, C, D, E off);
bulb A, in a parallel branch with 220 V across it, is unaffected.